ASSESSMENT OF THE STRUCTURE AND PERFORMANCE OF THE
MILK VALUE CHAIN IN WESTERN KENYA

BY

SIMON PETER WANJALA OMONDI

A/99/24915/2011

THESIS SUBMITTED TO THE SCHOOL OF AGRICULTURE AND
ENTERPRISE DEVELOPMENT IN FULFILMENT OF THE
REQUIREMENTS FOR THE AWARD OF THE DEGREE OF DOCTOR OF
PHILOSOPHY IN AGRIBUSINESS MANAGEMENT OF KENYATTA
UNIVERSITY

NOVEMBER, 2015
DECLARATION

This thesis is my original work and has not been presented for a degree in any other University or for any other award.

Signature................................................................................ Date..........................

Simon Peter Wanjala Omondi (A99/24915/2011)
Department of Agribusiness Management and Trade

SUPERVISORS

This thesis has been submitted with our approval as the University supervisors:

Signature................................................................................ Date..........................

Prof. Bernard K. Njehia
Department of Agribusiness Management and Trade,
Kenyatta University

Signature................................................................................ Date..........................

Dr. Festus M. Murithi
Kenya Agricultural and Livestock Research Organization,
Nairobi
Completing this thesis has been a challenging task that required dedication and was made possible through the support I received from a number of people. I cannot mention all here but omission should not imply lack of gratitude.

First, I am greatly indebted to my supervisors: Professor Bernard Njehia, Dr Festus Murithi and the late Dr Christopher Ngichabe. Prof Njehia: Your mentorship, guidance and encouragement from the preparation of the proposal, to support for funding, monitoring and evaluation of data collection in Western Kenya, regular feedback on my progress, provided me with the confidence needed to complete the study. Dr Murithi: Thank you for accepting to step in as my supervisor following the untimely demise of Dr. Ngichabe. Your support and useful comments on my progress reports and critical review of the drafts helped me to fine tune this thesis. The late Dr.Ngichabe encouraged me to publish findings of every objective. Indeed the four papers and a policy brief emanating from this research are dedicated to you. Besides being my supervisor you were like a big brother to me, always concerned about my academic and social welfare progress.

Much appreciation to: Dr. E. Bett, Dr. N. Nyairo and Dr. J. Mugwe for support, encouragement and useful feedback received from you and other lecturers in the School of Agriculture and Enterprise Development during seminars on progress reports.

I am very much grateful to KALRO through the East African Agricultural Productivity Project (EAAPP) for providing me with the scholarship and time off to study. In particular, I wish to thank Dr. E.A. Mukisira (Former Director KARI), Dr J.G. Mureithi (Deputy Director-General, KALRO), Dr F.P. Wandera (EAAPP desk officer), Dr. D. M. Mwangi, Mr M. Kivui, Dr. J. M. Mugambi, Dr. J. Nginyi and Mr. B. Onyancha, for their invaluable support.

My appreciation goes to Mr. Elias Thuranira (KARI Kabete) and Philip Siminyu (University of Nairobi) for biometrics assistance. Thanks to my field drivers: Mr. Njoroge, Mr. Ongaya and Mr. Njuguna.

My special thanks to all the field facilitators who supported me during data collection: County Directors of Livestock: Busia (Mr Wafula), Bungoma (Mr. Wechabe), Kakamega (Mr. Anunda) and Vihiga (Mr. Kunzu). To Mr. Agesa (County Dairy officer Kakamega), Mr Namwalo (Kenya Dairy Board), Mr. Buluma (Butula Livestock officer), Mr. Ouko (Butere Livestock Officer), officials of dairy cooperatives, farmer group leaders, all respondents who participated in the study, and of course, the many enumerators who assisted me in collecting data. To all of you, I say thank you very much and may God reward you with abundant blessings.
DEDICATION

To God, Almighty

Who continuously encouraged me to be of good courage and not faint even in times of adversity, with these words: "The steps of a righteous man are ordered by the Lord and he delighteth in his way" (Psalms 37:23). "For promotion neither comes from the East nor West nor South. But its God who judges: He brings one down, he exalts another". (Psalms 75: 6-7). "And the gentiles shall see your righteousness, and all Kings your glory, and you shall be called by a new name, which the mouth of the LORD shall name (Isaiah 62:2). King James Version.

To my family and parents

My family was often in fervent prayer and fasting, especially when funding to continue with field research was not available, you continuously encouraged and joined me in trusting God who makes way where there is no way. I dedicate this thesis to you.

My parents, though they only received little primary level education in the pre independence period of 1940s and 1950s, inspired me to have a vision and always prayed for me since my early childhood, that I may attain the highest standard of education. This thesis is a fulfilment of your desires.
TABLE OF CONTENTS

DECLARATION.......................................................................................................................... ii
ACKNOWLEDGEMENTS........................................................................................................ iii
DEDICATION ........................................................................................................................... iv
TABLE OF CONTENTS ........................................................................................................... v
LIST OF FIGURES .................................................................................................................. xii
LIST OF APPENDICES ........................................................................................................... xiii
OPERATIONAL DEFINITION OF TERMS ............................................................................ xiv
ACRONYMS AND ABBREVIATIONS ..................................................................................... xvii
ABSTRACT ............................................................................................................................. xix

CHAPTER ONE ....................................................................................................................... 1
1 INTRODUCTION ..................................................................................................................... 1
  1.1 Global environment ........................................................................................................ 1
    1.1.1 Linking structure and performance of value chains .............................................. 1
    1.1.2 Kenya Vision 2030 and the dairy industry .............................................................. 2
  1.2 Background to the study ............................................................................................... 3
    1.2.1 Background to study area ..................................................................................... 4
  1.3 Statement of the Problem ............................................................................................. 5
  1.4 Research questions ...................................................................................................... 5
  1.5 Research objectives .................................................................................................... 5
  1.6 Justification/ Significance of study ............................................................................. 6
  1.7 Scope of the study ...................................................................................................... 7
  1.8 Limitations of the study ............................................................................................. 7
  1.9 Organization of the thesis .......................................................................................... 8

CHAPTER TWO ........................................................................................................................ 10
2 LITERATURE REVIEW .......................................................................................................... 10
  2.1 Introduction .................................................................................................................. 10
  2.2 The value chain concept ............................................................................................. 10
    2.2.1 Agricultural value chains ..................................................................................... 12
  2.3 Structure and performance of global milk value chains ............................................. 13
  2.4 Structure and performance of milk Value chain in Sub Saharan Africa .................... 15
  2.5 Structure and performance of milk value chain in Kenya .......................................... 16
    2.5.1 Input supply ........................................................................................................ 16
    2.5.2 Production .......................................................................................................... 17
    2.5.3 Collection, bulking and cooling ........................................................................... 17
3.7.2 Data collection methods ........................................................................................................... 48
3.8 Ethical Issues .................................................................................................................................. 51
3.9 Data management and analysis ....................................................................................................... 51
   3.9.1 Objective 1: Assessment of milk markets .............................................................................. 51
   3.9.2 Objective 2: Assessment of value chain variables influencing milk production and level of commercialization on smallholder farms .............................................................. 52
   3.9.3 Objective 3: Assessment of inefficiencies in the value chain ................................................ 56
   3.9.4 Objective 4: Evaluation of potential upgrading strategy ......................................................... 57

CHAPTER FOUR ....................................................................................................................................... 59
4 RESULTS ............................................................................................................................................... 59

   Introduction ......................................................................................................................................... 59
       4.1 Assessment of the structure and performance of the milk market ............................................ 59
       4.1.1 Market Structure: Suppliers .................................................................................................. 59
       4.1.2 Quantity and Price ............................................................................................................... 60
       4.1.3 Problems associated with the quality of marketed milk ...................................................... 61
       4.1.4 Consumer preferences ........................................................................................................ 62
       4.1.5 Perceptions on milk supply and consumption in Counties .................................................. 64
       4.1.6 Performance of dairy cooperatives ...................................................................................... 66
       4.1.7 SWOT analysis of the milk market ...................................................................................... 69
       4.1.8 Making choices on markets ................................................................................................ 69

   4.2 Variables influencing milk production and level of commercialization ..................................... 71
       4.2.1 Household demographics ..................................................................................................... 71
       4.2.2 Selected farm characteristics .............................................................................................. 72
       4.2.3 Herd characteristics and performance ............................................................................... 73
       4.2.4 Status of value chain variables ........................................................................................... 79
       4.2.5 Strength of relationship between variables and milk yield ................................................. 94
       4.2.6 Multiple linear regression analysis ..................................................................................... 95
       4.2.7 Collective effect of variables after removal of non significant variables ................................ 96
       4.2.8 Stepwise regression analysis ............................................................................................... 97
       4.2.9 Collinearity diagnostics ....................................................................................................... 100
       4.2.10 Ranking of variables using focus group discussions and key informant interviews .......... 101

   4.3 Sources of inefficiencies in the milk value chain ......................................................................... 104
       4.3.1 Input supply ......................................................................................................................... 104
       4.3.2 Sources of inefficiencies in production ............................................................................... 108
4.3.3 Inadequate management and business skills in cooperatives ..........110
4.3.4 Consumption ...........................................................................111
4.3.5 Meso level: Service provision ..................................................111
4.3.6 Macro level: Policy .................................................................112
4.4 Evaluation of Potential upgrading strategy and impact model ........115
  4.4.1 Vision for upgrading the milk value chain in Western Kenya ....116
  4.4.2 Upgrading objectives ..............................................................116
  4.4.3 Implementing actors .................................................................121
  4.4.4 Anticipated impact of model on milk production .................124
4.5 Business case for Western Kenya Region ......................................130
  4.5.1 Addressing the 177 million litres milk deficit .................130
  4.5.2 Cost-Benefit analysis of intervention ........................................130
  4.5.3 Net Present Value .................................................................132
  4.5.4 Cost-Benefit Ratio and Internal Rate of Return ..................132
CHAPTER FIVE .............................................................................133
5 DISCUSSION .............................................................................133
  5.1 Introduction .............................................................................133
  5.2 Structure and Performance of milk market ................................133
    5.2.1 Suppliers and channels ......................................................133
    5.2.2 Performance: Quantity and price ........................................134
    5.2.3 Quality of marketed milk ...................................................135
    5.2.4 Consumer preferences .......................................................136
    5.2.5 Performance of dairy cooperatives in the region .............136
    5.2.6 SWOT analysis of the milk market ....................................138
    5.2.7 Cooperatives as the better option milk buyers ................138
  5.3 Relationships between value chain variables and milk production on smallholder farms .........................................................139
    5.3.1 Household demographics ..................................................139
    5.3.2 Farm characteristics ..........................................................140
    5.3.4 Herd characteristics and performance ................................141
    5.3.5 Cost of production and level of commercialization ........141
    5.3.6 Correlation between value chain variables and milk production .............143
    5.3.7 Important predictors of milk production .........................144
    5.3.8 Variance explained by individual predictors on milk production .........144
    5.3.9 Statistical and practical significance ...................................148
  5.4 Priority interventions for upgrading structure and performance ....149
5.4.1 Visualization model.......................................................... 149
5.4.2 The new value chain structure ......................................... 151
5.4.3 Carrying capacity on one acre feed models ..................... 156
5.4.4 Cost-Benefit analysis of proposed intervention.................. 158

CHAPTER SIX .................................................................................. 159

6 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS .......... 159
  6.1 Restatement of focus of study .............................................. 159
  6.2 Summary of empirical results for the four study objectives ...... 159
  6.3 Conclusions ................................................................. 164
  6.4 Recommendations .......................................................... 165
    6.4.1 Policy implications .................................................. 165
    6.4.2 Agenda for further research ..................................... 167

REFERENCES .............................................................................. 168

APPENDICES ............................................................................... 183
| Table 3.1: Target population and sample size of different actors | 44 |
| Table 3.2: Sample size and sampling technique of service providers | 44 |
| Table 3.3: Sample sizes used in farm assessment in Butula and Butere Sub Counties | 45 |
| Table 3.4: Data collection methods used | 49 |
| Table 4.1: Quantities of milk (litres) purchased by consumers on daily basis in the study area | 61 |
| Table 4.2: Problems associated with milk suppliers as perceived by consumers | 61 |
| Table 4.3: Parameters on performance of dairy cooperatives | 67 |
| Table 4.4: Costs and gross margins for dairy cooperatives | 68 |
| Table 4.5: SWOT of milk market in Western Kenya | 69 |
| Table 4.6: Ranking of milk markets | 70 |
| Table 4.7: Selected demographics in Butula and Butere | 71 |
| Table 4.8: Selected farm characteristics | 73 |
| Table 4.9: Herd structure on smallholder farms in the study area | 74 |
| Table 4.10: Herd performance in Butula and Butere Sub Counties | 76 |
| Table 4.11: Performance indicators of dairy cows on smallholder farms | 76 |
| Table 4.12: Dominant improved cattle breeds kept in the study area | 78 |
| Table 4.13: Mean milk yields of different cattle breeds in the study area | 78 |
| Table 4.14: Main fodder, sources, feeding systems used and evidence of conserved feed on smallholder dairy farms | 79 |
| Table 4.15: Use of dairy meal and other protein feeds | 80 |
| Table 4.16: Use AI and breeding services | 81 |
| Table 4.17: Problems associated with breeds as perceived by farmers | 83 |
| Table 4.18: Price at which the farmers were willing to pay to acquire a high yielder dairy cow | 83 |
| Table 4.19: Use of extension advice | 84 |
| Table 4.20: Use of improved research technologies | 85 |
| Table 4.21: Use of credit by farmers | 86 |
| Table 4.22: Use of revenue from dairy enterprise | 88 |
| Table 4.23: Linkages with buyers and service providers | 88 |
| Table 4.24: Socio cultural perceptions | 89 |
| Table 4.25: Policy and infrastructure needs | 90 |
| Table 4.26: Problems with quality of inputs | 91 |
| Table 4.27: Constraints encountered in dairy production | 92 |
| Table 4.28: HCI among smallholder dairy farms | 93 |
Table 4.29: Correlation Analysis (Pearson) of variables with average milk yield...94
Table 4.30: Multiple linear regression results (model with all 11 variables).........95
Table 4.31: Collective effect of variables in the final model ..............................96
Table 4.32: Variance explained by individual predictors on milk yield .............100
Table 4.33: Collinearity diagnostics ..................................................................101
Table 4.34: Summary of results of pair wise ranking of value chain factors...102
Table 4.35: Ranking of constraints limiting milk production on smallholder farms
.................................................................................................................................103
Table 4.36: Characteristics of artificial insemination providers .........................104
Table 4.37: Dairy feed technologies developed by KALRO Kakamega ..............106
Table 4.38: Analysis of commercial concentrate (dairy meal) from agrovet dealers
.................................................................................................................................107
Table 4.39: Analysis of commercial concentrate (dairy meal) on small and large
circle farms ..................................................................................................................108
Table 4.40: Inefficiencies in farmer groups .........................................................109
Table 4.41: Selected parameters on management, traditional and modern roles
among cooperatives ....................................................................................................110
Table 4.42: Service providers in the livestock department ...............................113
Table 4.43: Past and ongoing dairy development projects ..................................113
Table 4.44: Stakeholder and roles in the proposed upgrading strategy ...............122
Table 4.45: Nutritional requirements for 10 litres production, 500kg cow, 4% fat 128
Table 4.46: Feed types, intake and value .............................................................128
Table 4.47: Costs and benefits for the proposed intervention ...........................131
Table 4.48: Anticipated Net Present Value of the intervention .........................132
Table 4.49: Comparing Benefit-Cost, Internal Rate of Return and Net Present Value
.................................................................................................................................132
LIST OF FIGURES

Figure 2.1: Value chain structure: adopted and modified from GTZ, (2008) ..........12
Figure 2.2: Quantity of milk marketed through different channels ..................18
Figure 2.3: Market share of milk processors ..............................................19
Figure 2.4: Forms of chain upgrading by small scale farmers .......................26
Figure 2.5: Theoretical framework ..............................................................32
Figure 2.6: Conceptual framework ...............................................................33
Figure 3.1: Map of Western Kenya showing the study Counties .....................35
Figure 3.2 a & b: Sample sizes in four study Counties for different consumer categories .........................................................................................................................46
Figure 4.1: Milk marketing channels in Western Kenya ..................................60
Figure 4.2: Preferences for milk products .....................................................62
Figure 4.3: Preferences for milk products in Counties ....................................63
Figure 4.4: Preferences for milk products among consumers ........................63
Figure 4.5: Preferred attribute for milk supplier ............................................64
Figure 4.6: Perceptions on whether consumers experienced low milk supply ......64
Figure 4.7: Consumer perceptions on whether milk consumption had increased ....65
Figure 4.8: Perceptions on whether milk consumption would increase in Counties .65
Figure 4.9: Sources of dairy cattle breeding stock in the study area ................82
Figure 5.1: Potential Model for upgrading structure and performance of milk value chain in Western Kenya ..........................................................150
LIST OF APPENDICES

Appendix 1  Market study questionnaire and interview guides for key informants

Appendix 2  Farm assessment questionnaire and interview guides for key informants

Appendix 3  Institutional assessment questionnaire and checklist

Appendix 4  Map of study area: Butula and Butere sub Counties

Appendix 5  Selected SPSS outputs

Appendix 6  List of publications emanating from the study
OPERATIONAL DEFINITION OF TERMS

Value chain: A series of processes and linkages required to bring a product through the various stages from input supply through production, transportation, processing, wholesaling and retailing until it reaches the final consumer in either the local, national or export markets. It is a development tool (KIT et al., 2006, Feller et al., 2006). In this study the boundaries included: actors, service providers and policy makers along the continuum from supply of inputs to consumption of milk.

Supply chain: Supply chain refers to the sequence of sourcing and marketing functions of individual firms. It is a business management tool mainly concerned with logistics (GTZ, 2008, Feller et al., 2006, KIT et al., 2006).

Stakeholders: A group of people or institutions who are directly involved in the value chain.

Micro level: In a value chain, the micro level includes the value chain (VC) operations i.e. input supplying, production, collection and bulking, processing, wholesaling, retailing, consumption stages.

Meso level: The meso level includes support services in the value chain that provide both financial and non financial services. Examples include but not limited to extension, research, training and credit institutions.

Macro level: The macro level refers to the public agencies and institutions constituting the enabling environment. The macro level determines the policy, regulatory and infrastructural environment (GTZ, 2008). In this study they included: the County governments, the Kenya Bureau of Standards.

Commercialization: The level of participation of a farmer in both the input market as a buyer and the output market as a seller (Pingali, 1997; Pingali and Rosegrant, 1995).

Western Kenya: The Counties of Busia, Bungoma, Kakamega and Vihiga.

Free riders: Members of a Cooperative society who are inactive or dormant (e.g. not delivering milk) but receive certain benefits by virtue of membership eg voting rights (Olson and Cook, 2009; Prakash, 2000; Ortmann and King, 2007).
Value chain structure: The three levels of the value chain comprising the micro (actors), meso (service providers) and macro levels (policy makers), (GTZ, 2008).

Value chain variables: Components within themicro, meso and macro levels of the value chain (World Bank, 2008; Tefera et al., 2009; Jaleta et al., 2009).

Dummy variable: is an artificial variable created to represent an attribute with two or more distinct categories or levels (Skrivanek, 2009).

Performance: Refers to price, quantity, quality, reliability, governance regimes in the value chain (Ruben et al., 2007).

Vertical integration: Taking on more activities or functions of the value chain e.g farmers moving from being involved only in production to bulking, processing and even marketing (KIT et al., 2006).

Vertical coordination: The regulation of relationships between the different stages of the value chain from input supply to marketing continuum through agreements and written contracts.

Vision / visioning: The vision refers to the aspired change of the value chain answering the question: How should the value chain look like say, five years from now? (GTZ, 2008)

Impact model: This is the sequence proceeding from project outputs to outcome and on to direct and indirect impacts. It is an hypothesis about the results expected from potential interventions. The ultimate intervention resulting into big change (KIT et al., 2006; GTZ, 2008).

Upgrading strategy: Interventions for improvement carried out jointly by actors in the value chain to take advantage of specific market opportunities (KIT et al., 2006, GTZ 2008).

Chain leader or governor: The dominant actor in a value chain, usually cooperative, processor or supermarket assuming a coordination role within a value chain. The governor usually determines rules, price, quality, quantity requirements (Ruben et al., 2007).

Value chain governance: Governance refers to the way business activities in a value chain are vertically coordinated (Ruben et al., 2007).
Value chain map: The value chain map is a visual representation chart of the micro, meso and macro levels of the value chain.

Travelling trader: Travelling traders are mobile traders who go to the farms to buy agricultural products and transport these to a market elsewhere (KIT and IIRR, 2008)
## ACRONYMS AND ABBREVIATIONS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI</td>
<td>Artificial Insemination</td>
</tr>
<tr>
<td>AGRA</td>
<td>Alliance for A Green Revolution in Africa</td>
</tr>
<tr>
<td>ASDS</td>
<td>Agricultural Sector Development Strategy</td>
</tr>
<tr>
<td>ATCS</td>
<td>Agricultural Training Centres</td>
</tr>
<tr>
<td>BCR</td>
<td>Benefit Cost Ratio</td>
</tr>
<tr>
<td>CAADP</td>
<td>Comprehensive African Agricultural Development Programme</td>
</tr>
<tr>
<td>CAIS</td>
<td>Central Artificial Insemination services</td>
</tr>
<tr>
<td>COMESA</td>
<td>Common Market for Eastern and Southern Africa</td>
</tr>
<tr>
<td>CP</td>
<td>Crude Protein</td>
</tr>
<tr>
<td>DANIDA</td>
<td>Danish International Development Agency</td>
</tr>
<tr>
<td>DFID</td>
<td>UK Department for international development</td>
</tr>
<tr>
<td>DM</td>
<td>Dry Matter</td>
</tr>
<tr>
<td>EAAPP</td>
<td>East African Agricultural Productivity Project</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organization of the United Nations</td>
</tr>
<tr>
<td>GOK</td>
<td>Government of Kenya</td>
</tr>
<tr>
<td>GMP</td>
<td>Good Manufacturing Practices</td>
</tr>
<tr>
<td>GTZ</td>
<td>German agency for technical cooperation</td>
</tr>
<tr>
<td>HACCP</td>
<td>Hazard Analysis Critical Control Points</td>
</tr>
<tr>
<td>ICA</td>
<td>International Cooperative Alliance</td>
</tr>
<tr>
<td>IFAD</td>
<td>International Fund for Agricultural Development</td>
</tr>
<tr>
<td>IFCN</td>
<td>International Farm Comparison Network</td>
</tr>
</tbody>
</table>
IRR  Internal Rate of Return
IIRR  International Institute of Rural Reconstruction
ILO  International Labour Organization
IFPRI  International Food Policy Research Institute
ILRI  International Livestock Research Institute
KALRO  Kenya Agricultural and Livestock Research Organization
KARI  Kenya Agricultural Research Institute
KAGREC  Kenya Animal Genetic Resources Centre
KDB  Kenya Dairy Board
KDSCP  Kenya Dairy Sector Competitive Programme
KEBS  Kenya Bureau of Standards
KENBS  Kenya National bureau of Statistics
KIT  Royal Tropical Institute, Amsterdam
ME  Metabolizable Energy
NEPAD  New Partnership for African Development
NPV  Net Present Value
SDC  Swiss Development Cooperation
SDP  Small Holder Dairy Project
SMEs  Small and Medium Enterprises
SNV  Netherlands Development Organization
UNECA  United Nations Economic Commission for Africa
UNIDO  United Nations Industrial development organization
USAID -  United States Agency for International Development
COMPETE  Competitiveness and Trade Expansion
ABSTRACT

Western Kenya Counties of Busia, Bungoma, Kakamega and Vihiga experience persistent milk deficit and low commercialization on smallholder farms. Information and knowledge on sources and points of inefficiency along the dairy value chain that contribute to low milk production and hence persistent milk deficit are scanty. The main objective of this study was to assess the structure and performance of the milk value chain in the region to determine market opportunities, variables influencing milk production, sources of inefficiencies and an upgrading strategy. An explanatory research design was used to collect both quantitative and qualitative data from 385 consumers and seven institutions in the four Counties and 400 dairy farmers, six focus groups and twelve key informants in Butula and Butere Sub Counties using a stratified proportional random sampling technique. End market tool kit and descriptive statistics; Household Commercialization Index, Pearson’s correlation and multiple linear regression were used to analyse data on markets, farm assessment and upgrading strategy respectively. The findings on markets revealed that the region’s milk deficit was about 177 million litres per year with demand estimated to be 392 million litres per year against an annual production of 215 million litres. Quality and price were found to be the most important attributes significantly influencing choice of milk supplier (p<0.001). There was low milk supply in cooperatives with only 8.5% out of the installed cooler capacity of about 27600 litres utilized. Compared to households, hotels and institutions, cooperatives when restructured into business entities, were found to be the best milk market in an upgrading strategy. The level of commercialization in the region was found to be 39%, with low input household index of 32%. The mean milk yield per cow per day was 6.5 litres, with 89% of the farms producing less than 10 litres of milk per cow per day, while yield per cow per year was 1240 litres. There was a positive and significant linear relationship between eight variables and milk production. The most important predictors explaining variations in milk production were: Fodder, dairy meal, credit, A1 services, improved research technologies, group membership, policy and returns from milk sales. Collectively, they explained 63.9% of the variance, out of which 51% was explained by fodder and dairy meal combined. The model was highly significant at 1% (F8, 291= 65.089, p<0.001). The main sources of inefficiencies were found to be institutional.

These findings suggest a linear relationship between value chain components and milk production and hence may be useful in selecting: a) important variables b) prioritization c) estimation of impact before actual implementation d) key stakeholders in an intervention A potential model for improving the structure and performance of the milk value chain should consist of five levels: integrated input supply; dairy farmer business clusters, new structured cooperatives, contracted retailers and an enabling County government policy. The model appears feasible and could increase average yields to 10 litres per cow per day, increase annual income per cow from KES 62,000 to KES 126,500, reduce milk deficit by about 51%, with a benefit-cost of KES 14.14 for every KES 1 invested. The model has practical significance and could be adopted by the County Governments in Western Kenya to address the milk deficit problem. Further research should be carried out to validate the model.
CHAPTER ONE

1 INTRODUCTION

1.1 Global environment

More than 1.2 billion people worldwide live on less than one US dollar per day and majority are found in Sub Saharan Africa (SSA), whose economies are mainly agriculture based (AGRA, 2014; NEPAD, 2002; Ochieng, 2007). However, since 1990s, rapid global changes in agricultural markets have provided opportunities and challenges for smallholders supplying agri-food products (Humphrey and Navas, 2010). These changes include market liberalization and integration; the rise of agro processors and supermarket chains operating private standards for the products they buy; and reduced government support for farming communities for inputs, extension and commodity marketing boards (KIT et al., 2006). The changes have resulted in weaknesses both in the structure and performance of agricultural value chains. As a consequence, the majority of smallholder farmers in developing countries, including Kenya, are now less organized than before and often have difficulties accessing input and output markets. Most smallholders particularly in rural areas in Africa operate at subsistence level especially in food commodities, with very low commercial orientation, even in situations whereas commodity has a higher consumer demand (USAID-COMPETE, 2010).

1.1.1 Linking structure and performance of value chains

At international markets, Ruben et al (2007) examined relationships between four key dimensions of tropical food chains i.e channel choice, governance regime, quality improvement and value added distributions. He concluded there were strong
linkages between structure and performance and suggested further scientific analysis of technical, institutional, policy and knowledge factors that influence performance at different stages of the value chain.

Within Sub-Saharan Africa, the Comprehensive Africa Agriculture Development Programme (CAADP) advocates for the development of regional value chains for strategic agricultural commodities as essential for African countries to enhance their agricultural transformation and competitiveness (UNECA, 2007). The CAADP initiative stresses the need to invest in competitive value chains, taking into consideration local, regional and international market demands and requirements. However, analysis of structure and performance of specific value chains to determine sources, points of inefficiencies and potential upgrading strategies could constitute a firm foundation for enhancing productivity, commercialization and competitiveness of different agricultural commodities.

1.1.2 Kenya Vision 2030 and the dairy industry

Transformation of Kenya’s smallholder agriculture from subsistence to market orientation is the focus of key policy documents which include: the Vision 2030 (GOK, 2007), the Agricultural Sector Development Strategy (GoK, 2010a) and the National Agribusiness Strategy (GoK, 2012). In the dairy sector, the National Dairy Master Plan (GoK, 2010b) has been developed to provide specific framework for dairy agribusiness. All these initiatives are intended to put markets at the centre of production, processing, product development and packaging, using the value chain approach (GOK, 2012). Although these intentions provide a roadmap for the sector, three issues need to be resolved through research: first, determining the current (baseline) level of commercialization (integration of farmers in both the
input and output markets) of specific commodities so that targets are set. Secondly, current methods used to analyse value chains are mainly qualitative and incapable of determining where in the value chain stakeholders should focus and what would be the impact of such interventions (Rick et al., 2009). Third, a value chain system consists of many components and stakeholders and its structure and performance may be influenced by many factors including institutional, socio economic, technological, policy and environmental challenges (GTZ, 2008; World Bank, 2008; Tefera et al., 2009; Jaleta et al., 2009).

One of the key value chains in Kenya with potential for commercialization to contribute to improved livelihoods and the economy is dairy. The industry accounts for about 4% of the Gross Domestic Product (GDP) and is a major source of livelihood for more than 1 million people in the sub sector (GOK, 2010b). Total annual milk production is estimated at 4.2 billion litres out of which 70% is from grade dairy cattle and their crosses while the remaining 30% comes from zebu cattle, camel and goats (FAO, 2011). Out of the estimated national improved dairy cattle herd of 3.5 million, smallholders own 3.3 million and control over 80% of both produced and marketed milk (FAO, 2011; GOK, 2010b). These farmers own 1-3 cattle and supply milk mainly through the informal chain directly to consumers, traders or through cooperatives (Omore et al., 2004). Most of the improved dairy cattle are concentrated in the milk sheds of Rift valley and Central Kenya regions.

1.2 Background to the study

Despite the growing importance and promotion of agricultural value chains as vehicles for linking actors and especially farmers to increasingly dynamic markets, research has devoted minimal attention to analyzing variables within the
value chain system which influence structure and performance. As a consequence, relatively little is known about important variables and their potential impact on the structure and performance of specific value chains in which smallholders participate. Nevertheless, actors from input supply to consumption continuum are forced to evolve, adopt, forge linkages and relationships whether formal or informal that will enable them to produce and trade within the prevailing inefficient structures. Indeed from such a complex system consisting of many operators, service providers and policy makers; identifying, designing and implementing appropriate interventions to improve performance of value chains and support inclusion of smallholders in profitable market segments is a daunting task. The need to use empirical evidence in identifying, assessing and selecting important variables influencing the structure and performance of specific value chains is the subject focus of this study, using the case of the milk value chain in Western Kenya.

1.2.1 Background to study area

Western Kenya counties of Busia, Bungoma, Kakamega and Vihiga experience frequent milk shortages. The region has one of the highest milk prices in the country but dairy farmers in the area do not seem to respond to this attractive market by increasing production (Mudavadi et al., 2001; Waithaka et al., 2002; Wambugu et al., 2011). In addition, despite several dairy development interventions initiated in the region there has been little success towards a commercialization path and to solve the milk deficit problem since majority of farmers are still subsistence-driven (Otieno et al., 2005). Most of the work and studies done have focused at farm level with each suggesting interventions on single aspects, while neglecting to
consider a systems approach (Mudavadi et al., 2001; Waithaka et al., 2002; Ongadi et al., 2007).

1.3 Statement of the Problem

Smallholder integration in value chains especially rural producers needs to be studied from the perspective of specific local contexts. Relatively little is known about the structure and performance of the milk value chain in Western Kenya, particularly the market opportunities which actors could target, variables which influence milk production, sources and points of inefficiencies. As a consequence of this knowledge gap, milk insufficiency is persistent and despite the high raw milk price in the region, dairy farmers are not responding to the incentive by increasing milk production. The study would be useful in informing new ways to upgrade the milk value chain in the region.

1.4 Research questions

The study was guided by the following research questions.
1. How is the milk market in Busia, Bungoma, Kakamega and Vihiga Counties of Western Kenya organized and what are the potential market opportunities?
2. Which are the important value chain variables influencing milk production?
3. What are the sources inefficiencies in the milk value chain in Western Kenya?
4. What type of upgrading strategy is needed to improve structure and performance of milk chain in Western Kenya?

1.5 Research objectives

The broad objective of the study was to assess the structure and performance of the milk value chain in Western Kenya. The specific objectives were:

1. To assess the quantity, quality, price and reliability of households, hotels,
institutions and Cooperatives as milk market opportunities in Busia, Bungoma, Kakamega and Vihiga Counties.

2. To assess variables within the value chain which influence milk production and determine the level of commercialization on smallholder dairy farms.

3. To assess the sources of inefficiencies among actors in the milk value chain based on the identified variables.

4. To evaluate a potential upgrading strategy targeting the selected market opportunity which improves the structure and performance of the milk value chain in Western Kenya.

1.6 Justification/ Significance of study

Previous dairy interventions in Busia, Bungoma, Kakamega and Vihiga Counties have not been successful in enhancing market-oriented dairy farming for smallholders (Mudavadi et al., 2001; MOLD Busia Sub County personal communication). In addition, most studies conducted so far have targeted production level challenges (Mudavadi et al., 2001; Makokha et al., 2007; Limo, 2011; Musalia et al, 2010), yet in a value chain the major bottleneck influencing structure and performance can be at different levels of the chain. Most of these studies suggest interventions on single aspects, while neglecting to consider a systems approach. As a consequence, these initiatives have been incapable of solving the vicious cycle of milk deficiency. This study is necessary because at present, knowledge on the structure and performance of the milk value chain in Western Kenya is scanty; particularly market opportunities which actors could pursue, the variables which influence milk production and sources of inefficiencies along the value chain. Despite the promotion of the value chain approach in the agricultural sector, the use
of empirical evidence as basis for selecting key interventions is very limited (World Bank, 2008; Rick et al., 2009). Interventions identified through such a rigorous study would be attractive to partnerships. Hence the research findings would be beneficial to a wide range of actors including input suppliers, farmers, milk cooperatives, processors, consumers, research organizations such as KALRO and EAAPP which supported this study and, policy makers especially the County Governments in Western Kenya.

1.7 Scope of the study

The focus of this study was on assessment of the structure and performance of the milk value chain in Western Kenya. The study analyzed milk markets and cooperatives in the four Counties of Busia, Bungoma, Kakamega and Vihiga, while assessment of inefficiencies in the value chain, variables influencing milk production, and upgrading strategy was limited to Butula and Butere Sub Counties of Busia and Kakamega Counties respectively. The study was conducted between 2012 and 2014 and data collected relates to this period.

1.8 Limitations of the study

As with any research there are limitations to this study. Efforts were made to minimise limitations but some remain and must be acknowledged.

First, due to financial constraints it was not possible to sample respondents at different levels of the value chain across the four counties as earlier envisaged during the proposal development. Hence the scope of the study was as outlined in the preceding section. Only one processor was sampled because from the key informants interviewed in Busia, Bungoma, Kakamega and Vihiga, it was revealed that there was only one registered milk processor in the area i.e Kitinda dairy in
Bungoma County and, ten active cooperative societies in the region but with very low operations for reasons discussed later in the results chapter (County directors of livestock, personal communication). According to the Kenya Dairy Board (KDB) there were 27 cooperatives societies before 2010, but most of these cooperatives have since collapsed and hence only the remaining active ones were sampled. No records were available on the number of milk traders. Nevertheless, Butula and Butere Sub Counties had several characteristics suitable for the study of performance of the milk value chain. Besides, they are located in Low Midland1 (LM1) sugarcane zone, typical of most of Western Kenya (Jaetzhold et al., 2006). Hence results obtained could be generalized to the entire Western region. Finally, case studies are considered specific and not to the universe and, perhaps the findings of this study may not equally apply to other milk deficit regions. Despite these limitations, this study forms a strong basis for further research in the future.

1.9 Organization of the thesis

This thesis is organized in six chapters. The introduction is presented in Chapter one and covers: Global agricultural market environment, the link between structure and performance of value chains, Vision 2030 and the dairy industry and background of study area. This is followed by statement of the problem, research questions, study objectives, study justification, scope and limitations of the study.

Chapter two gives an overall review of relevant literature starting with historical background of the value chain concept, followed by sections on agricultural value chains, structure and performance of milk value chains globally, SSA, in Kenya and Western region; it also examines types of upgrading strategies.
commonly used, current approaches used in selection of variables in upgrading, and identifies knowledge gaps in the literature.

Chapter three presents a systematic description of the methodology beginning with the study location, research design, study variables and measurement, target population, sample size and sampling technique, instruments and data collection methods, data management and analysis.

Chapter four is a presentation of the results organized according to objectives. Section one analyses structure and performance of milk market ending with ranking of markets; section two are results on household, farm and herd characteristics; commercialization, correlation and multiple regression results. Section three presents sources of inefficiencies, while section five deals with evaluation of potential strategy and impact model.

Chapter five presents a discussion along three thematic areas: structure and performance of milk market; important predictors of milk production; upgrading strategy and the impact model. Chapter six gives a summary of empirical results, conclusions and recommendations. Finally, a list of references and appendices is provided at the end.
CHAPTER TWO

2 LITERATURE REVIEW

2.1 Introduction

A broad spectrum of literature on value chains is available. Therefore the study will review relevant and representative works rather than attempt to give a universal discussion. The literature is organized in nine parts. The first part covers a brief review of the value chain concept and explains the value chain structure. The second part reviews the increasing trend in mainstreaming value chains in the agricultural sector. The structure and performance of global milk value chains is presented in part three, while the structure and performance of the milk value chain in SSA and Kenya form parts four and five respectively. Part six reviews the performance of the value chain in Western Kenya, while part seven examines types of upgrading strategies commonly used and current approaches used in selection of variables in upgrading. Part eight presents conclusions from literature review while nine is an exposition of knowledge gaps. Part ten presents the study theoretical and conceptual frameworks.

2.2 The value chain concept

The value chain concept is premised on the fact that a product is rarely consumed at the place of its production. It is transformed, packaged, transported, and distributed until it reaches the final consumer (KIT et al., 2006). The consumer may be in the local, national or global markets (Gereffi, 1994; KIT et al., 2006). The starting point in value chain interventions is identifying end market opportunities of specific products, understanding their requirements and analyzing benefits and risks associated with trading in these markets. It is then followed by analyzing the value chain to determine sources or points of inefficiencies (USAID, 2008; KIT et al.,
The intervention or upgrading strategy entails public-private partnerships working in complementarities to improve the processes, products and services. Recent studies have characterized the value chain and adapted the conventional definition of a value chain as “the full range of activities which are required to bring a product or service from conception, through the intermediary phases of production, transformation, delivery to final consumers, and final disposal after use” (Kaplinsky and Morris., 2000; KIT et al., 2006; GTZ., 2008). As the product passes through several stages of the value chain, the value of the product increases (ILO, 2007). In this process the inputs and final product, in this study milk, are owned by various actors who are linked by trade and services, each add value to the product. At the same time, various types of public and private services such as extension, research, credit, policy and regulations interact to influence the value chain. These works suggest that the value chain approach has considerable merit in highlighting the constraints and opportunities at and between stages of the chain. The concept supposes that by understanding these interrelationships and influences, it is possible to develop interventions that target chain inefficiencies at different levels and hence improve performance of the value chain. The value chain structure consists of three groups of stakeholders as shown in Figure2.1. The micro level: Input suppliers, producers, processors, traders and consumers. The meso level: Service providers - public and private such as extension, research, credit, transport, business development services and the macro level: Enabling environment - policy and regulations, both national and international, infrastructure, electricity, water(KIT et al., 2006; GTZ, 2008; USAID, 2010). A recent study by Ruben et al (2007) found that there were strong linkages between the structure of a value chain and its performance. Weaknesses at any of the three levels
could affect its performance in terms of quantity, quality, price, and reliability of the final product. He suggested further studies to determine which variables at the micro, meso and macro levels had the greatest influence.

**THE VALUE CHAIN STRUCTURE**

![Value Chain Diagram]

**Figure 2.1: Value chain structure: adopted and modified from GTZ, (2008)**

2.2.1 Agricultural value chains

Value chain approaches are now increasingly being utilized by many development partners (USAID, GTZ, IFPRI, DFID) as the preferred vehicle for linking actors, especially farmers, small and medium enterprises (SMEs) to markets (SDC, 2007; Humphrey and Navas, 2010; Trienekens, 2011). The World Bank’s development report dubbed Agriculture-for-Development Agenda (A4D) recommends that agriculture must be organized and coordinated through a systems approach and innovation focusing on markets (World Bank, 2008). The report observes that agriculture in both the developed and transition countries is structured
along specific value chains and hence market oriented. These value chains exhibit a great deal of connectedness from input supply to different markets across the globe exploiting trends in quality standards and price, thus making them efficient (Humphrey and Navas, 2010).

However, in developing countries especially Sub Saharan Africa, despite decades of interventions mainly at farm level, smallholders have not taken off on a commercialization path (Ochieng, 2007; Tefera, 2009; UNIDO, 2010). Recent initiatives by AGRA and New Partnership for Africa’s Development (NEPAD) under the Comprehensive African Agriculture Development Programme (CAADP) are aimed at supporting value chain approaches to enhance the development of specific agricultural commodities which are important to national economies (NEPAD, 2002; UNECA, 2007, AGRA, 2014). However, the structure and performance of value chains and how it affects especially rural producers still needs to be studied from the perspective of specific local contexts.

2.3 **Structure and performance of global milk value chains**

Milk production worldwide is estimated to be carried out by around 122 million dairy farms keeping 363 million milking cows and buffaloes (IFCN, 2013). World total milk production is estimated to be 703,996,079 tonnes per year from cow milk, buffalo milk, goat milk, sheep milk, and camel milk (USDA, 2011). However there are major differences among countries in terms of farm size, breeds, production and feeding systems.

IFCN (2013) reports that in the developed world, dairy farms are much bigger and range between 70 to 5000 pure bred cows with an average production of more than 5000 litres per cow per lactation (305 days). On the other hand in
developing countries of Africa, dairy farms consist of smallholder farmers keeping 1-3 cows, mainly crosses, with a production of 2100 litres per cow per lactation (Staal et al., 2008). India, the world's leading milk producer, China and Pakistan have a dairy system that resembles Africa, comprising numerous smallholdings keeping 2-8 cows or buffaloes with about 85% of milk marketed through the informal chain (Garcia et al., 2003; Hemme et al., 2006; Staal et al., 2008). Thus dairy systems are distinct both in structure and performance in different countries and regions. The dairy value chain in developed countries (European Union, USA, Canada, New Zealand and South Africa) has a highly integrated commercially-oriented structure from input supply to production, processing, distribution, wholesaling, retailing activities which are vertically coordinated by a lead firms such as industrial processors and supermarket chains (Gereffi et al., 2011). Safety, quality and traceability standards are adhered to at all levels of the value chain while production is carried out by registered large scale farms under a quota milk system. Milk production is vertically coordinated through efficient value chains. Because of strong institutions and supportive policy environment, the dairy value chain in these countries is globally linked due to opportunities presented by liberalization under WTO regulations (FAO, 2004; Staal et al., 2008; Gereffi et al., 2011). The structure and performance of these global value chains observes Ruben et al (2007), exhibits strong linkages between channel choice, governance issues, quantity and quality improvement as well as value added distribution. Globally milk prices per 100kg range from USD 0.30 in USA, EU, South Africa, New Zealand to 0.45 in Finland (IFCN, 2013). Though the structure and performance of dairy value chain is efficient in developed countries compared to Africa, there is little information and empirical evidence on how inefficiencies among actors was assessed, which
variables within the value chain system were selected and how they were used to strengthen performance.

2.4 Structure and performance of milk Value chain in Sub Saharan Africa

About 80% of Africa’s population is dependent on agriculture (UNECA, 2005; AGRA 2014). Agriculture contributes 17% of Africa’s GDP, and accounts for 57% of employment opportunities (UNECA, 2005). Despite its importance and decades of interventions, production is still largely subsistence oriented with little market orientation (AGRA 2014; Ochieng 2007). To revitalize and put Africa’s agriculture on a commercialization path, NEPAD through CAADP strategy outlined the need for national agricultural sectors to focus on strategic commodities using the value chain approach (UNECA, 2007). One such commodity being targeted is dairy.

The dairy systems in Sub Saharan Africa are based on pastoral systems (local cows), semi intensive systems (local and exotic cows) and intensive systems - crosses and exotic cows (Ndambi et al., 2007). For the purpose of this study, a summary review of intensive system is made.

Staal et al (2008) reported that the structure of the milk value chain in SSA consisted of mainly of small-scale subsistence model, multi-objective farmer behaviour, low levels of inputs and outputs. Marketing was characterised by a widely spread market structure, consisting of many small-scale market agents, different transport modes, low-cost products, mostly liquid milk and limited diversity in products. On the other hand the demand for milk and dairy products in Africa is growing at an average rate of 4.0% per annum compared to production at 3.1%, meaning that with growing human population, urbanization and rising incomes, Africa may continue to experience milk shortages and hence rely on
imports (Delgado et al., 2002; Ndambi et al., 2007). Tefera (2009) observes that despite decades of investment Ethiopian smallholders have not taken off on a commercialization path. This assertion reflects the status of the dairy sector in Africa (except South Africa, Zimbabwe, Egypt and Algeria). The continents portfolio of value addition combined is much less than Brazil and Thailand (UNIDO, 2010). As a result of the weak structure and performance of the dairy value chain, exacerbated mainly by liberalization policies of 1980s in much of Africa, several studies suggest an analysis of socio economic, institutional, policy and infrastructural variables to determine an appropriate upgrading strategy on smallholder farms for increasing milk production (Staal et al. 2008; World Bank, 2008; Tefera et al., 2009, FAO, 2011). Thus this study seeks to fill these knowledge gaps.

2.5 Structure and performance of milk value chain in Kenya

A study by Omore et al (1999) showed that the structure of the value chain in Kenya consists of input supply, production, collection/ bulking, processing, retailing, consumption, service provision and policy levels. A review of these levels is as follows:

2.5.1 Input supply

The main dairy inputs supplies consist of breeding stock from large and small scale farms, artificial insemination (AI) services from Kenya Animal Genetic Resources Centre (KAGREC) and private providers dealing with imported semen, sexed semen and embryo transfer technology services; feeds from commercial feed manufacturers; drugs and vaccines, equipment and machinery supplied from drug companies (Karanja, 2003). Following liberalization policies of 1990s, the quality of
inputs such as AI services, commercial feeds and drugs have been reported to be inefficient (FAO, 2011; Karanja, 2003). These studies fail to show how the variables and sources of inefficiencies were determined.

### 2.5.2 Production

A study by FAO (2011) reports that Kenya produces more than 4.2 billion litres annually mainly from cattle (3.5 million herd of Friesian, Ayrshire, Jersey and Guernsey breeds and their crosses, and 9.3 million indigenous local cattle), camels (1 million) and goats (13.9 million). Dairy cattle are kept by more than 800 000 smallholders and 2000 large scale farmers, accounting for about 70 percent of total national milk output (FAO, 2011). The national dairy herd and large scale farms are concentrated in the Central and Rift Valley regions due to historical ties with former settler farmers. These areas are largely self sufficient in milk. The study further reports that the rest of Kenya, particularly the Western region has low numbers of dairy cattle and low milk supply for most parts of the year. The National Dairy Master Plan (GoK, 2010b) proposes to upgrade the national milk value chain through increasing feed production, disease control and marketing of quality milk. However, the Master Plan does not provide empirical evidence on how these variables were selected, and what would be potential impact of upgrading on the farms and the value chain.

### 2.5.3 Collection, bulking and cooling

Data from the Central Bureau of Statistics (CBS, 2013) show that the number of cooperatives bulking milk has been increasing from 264 in 2008 to 343 in 2012, while membership increased between 2008 to 2011, but declined in 2012. Omore et al (1999) and Karanja (2003) observed that cooperatives though important for
collective marketing by farmers were not popular due to mismanagement. The studies fail to indicate areas in which cooperatives being could be improved to remain attractive to farmers.

2.5.4 Milk marketing

Before the 1990s milk marketing was dominated by the Kenya Cooperative Creameries (KCC). (Muriuki, 2004). Since 1992, liberalization led to a rapid growth of the informal milk trade that mainly consists of small-scale operators dealing in marketing of raw milk. At that time, there was an emergence of new institutional arrangements in milk collection, processing and marketing, which included traders/hawkers, brokers, self-help groups, neighbours and business establishments like hotels (Karanja, 2003). The informal milk market controls an estimated 70 percent of the total milk marketed in Kenya while the formal channel through cooperatives and processors account for less than 30% (KDB 2009; GoK, 2010 b) as shown in Figure 2.2. All these studies fail to provide an analysis of the marketing channel actors could target to improve the structure and performance of the value chain.

![Figure 2.2 : Quantity of milk marketed through different channels](image)

(Source: Omoreet al (1999). Percentage marketed flows are calculated on marketed milk, not on total production).
2.5.5 Milk processing

The dairy processing industry in Kenya comprises of large, medium and small scale processors. As already mentioned, until the 1990s, the Kenya Cooperative Creameries (KCC) processed all the milk in Kenya, but its monopoly slowly decreased between 1993 and 1996 (Karanja, 2003). Consequently, the termination by the Government of the monopoly status of KCC encouraged private sector participation through other large-scale processors. Many private processors joined the dairy business in 1992, and have increased greatly since 1999. According to the industry statistics by the Kenya Dairy Board there were an estimated 27 processors, 64 mini dairies, 78 cottage industries and 1138 milk bars in 2010.

Presently, milk processing in Kenya is dominated by three major processors, namely, Brookside Dairy Limited, New KCC and Githunguri Dairy Farmers Cooperative Society (Figure 2.3).

Figure 2.3: Market share of milk processors

(Source: Kenya Dairy Board Annual Report, 2013)
2.5.6 Transport and distribution

Transportation of milk between each step of the chain is carried out by over 5000 informal and formal traders including producers, cooperatives and processors.

2.5.7 Retailing

Retailing entails the sale of raw or processed milk and milk products to consumers. It is carried out by shops, supermarkets, mini dairies, milk bars, traders, cooperatives and individual farmers or farmer groups.

2.5.8 Consumption

Milk consumers consist of households, hotels, institutions and export market (Ouma et al., 2000). A study by FAO (2011) showed that milk consumption trends in Kenya were among the highest in the World with an average of 100 kg/year per capita. The National dairy Master plan estimates annual per capita consumption to be 110 kg and 25 kg in urban and rural areas respectively GoK, (2010 b). There is a high preference for liquid milk among consumers (Ouma et al., 2000). The study by Ouma et al., (2000) did not indicate the capacity of any of these consumers as final markets and which arrangement of actors was needed to improve the structure and performance of the value chain.

2.5.9 Service provision and policy

The ASDS identifies key service providers at various levels of the chain and policy makers. The structure includes:

a) Government

The government provides the policy and regulatory environment. The Ministry of Agriculture, Livestock and Fisheries is responsible for policy formulation and
implementation; facilitate production, research and delivery of extension services through the State Department of Livestock Production (DLP) which includes the Directorate of Veterinary Services (DVS), while the Ministry of Industrialization and Enterprise Development is responsible for the management of dairy cooperatives. The Government is the main influencer of the policy and business environment in which other actors operate. From 2013, the National Government was left with responsibility of policy formulation and research, while devolved County Governments are now in charge of implementing Agriculture and Livestock programmes at the grass root levels (GoK, 2010a).

b) **Kenya Dairy Board**: It is responsible for regulating the dairy sub sector through licensing, inspection, and certification. It also ensures quality control of milk and dairy products from production to marketing by training actors on milk handling practices and promotional activities (Karanja, 2003; Kurwijila and Bannett, 2011)

c) **Kenya Bureau of standards**: Responsible for providing standards and code of practice for production and processing necessary for marketing of milk and dairy products in local and international markets.

d) **Ministry of Health (MoH)**: The Public Health Division, operating within both the MOH and local authorities, ensures/controls the maintenance of hygiene in milk handling activities and premises.

e) **NGO’s - Land O Lakes /Heifer Project International**

Trains mainly farmer organizations on feed conservation methods and coordinates various projects on the Kenya Dairy Sector Competitive Programme (USAID, 2008). The goal is to identify opportunities for competitiveness of dairy farmers and
other actors in the sector. Heifer Project International supports dairy production across the country through provision of heifers to organized groups.

f) **Research and training**

- **KALRO:** KALRO is a government agency responsible for agricultural research. It collaborates with other stakeholders in development and dissemination of knowledge, information and technologies for improving productivity of the sector (KARI, 2009).

- **Universities:** The Universities train manpower in areas related to animal husbandry and health, feeds, milk processing and agribusiness.

g) **Development partners:** They support various projects along the chain in collaboration with the government and service providers. With the support from the private sector and donor agencies, various interventions have been spearheaded with the intention of analyzing the factors constraining the competitiveness of smallholder dairy farmers and policies and institutions affecting the dairy sub-sector, among others. These interventions include: the Smallholder Dairy Project; Kenya Dairy Sector Competitiveness Program (KDSCP), IFAD funded Smallholder Dairy Commercialization Programme (SDCP); East African Dairy Development (EADD); Heifer International dairy project in parts of the Rift Valley and Central Province through gifts of income-producing animals and training; and, the Kenya Dairy Project (KDP) funded by private donors and implemented by Technoserve Inc. (GOK, 2010b; USAID, 2008).

h) **Financial institutions.** Financial institutions support dairy actors by providing credit: These include banks, savings and credit societies, and micro credit
institutions.

Though the structure identified by ASDS performs various functions, information on its efficiency in improving the performance of the value chain is not known.

2.5.10 Main challenges in the dairy sector

Various studies and reports on the sector have pointed out that the sector faces a number of technical, economic and institutional challenges in milk production, processing and marketing (Omore et al., 1999; Karanja, 2003; GoK, 2010a, FAO, 2011; Kilimo Trust, 2012). Some of the main constraints to increased milk production in Kenya have been identified as seasonality in production; inadequate quantity and quality of feed (including limited use of manufactured cattle feeds); inadequate animal husbandry practices; poor access to breeding stock; animal health and credit services, inefficient artificial insemination (AI) services, low adoption of technologies, high cost of farm inputs (including fodder/pasture seeds, dairy meal) and low milk value addition. These constraints have resulted into weak structure and performance of the value chain affecting productivity, commercialization and competitiveness in the domestic and regional markets (GOK, 2007). However, there exist gaps in knowledge on how to prioritize and address these constraints in specific regions using empirical evidence.

2.6 Structure and performance of milk value chain in Western Kenya

The structure of the milk value chain in the Western Kenya Counties of Busia, Bungoma, Kakamega and Vihiga consists of an estimated 99000 smallholder farmers (County Government of Kakamega, personnel communication) keeping an improved dairy cattle population of 192 300 (FAO, 2011). Total annual milk
production from both grade and local cows is estimated at 215 million litres (KDB Kakamega annual report, 2011).

Low productivity of cows and milk insufficiency still persist in Busia, Bungoma, Kakamega and Vihiga Counties of Western Kenya despite several interventions in dairy development projects (Waithaka, 2002; Mudavadi et al., 2001). For instance, Busia District had a milk supply of five million litres against a demand of ten million litres (MOLD Busia district livestock office annual report, 2011). Majority of smallholder dairy farmers’ enterprises are mainly subsistence with little commercialization (Waithaka, 2002). Data from studies by Wambugu (2011) reported that Western Kenya had low production of about 500 litres per cow per year compared to the Central highlands with yields of 2,000 litres per cow per year. At the cooperative level, a study by Limo (2011) showed that between 1992-2008 there were 27 dairy cooperatives but many of these have since collapsed or operate with very low milk supply. The Kenya Dairy Board puts the number of active cooperatives in the region to be about 10 by 2013 with none of them involved in active processing of milk (KDB Kakamega, annual report). The KDB report identifies travelling traders from outside the region, milk bars, households, hotels and institutions as the other key actors in the value chain.

At the service provision level, Ongadi et al (2007), Otieno et al (2005) and Musalia et al (2010), all reported that institutional services especially AI, breeding stock, disease control, extension and marketing were weak. The region’s market offers one of the highest raw milk prices in the country at between KES 45-60 per litre, yet paradoxically, farmers do not seem to respond to this attractive market by increasing production (Livestock County directors-Busia, Bungoma, Kakamega, Vihiga personal communication). At the policy level, many development
Interventions have been carried out in the dairy sector in the region (Mudavadi, 2001; DLPO Busia personal communication), yet the low milk production still persists. From the reported works, there are gaps which are still unknown and questions which need to be answered about the milk value chain in the region. They include: what structure is needed to improve the performance of the value chain? Which stakeholders? Which market opportunities exists and which of these should farmers pursue? What is the influence of variables identified by studies in the region such as use of feeds, A.I services, extension services, credit, dairy meal, access to markets and policy on milk production? Which are the sources and points of inefficiency and how should the value chain be upgraded? This study seeks to find answers to these questions.

2.7 Value chain upgrading strategies: Vertical coordination versus vertical integration

Four types of upgrading strategies to improve structure and performance of value chains have been described by Kaplinsky et al., (2002), GTZ (2008) and Trienekens (2011). These are: Process upgrading (i.e improving processes e.g the use of new technologies); product upgrading (i.e improving quality or value addition); functional upgrading (i.e taking on other activities e.g processing, marketing) and; chain upgrading (i.e abandoning the current chain and moving into a completely new chain). Peppelenbos in KIT and IIRR (2006) however views upgrading from a farmer perspective and proposes four possible strategies for smallholder inclusion (Figure2.4).
Forms of chain participation by small scale farmers

(Peppelenbos, 2005)

Figure 2.4: Forms of chain upgrading by small scale farmers

i) Upgrading as a chain actor. Farmers become commodity specialists with a clear market orientation.

ii) Adding value through vertical integration. Farmers move into processing and marketing in order to add value to the product.

iii) Developing chain partnerships. Farmers build linkages with buyers that are centred on shared interests.

iv) Developing ownership over the chain. Farmers try to build direct linkages with the consumers.

In practice though, a mix of these strategies has often been used in the agricultural sector (KIT and IIRR, 2008; Trienekens, 2011). These could be summarised into two broad categories:
i) Vertical coordination that employs contract farming through lead firms such as agro processors or supermarket chains.

ii) Vertical integration in which producers are horizontally organized, and through cooperatives, move up to take on other activities in the value chain such as processing and marketing (GTZ, 2008; KIT *et al.*, 2006).

The Anand model of India is an example of vertical integration strategy which was developed to improve structure and performance of the milk value chain. Milk production in India is dominated by smallholder farmers and by landless labourers who own about 70 percent of the national dairy herd (Gupta, 1983). Before this intervention, milk production was low due to poverty, lack of technology, difficulties in collecting milk from rural areas, credit; yet demand for milk in India was high. The areas of upgrading entailed a four tier structure each performing a specific function: The milk producers' cooperative society at the village level is responsible for procurement and provision of input services. All Cooperatives form a Union with a processing facility. The Unions form a Federation of Cooperatives for milk marketing. The State Federation form the National Cooperative Dairy Federation of India (NCDFI), which is a national-level body that formulates policies and programmes designed to safeguard the interests of all milk producers. There are three similarities between the situation in India as reviewed by Gupta (1983) and Western Kenya: Production by smallholder farmers, low milk production and high demand. However, there are missing links on how the four-level structure was determined.

A local example of a successful vertical integration model is the Githunguri dairy Farmers Cooperative in which the dairy cooperative specialized and moved
into other functions of the value chain such as input supply, extension, processing and marketing of dairy products (Wambugu, 2011, USAID, 2012). The upgrading made Githunguri Cooperative control about 15% of the national market share among processors as shown earlier in this chapter. Both studies by Wambugu (2011) and USAID (2012) have little information on how the vertical integration structure was determined.

An example of a successful vertical coordination upgrading strategy in Poland is described by Dries and Swinnen (2004). They report the impact of vertical coordination model in the Polish dairy sector dominated by more than one million smallholders owning 1-4 cows. Following liberalization policies of 1990s, the sector had declined due to economic and institutional reforms. Through vertical coordination using Foreign Direct Investment (FDI) channelled through one dairy company, farmers were recruited through contract farming to deliver milk to the processor. These services were repaid through milk check off system tied to milk supplies. The processor in turn provided farm assistance programs such as extension, inputs and dairy loans. The study found that within five years, this model had enhanced milk production, quality improvement and spill over effects to other dairy processors who replicated the model. The upgrading made Poland to become one of the leading producers of milk in Europe.

Locally, a successful vertical coordination example is the Kabiyet Dairy in Nandi County. This is a Nestle company model supported under the East African Dairy Development project. Four thousand active dairy farmers were recruited in Kabiyet village to reach the desired numbers and required quality standards. Through this structure, dairy farmers are provided with continuous training,
technology and skill development: from cow selection, quality feed, breeding practices, disease prevention, milking, housekeeping, storage and transportation to improve the quantity and quality of milk.

Both the Polish and Kabiyyet cases coordinated by lead firms fail to provide empirical evidence which justified selection of various interventions. The success and performance of both structures could be influenced by the prevailing socio economic, organizational, policy and technological factors. Copying successful models from elsewhere does not necessarily guarantee adoption to a new location. Staal *et al* (2008) discusses the pitfall of importing high grade cows not adapted to local conditions and suggests the need to tailor interventions to local circumstances. Though the application of both vertical integration and vertical coordination structures in different regions appeared successful, there are missing links on how both variables for intervention and the choice of the value chain structure were determined.

2.7.1 Current approaches used in selection of variables in upgrading of value chains

The current approaches used in selection of variables when upgrading value chains are relatively qualitative (Ricket *et al.*, 2009). The most common methods used to select interventions include: The use of secondary information and stakeholders in ranking constraints followed by intervention, the analysis of Strengths, Weaknesses, Opportunities and Threats (SWOT); spider web matrix, Ansoff’s matrix, Porter’s diamond (GTZ, 2008; USAID AMAP, 2008). In Kenya where the value chain approach is being promoted to drive the agricultural sector in line with Vision 2030, various organizations (KARI, GTZ, USAID, DANIDA, SNV, ILRI, Kilimo Trust, ASDSP) have used qualitative methods to design upgrading of value chains. First,
secondary data related to a particular value chain are collected. Key stakeholders at different levels are identified to take part in analysis and prioritization of value chains, constraints and interventions. Using this qualitative approach, dairy was identified as a key value chain in Rift Valley, Central, Mt Kenya region, and Coastal regions (GoK, 2012). However, there is very little empirical evidence in the selection of interventions and hence the need for this study.

2.8 Conclusion from literature

This review has examined studies on the milk value chain in three Worlds: The developed, transition (India, Poland) and developing countries (Sub Saharan Africa) which suggest that structure and performance of value chains influenced milk production. Regions in which the value chains performed strongly in including smallholders in input and output markets adopted either a vertical integration or vertical coordination upgrading strategy suitable to the local conditions. The literature suggests that upgrading had an overall impact on increasing yields and national production. However, the various works reviewed have limited information on the use of empirical evidence in the selection of interventions to improve the structure and performance of value chains in different regions.

2.9 Knowledge gaps in the literature

Even though the literature reviewed suggested that the structure and performance of the milk value chain in different countries and regions influenced milk production especially by small holder farmers, there was lack of empirical evidence on how key socio economic (i.e credit, group membership, returns); technological (extension, feeds, use of improved technologies), institutional (linkages) and policy interventions were selected from the entire value chain system.
Secondly, equally less known from the case studies was the impact or contribution of individual factors in the overall improvement. Third, the literature reviewed had inadequate information on how the target market for milk from dairy farms was analysed and selected. Fourth, information on the analysis of sources of inefficiencies in the value chain and the selection of target market for smallholders were not indicated. The reviewed works fail to show how the influence of different variables on milk production was determined. Therefore the lack of empirical research in selection of interventions, the study on relationships between specific value chain variables and milk production and, demonstration of impact *ex ante* is a critical knowledge gap that needs to be studied. The study findings would be useful in helping stakeholders select the most important variables and therefore guide policy action.

2.10 Study theoretical and conceptual framework

2.10.1 Theoretical framework

The theoretical framework used in this study was based on Saunders *et al* (2009) who postulated the importance of understanding the meanings individuals placed on social phenomena. Social phenomena are created from the perceptions and consequent actions of social actors. It is a continuous process in that through the process of social interaction these social phenomena are in a constant state of change. Saunders *et al* (2009) stress the necessity to study the details of the situation to understand the reality since reality is socially constructed. Different actors may perceive the milk value chain system in Western Kenya in different ways according to their own views. These different interpretations are likely to affect their actions as a result of their interaction with the environment which in this case is the value
chain system consisting of actors, service providers and policy environment. The knowledge gap for research is to investigate which variables influence views and actions of actors hence affecting the structure and performance of the milk value chain (Figure 2.5). The study therefore employed the inductive approach since it sought to explore how respondents view variables influencing low production and persistent milk insufficiency in the region.

Figure 2.5: Theoretical framework

2.10.2 Conceptual framework

The framework for this study was adopted from the value chain concept of Potter (1985), Kaplinsky and Morris (2000), USAID (2008), Trienekens (2011). They conceptualize a value chain as sequence of vertically linked processes performed by various actors from input supply to consumption of the final product.
The actors interact with both service providers and policy makers. Both the vertically linked stages and service provision operate within a policy environment. These three constitute the value chain system. Specific value chain variables (identified through secondary data and interviews) and at the three levels may influence market characteristics, efficiency of the value chain, milk production and level of commercialization on smallholder farms. This in turn could impact on the structure and performance of the milk value chain in the region (Figure 2.6). The study used this framework to understand the magnitude of this relationship and the type of actor linkages or structure needed to improve performance.

Variables in Value chain system:
(Fodder, dairy meal, A.I, credit, group membership, extension, linkages, research technologies, returns, community attitude, policy)

Specific variables
Market performance (quantity, price, quality)
Efficiency of value chain
Milk production & level of commercialization on smallholder dairy farms

Structure and performance of milk value chain

Figure 2.6: Conceptual framework
CHAPTER THREE

3 METHODOLOGY

3.1 Introduction

The chapter begins with describing the study location of Western Kenya (Busia, Bungoma, Kakamega and Vihiga) Counties in general and Butula and Butere sub Counties in particular. Data on assessment of milk market opportunities, sources of inefficiencies and evaluation of upgrading strategy were collected in the four counties because of the need to obtain a broader perspective on actors, service provision and policy environment in the region. Data on variables influencing milk production and level of commercialization were collected only in Butula and Butere sub Counties due to logistical issues. This is followed by sections on the research design that was used. The rest of the chapter provides detailed description of sections on study variables and how these were measured; target population, sample size and sampling techniques; data collection instruments; data collection methods, data management and analysis.

3.2 Study Location- Western Kenya region

The study was carried out in Busia, Bungoma, Kakamega and Vihiga Counties of Western Kenya. The region lies on the Equator between latitude 0.03°N to 1°N and 34° E to 35.30°E longitude. It borders Trans Nzoia, Uasin Gishu Counties to the North, Nandi County to the East, Kisumu, Siaya Counties to the South, and Uganda to the West. The region has a total population of 4.3 million and 904,000 households (GOK, 2009). The area has an estimated 99,000 smallholder dairy farmers keeping about 192,300 improved dairy cattle. Western Kenya produces about 215 million litres of milk and is a deficit region. A large part of the region lies in Agro Ecological Zone (AEZ) Low Midland 1 (Jaetzhold et al., 2006)
characterised as sugarcane-maize zone, at an altitude of 1200-1500 meters above sea level (Figure 3.1). The mean annual rainfall is 1500-2000 mm and is bimodal with long rains occurring in March-May and short rains in October-December. Farmers practise mixed crop-livestock farming: Sugarcane is the main cash crop, while maize, cassava, beans, sorghum, millet and sweet potatoes are the major food crops. The livestock kept include indigenous chicken, local zebu cattle, sheep and goats. Dairy farming is practised in all the four counties.

Figure 3.1: Map of Western Kenya showing the study Counties

Source: KARI Soil survey maps
3.2.1 Butula Sub County, Busia County

Butula Sub County is in Busia County. It covers an area of 245 km² and borders Nambale and Funyula Sub Counties of Busia, Matungu Sub County of Kakamega and Ugenya Sub County of Siaya County. It has an estimated human population of 129,359 (GOK, 2009). Annual rainfall is ranges between 1500 mm and 2000 mm and is bimodal. The soils are fertile red loam. The Sub County has a dairy cattle population of 3,400 and about 1,700 farmers (Sub County livestock office personal information, 2012). The map of Butula is shown in Appendix 4 a.

3.2.2 Butere Sub County, Kakamega County

Butere Sub County lies in Kakamega County. It covers an area of 211 km² and borders Mumias and Khwitsero Sub Counties of Kakamega, Ugunja and Gem Sub Counties of Siaya County. It has an estimated human population of 139,780 (GoK, 2009). Annual rainfall is about 1,500 mm and is bimodal. The soils are sand loam. The Sub County has a dairy cattle population of 2,600 and about 1,300 farmers (Sub County livestock office personal information, 2012). The map of Butere is shown in Appendix 4 b.

3.3 Research design

This study adopted an explanatory research design. The approach was considered appropriate because of the need for a full contextual analysis of the selected sample population, examining the relationship between and interrelationships among the study variables. Explanatory survey design was useful in providing information on perceptions, attitudes, motives and actions of various actors in understanding the structure and performance of the milk value chain in the study area. A combination of both qualitative and quantitative data collected using
this design generated the necessary depth of information for establishing the relationship between milk production on smallholder farms and specific variables within the value chain system. While quantitative data were used in making comparisons, qualitative data provided alternative viewpoints in enabling the researcher to answer key study objectives and draw insights that could not be gained with quantitative data only.

The study was organized into four phases:

i) Assessing the quantity, quality, price and reliability of households, hotels, institutions and Cooperatives as milk market opportunities in Busia, Bungoma, Kakamega and Vihiga Counties and; selection of best option market which stakeholders could target.

ii) Assessing relationship between variables within the value chain and milk production on smallholder dairy farms and, determining the level of commercialization.

iii) Assessing the sources of inefficiencies among actors in the milk value chain based on the important variables identified.

iv) Evaluating a potential upgrading strategy targeting the selected market opportunity which improves the structure and performance of the milk value chain

3.4 Study variables and their measurement

The variables measured per study objective were as follows:

i) Objective one – Assessment of milk markets entailed: categories of consumers, sources of milk supply and suppliers; type of milk products, price, quality, quantity, reliability and packaging; marketing channels; consumer preferences, perceptions on milk supply, status of dairy cooperatives (i.e capacity, registered suppliers, quantity
of milk collected and price, quality tests used, constraints facing cooperatives) and ranking of markets. (Details are provided in appendix 1).

ii) Objective two: Eleven variables were identified and selected from the value chain system and their relationship with milk production determined using Pearson’s correlation and multiple regression analysis. The variables were identified from secondary data on studies in the region, the pre testing stage of the questionnaire, focus group discussions with farmers, and interviews with officials from the county livestock department. The variables were: Fodder, dairy meal, extension, artificial insemination services, research technology, group membership, linkages with buyers, returns from milk sales, policy, and credit and community attitude. This objective had both the dependent and independent variables since it was aimed at establishing whether there was a relationship between milk production on smallholder farms and identified variables.

3.4.1 Dependent and independent variables

To determine the relationship between value chain variables and milk production on smallholder farms, the dependent variable measured was:

- Average milk yield per cow per day on the farms was measured in litres.

  Average milk production was estimated over one lactation period in the area (230 days). The independent variables were the eleven value chain variables. They included:

- Fodder
- Dairy meal
- Extension
• Artificial insemination (A.I)
• Use of research technologies
• Availability of credit
• Group membership
• Linkages with buyers
• Returns from milk sales (value added distribution)
• Policy
• Community attitude towards keeping of grade cattle.

These were measured on a Likert scale with rating 1-5 used in the questionnaire to obtain each farmer's response towards every variable and how it influenced milk production. A five represented the most favourable response (strongly agree) and a one represented the least favourable (strongly disagree). They were coded as shown: 1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly agree.

To determine the level of commercialization on farms, the dependent variable measured was:

• Household commercialization index (HCI)

The HCI measured the extent to which an individual household was market-oriented as buyer of inputs and as a seller of milk. It was measured on a continuum of 0-100, where 0 represented no participation in either the input or output markets, and 100 represented full commercialization, as adopted from Strassberg et al (1999) and Govereh et al (1999).
The independent variables were:

a) Input Market Commercialization Index (IMHCl)

\[ IMHCl_i = \sum_{i=1}^{n} \left( \frac{Q_1P_1}{Q_2P_2} \right) \]

Where Q1 and P1 refer to respective quantity and price of inputs purchased and, Q2 and P2 refer to respective quantity and price of inputs used, as described by Pingali and Rosegrant, (1995)

The inputs measured (n) included: the values of fodder, dairy meal, veterinary services, labour and other general expenses.

b) Output Market Commercialization Index (OMHCl)

\[ OMHCl_i = \sum_{i=1}^{n} \left( \frac{Q_sP_s}{Q_pP_p} \right) \]

Where Qs and Ps refer to respective quantity and price of milk sold and, Qp and Pp refer to respective quantity and price of milk produced per cow.

iii) Objective three: assessment of sources of inefficiency in the value chain was based on key variables influencing milk production selected through multiple regression analysis in objective two. The stages of the value chain assessed included:
a) Input supply: (Number of A.I providers, capacity and challenges faced by A.I providers; Source and quality of breeding stock; types and quality of dairy meal in agrovet dealers).

b) Production: types of feed resources used; herd performance (yield per cow/day lactation length), proportion of farmers accessing credit.

c) Collection and bulking: Parameters related to management, availability of and the extent to which cooperatives performed traditional roles and modern functions.

d) Service provision: assessment of capacity and capability of department of livestock services, types of improved fodder technologies developed, commercialised and disseminated. Extent of commercialization of pastures and legumes; constraints faced in commercialization and dissemination of dairy technologies; credit institutions with products for dairy farmers.

e) Policy (Existence of strategic plan on dairy development by the County government, past and on going projects on development).

iv) Objective four: Evaluation of potential upgrading strategy entailed both thematic and quantitative approach. A vertical co ordination strategy incorporating five key areas of intervention identified in objective two and three was analysed. The proposed model was built around re structured cooperatives as the chain governor responsible for provision of inputs, training and marketing of milk. Other stakeholders were selected based on variables identified. One acre feed model based on locally available feeds (Napier, Maize germ, sweet potato vines - dry matter yield per acre) was analysed to determine its carrying capacity (number of animals it could sustain) and the feasibility to increase milk yields from the baseline obtained to 10 litres per cow per day.
3.5 Target population, sample size and sampling technique

3.5.1 Target population

There were different target populations at different levels of the value chain as shown in Table 3.1. At production level, the target population used in this study were smallholder dairy farmers keeping improved breeds/crosses in Busia, Bungoma, Kakamega and Vihiga Counties in Western Kenya. This was because farmers who kept improved breeds or their crosses did so with commercial objective i.e selling milk (Wambugu, 2011). The estimated population of dairy farmers keeping improved breeds in the four Counties was 99,000 (MOLD, Busia report, 2011). From this target population, the accessible population were farmers who were organized in groups because their numbers and records were kept by the livestock office. These groups also had the added advantage of experience in dairy production and hence information and knowledge obtained from these groups could be generalized to the target population.

At input supply, the target groups were: agrovet dealers supplying dairy meal and drugs in Butula and Butere sub Counties.

At collection and bulking, the target group was cooperatives in the four counties, while at processing, there was only one small dairy cooperative (Kitinda dairy in Bungoma County). At consumption (market) level, the target group investigated were households, hotels, institutions (schools, hospitals, universities/colleges) in the four counties.

Within the service provision category, the target groups were: AI providers, extension staff at the County and Sub County offices, Kenya Dairy Board regional office in Kakamega, KALRO and financial institutions. The County livestock
directors provided information on general policy issues and initiatives on dairy development.

3.5.2 Sample size

The sample size needed was determined using formula by Mugenda (2003) and Kothari (2008). i) For known target population sizes----- $n = \frac{N}{1+N(e^2)}$

Where $n = \text{required sample size}$

$N = \text{Estimated population size}$

$E = \text{Acceptable marginal error, which is 5% or 0.05}$

ii) For infinite populations estimated to be more than 10,000 (Mugenda, 2003)

$$n = \frac{Z^2pq}{e^2}$$

Where $n = \text{Sample size (if target population is greater than 10,000)}$

$Z = \text{the standard normal variate which is 1.96 in this case}$

$P = \text{the proportion in the target population estimated to have the characteristic being measured (i.e low milk production)}$

$q = 1-p$

$e = \text{the level of statistical significance (marginal error) which is 5%}$

To determine the sample size of farmers upon substitution in the above formula:

$$n = \frac{99000}{1+99000(0.05^2)} = 400$$

Hence the sample size required was 400 smallholder dairy farms selected from Busia and Kakamega, the two Counties with the highest milk deficit.

Since this study examined the whole value chain, other actors as well as service providers were sampled as shown in Tables 3.1 and 3.2 respectively.
### Table 3.1: Target population and sample size of different actors

<table>
<thead>
<tr>
<th>Value chain segment</th>
<th>Target population</th>
<th>Estimate number</th>
<th>Accessible population</th>
<th>Sample size</th>
<th>Sampling technique</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input supply</td>
<td>Agrovet dealers</td>
<td>&gt;30</td>
<td>Stockists of dairy meal</td>
<td>30</td>
<td>Random</td>
<td>Butula and Butere</td>
</tr>
<tr>
<td>Production</td>
<td>Dairy farmers</td>
<td>99000</td>
<td>Members of Dairy groups</td>
<td>400</td>
<td>stratified, proportionate, random</td>
<td>Butula and Butere</td>
</tr>
<tr>
<td></td>
<td>keeping improved breeds or crosses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collection / bulking</td>
<td>Cooperatives</td>
<td>10</td>
<td>Cooperative members</td>
<td>10</td>
<td>Purposive</td>
<td>Four Counties</td>
</tr>
<tr>
<td>Processing</td>
<td>Processors/dairies</td>
<td>&gt;10000</td>
<td>Mini dairies</td>
<td>1</td>
<td>Purposive</td>
<td>Bungoma</td>
</tr>
<tr>
<td>Consumption</td>
<td>Consumers</td>
<td>&gt;10000</td>
<td>Households, Hotels, institutions</td>
<td>385</td>
<td>Stratified, proportionate, random</td>
<td>Four counties</td>
</tr>
</tbody>
</table>

### Table 3.2: Sample size and sampling technique of service providers

<table>
<thead>
<tr>
<th>Service provider</th>
<th>Position</th>
<th>Sample size</th>
<th>Sampling technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department of Livestock</td>
<td>Livestock officers</td>
<td>4</td>
<td>Purposive</td>
</tr>
<tr>
<td>Artificial inseminators</td>
<td>AI providers</td>
<td>6</td>
<td>Purposive</td>
</tr>
<tr>
<td>Kenya Dairy Board</td>
<td>Manager</td>
<td>1</td>
<td>Purposive</td>
</tr>
<tr>
<td>KALRO</td>
<td>Centre Director</td>
<td>1</td>
<td>Purposive case</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>study</td>
</tr>
<tr>
<td>Financial institutions</td>
<td>Branch manager</td>
<td>3</td>
<td>Purposive</td>
</tr>
<tr>
<td>Agricultural Training Centres</td>
<td>Principal</td>
<td>2</td>
<td>Purposive</td>
</tr>
</tbody>
</table>
3.5.3 Sampling techniques

The sampling procedure used to select farmers was Proportional and Random Sampling. Out of the four counties in the region, two counties with highest milk deficit (Busia and Kakamega) were purposively selected. From each county, one Sub County was purposively selected based on number of farmers and organized farmer groups. Butula and Butere Sub counties were selected from Busia and Kakamega Counties respectively. Within the Sub County, all divisions were stratified, while the number of farmers from each division was proportionally determined (Table 3.3) and subjects for the study chosen at random from lists provided by the Livestock office. The estimated number of dairy farmers in Butula was 1,700, while Butere had 1,300 farmers. The sample size for Butula was determined as: \( \frac{1700}{3000} \times 400 = 227 \), while Butere was \( \frac{1300}{3000} \times 400 = 173 \). Thus 227 farmers were chosen from Butula Sub County while 173 were selected from Butere Sub County as shown in Table 3.3.

Table 3.3: Sample sizes used in farm assessment in Butula and Butere Sub Counties

<table>
<thead>
<tr>
<th>Sub County</th>
<th>Sample size</th>
<th>Division</th>
<th>No of farmers</th>
<th>Study farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butula</td>
<td>227</td>
<td>Marachi West</td>
<td>114</td>
<td>107</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Marachi Central</td>
<td>64</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Marachi East</td>
<td>64</td>
<td>60</td>
</tr>
<tr>
<td>Butere</td>
<td>173</td>
<td>Butere</td>
<td>53</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shiatsala</td>
<td>53</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lunza</td>
<td>78</td>
<td>73</td>
</tr>
<tr>
<td>N</td>
<td>400</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
As for consumers, 385 milk consumer respondents were randomly selected in Busia (72), Vihiga (72), Bungoma (120) and Kakamega (121) Counties through proportional sampling technique (Figure 3.2a). Out of 385 respondents, 253 (65%) comprised households, 107 (28%) hotels and 25 (7%) institutions (universities, schools, hospitals) as shown in Figure 3.2b. The rest of the target groups were sampled as shown in Table 3.1.

Figure 3.2 a & b: Sample sizes in four study Counties for different consumer categories.

3.6 Types of instruments and their pre testing for data collection

For all the objectives, three types of instruments: questionnaires, interview schedules and observational checklist were used to collect information for the study.

The instruments were first pre tested in Ugunja Sub County, Siaya County to ensure all thematic areas in the questionnaire were clearly understood and answered by respondents. Siaya County was chosen due to similar characteristics with the four Counties of Western Kenya. The sample size used in pre testing was 10% as described by Mugenda (2003). These included forty farmers, twenty milk traders,
twenty agrovets, one cooperative, one focus group discussion and one key informant interview.

3.6.1 Questionnaires and administration

Questionnaires were used to collect data from consumers, farmers and cooperatives. For assessment of smallholder farms, the questionnaire comprised two types of questions: closed and open ended, structured in the following thematic sections: Household characteristics; dairy farm characteristics and resource endowment; access to dairy inputs- breeding stock, feeds(fodder and dairy meal), A.I services; access to extension and research services; access to credit and financial services; economic returns from milk sales; relations and linkages with other value chain actors, socio cultural perceptions on keeping grade cattle, policy and infrastructure and other factors influencing milk production / commercialization. questionnaires are shown in appendices 1a, 1c and 2a.

The questionnaires were administered by enumerators selected with the assistance of livestock officers in the specific location. All enumerators had college diploma or bachelor degree in animal production / community development. They were trained to ensure they understood the objective of the study, understood all the questions correctly in both English and the local language (Luhya) that is spoken by the community, and on how to record the responses. They were also trained on interview ethics such as: self introduction and objective of the exercise, time management, and respect for confidentiality.

All enumerators were issued with writing materials and badges for easy identification. The researcher followed the enumerators closely in the field for monitoring and evaluation.
3.6.2 Checklists

Checklists were used to collect data from focus group discussions with farmers and key informants. The checklists are shown in appendices 2c and 3.

3.6.3 Interview guides

Interview schedules consisted of semi-structured questions to gather in-depth data and were administered to key informants in the region: County and Sub County livestock officers, Kenya Dairy Board, KALRO, AI providers, agrovet dealers and financial institutions, as shown in appendices 2b and 3.

3.7 Data sources and data collection methods

3.7.1 Sources of data

i) Secondary data – Information was collected from reports, institutional data bases of KALRO; Ministry of Agriculture, Livestock and Fisheries; International Livestock Research Institute (ILRI); KDB; Journal Papers and internet web sites.

ii) Primary data – Data were collected from stakeholders at three levels of the value chain: Actor level: smallholder farmers, cooperatives, processor, consumers; Service provision level: Agrovet dealers, KALRO, County livestock staff, AI providers, credit institutions. Policy level: County livestock officers and KDB.

3.7.2 Data collection methods

Five data collection methods were used as follows: Survey, focus group discussions, interviews of key informants, case study and personal observations as shown in Table 3.4. It was necessary to combine qualitative and quantitative methods of data collection so as to gain deeper understanding of the phenomenon under study.
Table 3.4: Data collection methods used

<table>
<thead>
<tr>
<th>Objective</th>
<th>Data collection method</th>
</tr>
</thead>
<tbody>
<tr>
<td>To identify and assess milk markets</td>
<td>Survey, interviews and Direct observations.</td>
</tr>
<tr>
<td>To assess variables influencing milk production and level of commercialization</td>
<td>Survey, interviews and Focus group discussions.</td>
</tr>
<tr>
<td>To assess sources of inefficiency in the value chain</td>
<td>Survey, interviews and case study</td>
</tr>
<tr>
<td>To evaluate upgrading strategy</td>
<td>Interviews</td>
</tr>
</tbody>
</table>

a) Surveys

The Survey method was used to collect data from 385 consumers in Busia, Bungoma, Kakamega and Vihiga Counties, from 400 dairy farms in Butula and Butere Sub Counties, cooperatives and 30 agrovet dealers. Surveys were preferred because the type of data required was broad based, and mainly quantitative.

b) Focus group discussions

Focus groups were used for engaging participants in discussing and raising issues that were important to them or questions that individual farmers responded to directly during interviews. Discussions and dissent within a group were useful in helping a researcher understand which variables within the value chain system are held common among farmers and which the group perceived as important in influencing milk production. Six focus group discussions (FGDs), one each from every division were carried out with farmer groups to gain a deeper understanding of factors perceived to influence milk production and priority constraints. Each FGD comprised 12 participants stratified in each division. The participants were randomly
selected from groups. The participants per FGD were male, female and youth in the ratio of 5:5:2 respectively. During discussions, participants talked among themselves on every key topic or question before a consensus was reached. They also ranked important variables and constraints through pair-wise ranking method as described by Mulwa (2006). All combinations were done and responses were recorded and visualized on flipcharts. The venue for FGDs was chosen by the area Livestock officer. The most preferred venues were church compounds and farms where members frequently meet. Each FGD lasted for about three hours between 9.00 am to 12.00 noon.

c) Interviews of key informants

Interviews were used to collect data from key informants. The informants were service providers and knowledgeable on the milk value chain. They included officials of Cooperatives, County livestock officers, Kenya Dairy Board, financial institutions and AI providers. Interviews with key informants were particularly useful in obtaining an overview of the general context of the milk value chain and perceptions on variables influencing milk production.

d) Observations

Direct observations were done at different points in the value chain to triangulate information given by respondents. The observations included farms, cooperatives, agrovet dealers, market facilities, KALRO research farms, ATC farms.

e) Case study

A case study of KALRO Kakamega was carried out to obtain deeper understanding on the development, dissemination and commercialization of various
types of feeds and technologies in the region. The Centre Director and heads of dairy programme provided the data.

3.8 Ethical Issues

The study incorporated several ethical considerations. Permission to carry out the study was sought through letters from Kenyatta University and the researcher’s employer, KALRO, addressed to the Ministry of Agriculture, Livestock and Fisheries and County livestock officers in the region. Consent for respondents to participate in the study was sought through Livestock officers and farmer group leaders who informed them of the impending farm interviews. Other ethical issues considered were: respect for diverse and alternative opinions, equal participation, gender and youth inclusion in focus group discussions, information and experience sharing, time management, choice of venue for meetings, confidentiality of any information given, freedom to decide to answer or not to answer some questions and hospitality (Varkivisser, 1993; Oliver, 2004, Saunders et al., 2009).

3.9 Data management and analysis

The data collected under the study objectives were analyzed as shown below:

3.9.1 Objective 1: Assessment of milk markets

The data collected from 385 respondents were both quantitative and qualitative. They were entered in SPSS version 19 (IBM, 2010), coded and cleaned. For quantitative data, frequency counts, percentages and means were calculated to produce tables and bar charts, while chi square tests were done to test associations observed in some attributes such as channels for milk supply and contamination, types of consumers and preferred attributes. Qualitative data was grouped into categories and results presented under thematic areas.
To make choices on the identified milk markets, the market ranking tool (USAID, 2008) was used in prioritization and ranking. The tool uses three parameters to make choices. These are the markets to choose from, the criteria and weights. In this study the markets were: households, institutions, hotels and cooperatives; while the criteria were: quality, quantity, price, reliability, packaging and availability of organized structure for each milk market. Finally the weights for the criteria were ranked as 1= very low, 2= low 3= average 4= Good. The market with more weights was considered the best option. However, advantages and disadvantages of each market as a buyer of milk (from farmers) were taken into account before a decision was made by the researcher.

3.9.2 Objective 2: Assessment of value chain variables influencing milk production and level of commercialization on smallholder farms

i) Household commercialization index (HCI)

Analysis of level of commercialization was determined from value of inputs purchased from the market, total inputs used in production, value of milk sold and value of total milk produced. HCI was calculated from five parameters: Fodder, dairy meal, hired labour, veterinary services and general expenses (Staal et al, 2003). Data were coded, entered in SPSS program (IBM version 19), cleaned and then exported to excel. Two hundred and ninety one farms with lactating cows were used in calculating HCI to satisfy the requirements of the formula.

Assumptions:
- Where the farm used legumes, the equivalent average value of dairy meal (120 kg per month) was used.
- Where the farm used own fodder, the equivalent average value of purchased fodder was used.
- Where the farm used own labour, the equivalent average opportunity cost of hired labour was used.
Analysis of household participation in input markets as a buyer was calculated as shown:

Input market commercialization index (IMHCIi) ----------------------------------- (1)

\[
IMHCIi = \frac{\text{Gross value of inputs purchased hh i year } j}{\text{Gross value of all inputs used in milk production hh iyear } j} \times 100
\]

(Pingali and Rosegrant, 1995)
Inputs measured included: the values of fodder, dairy meal, veterinary services, labour and other general expenses (Staal et al., 2003).

Analysis of household participation in output markets as a seller

Output market commercialization index (OMHCIi) ----------------------------- (2)

\[
OMHCIi = \frac{\text{Gross value of milk sold hh iyear } j}{\text{Gross value of all milk produced by hh iyear } j} \times 100
\]

(Govereh et al. 1999; Strasberg et al., 1999)
Output measured included: the value of the quantity of milk produced per cow.

Analysis of extent of household market orientation

Overall Household commercialization index------------------------------------- (3)

\[
HCIi = \frac{(IMHCIi \text{ hh } i \text{ year } j + OMHCIi \text{ hh } i \text{ year } j)}{2} \times 100
\]

(Jaleta et al., 2009)

ii) Costs and gross margins

Analysis of costs of production and gross margins (Staal et al., 2003) on individual farms and in the study area was calculated as follows:

Variable costs (VC) per cow per month: Total value of fodder, dairy meal, disease control (vet services), labour and other general expenses.

Gross Revenue (GR) per cow per month: Total value of all milk produced/cow/month
Gross Margin (GM) = GR–VC

Measures of central tendency, range and measures of dispersion were calculated.

iii) Analysis of socio economic variables

Analysis of socio economic variables (age, level of education, income) was expressed using percentages and means.

iv) Analysis of status of value chain components on the farms

Analysis of status of value chain components i.e usage of feeds, dairy meal, A.I, research technologies, credit, economic returns, extension, policy needs and constraints in production were determined using frequencies and means. Chi square was used to test for associations between variables.

v) Analysis of herd characteristics

Assessment of herd characteristics was done for four categories of variables: Herd structure (size, composition); herd performance (milk production, lactation length, calving interval and age at first calving); breeds kept (sources, their performance and associated problems); and, grazing systems, sources and types of fodder on farms. Frequency counts, percentages and means were calculated to produce tables and pie charts, while the ANOVA test was used to establish differences in milk yields between breeds.

vi) Analysis of relationship between value chain variables and milk production

Pearson’s Correlational analysis was carried out to explore if there was a linear relationship between each of the eleven value chain variables and milk production. Since the responses were categorical (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree) they were re-coded into dummy variables for ease of interpretation of the results (Tabachnick and Fidell, 2001; De Maris, 2004). Regression analysis treats all independent (X) variables in the analysis
as numerical. Dummy variables provide a means by which qualitative variables can be analyzed in a regression analysis. Responses 1, 2 and 3 were coded 0 = absence of attribute, while responses 4 and 5 were coded 1 = presence of attribute (Skrivanek, 2009). Bivariate correlation analysis was carried out on farms producing milk. Variables with significant and positive correlation were taken for further analysis in a regression model.

vii) Assessment of predictors of milk production

In order to determine the influence of independent variables on milk production, multiple regression analysis was used to determine their collective or single effect.

The regression equation was given as:

\[ Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} \]

Where

- \( Y \) = Average milk production per cow per day in litres (dependent variable)
- \( \beta_0 \) = intercept (constant)
- \( \beta_1 \) to \( \beta_{11} \) are the regression coefficients
- \( X_1 \) to \( X_{11} \) were the dependent variables representing: fodder, dairy meal, credit, extension, research technologies, artificial insemination, group membership, linkage to buyers, returns, community attitude and policy.

Multiple regression analysis was carried out in a three phase process.

Phase one: All the variables were entered in the model to determine their collective effect on milk production.

Phase two: Non significant variables were dropped while only significant variables were entered in a regression analysis to produce a final model.
Phase three: The effect of individual predictors was analysed using a step wise regression. Variables were entered into the model one at a time starting with the most significant variable as judged by the strength of the beta coefficient. As a single variable was added, the explained variance $R^2$ was calculated.

viii) Assessment of multicollinearity

To ensure that the effect produced by each independent variable (IV) was not as result of one or more of the other independent variables (IVs), collinearity diagnostics was carried out using standard measurements of Tolerance, Variance inflation factor, Eigen value and condition index. Evidence of multi collinearity problems exist when the values of $T<0.1$, Variance Inflation Factor (VIF)$>10$, Eigen value = 1, Condition index=30 (De Maris, 2004; Stevens, 2002; Tabachnick and Fidell (2001).

3.9.3 Objective 3: Assessment of inefficiencies in the value chain

Data collected from different levels of the value chain especially service provisions were mainly qualitative and were analysed using thematic areas. These included: KALRO Kakamega (commercialization of dairy research technologies- fodders and legumes); Agrovet dealers (types and quality of dairy meal), financial institutions (credit types); A.I providers (A.I services- type of constraints); County livestock office (staff compliment; Dairy Policy and strategic plan breeding stock). Data collected through interviews, focus groups, case study and observations were also mainly qualitative, and were therefore analysed and discussed using a thematic approach. Data at production level was mainly quantitative and analysed using frequency counts and percentages.
Quantitative data from survey of cooperatives to determine the number of milk suppliers, intake, capacity of cooperatives, were analysed using descriptive statistics. The extent to which they have embraced specific functions was analysed using percentages.

3.9.4 Objective 4: Evaluation of potential upgrading strategy

Evaluation of upgrading strategy and impact model was informed by findings of objective one (milk market assessment) and objective two (intervention areas identified using multiple regression model) and objective three (inefficiencies in the value chain – capacity of stakeholders). The key issues analysed were: How the deficit of 177 m litres per year could be addressed by increasing milk production on the farms: This was calculated from predicted yield per cow per day (i.e 10 litres) and the number of lactating cows in the Sub County and Western region. The standard feed rations needed across farms: This was calculated from dry matter requirements of a cow producing 10 litres and available feed types and their respective nutritional values i.e Napier grass, Sweet potato vines and maize germ produced in one acre i.e one acre feed models (Chamberlain and Wilkson, 2000). Thenew roles of selected stakeholders in the value chain were based on identified interventions. Changes needed in the market of choice (dairy cooperatives) were based on a restructuring approach (Cook, 1995; Prakash, 2000; Bijman, 2007).

Descriptive statistics and lessons from successful case studies (Githunguri and Kabiyet dairies) were used to analyse and make a proposition for an impact model. To determine the benefits and costs of the proposed interventions, three metrics were assessed:
a) Net Present Value

\[ NPV = \frac{B_0 - C_0}{(1+i)^0} + \frac{B_1 - C_1}{(1+i)^1} + ... + \frac{B_T - C_T}{(1+i)^T}, \]

where: NPV, t = year, B = benefits, C = cost, i=discount rate

b) Benefit-Cost Ratio:

\[ B/C = \left[ \frac{B_0}{(1+i)^0} + ... + \frac{B_T}{(1+i)^T} \right] + \left[ \frac{C_0}{(1+i)^0} + ... + \frac{C_T}{(1+i)^T} \right] \]

c) Internal Rate of Return

\[ IRR = \frac{\text{Discounted benefits} - \text{Discounted costs}}{\text{Total costs}} \]
CHAPTER FOUR

4 RESULTS

Introduction

The results presented in this chapter cover the four study objectives:
Section one presents results of the analysis of structure and performance of the milk market ending with ranking of markets; section two presents the results on household, farm and herd characteristics; level of commercialization, correlation and multiple regression analysis. Section three is on inefficiencies in the value chain while the upgrading strategy and impact model are presented in section four.

4.1 Assessment of the structure and performance of the milk market

The results on the assessment of milk markets include: suppliers and marketing channels, quantity and price, quality, consumer preferences, milk consumption in counties, performance of dairy cooperatives, SWOT analysis of the milk market; and, ranking of milk markets.

4.1.1 Market Structure: Suppliers

Figure 4.1 shows that the largest suppliers of raw milk to consumers were farmers (35%), followed by travelling traders (23%), milk bars (7%) and dairy cooperatives (5%). Pasteurised milk was supplied by shops (22%) and supermarkets (8%). Fifty three percent (53%) of the milk consumed came from outside the region.
4.1.2 Quantity and Price

The mean quantity of milk purchased by households on daily basis was one litre with a range of 0.25 to five litres, while hotels purchased a mean of 10 litres with a range of 0.5 to 100 litres. The mean for institutions was 23 litres with a range of two to 115 litres. Both households and hotels bought raw milk at KES 60 per litre while institutions bought at KES 55 (Table 4.1).
Table 4.1: Quantities of milk (litres) purchased by consumers on daily basis in the study area

<table>
<thead>
<tr>
<th>Consumer</th>
<th>N</th>
<th>Min. (l)</th>
<th>Max. (l)</th>
<th>Mean</th>
<th>SD</th>
<th>Price/litre KES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Households</td>
<td>253</td>
<td>0.25</td>
<td>5</td>
<td>1.0</td>
<td>0.80</td>
<td>60</td>
</tr>
<tr>
<td>Hotels</td>
<td>107</td>
<td>0.5</td>
<td>100</td>
<td>10</td>
<td>9.27</td>
<td>60</td>
</tr>
<tr>
<td>Institutions</td>
<td>25</td>
<td>2</td>
<td>115</td>
<td>23</td>
<td>20.50</td>
<td>55</td>
</tr>
</tbody>
</table>

4.1.3 Problems associated with the quality of marketed milk

Table 4.2 shows the problems associated with different milk suppliers as perceived by consumers. Adulteration of milk with water was the most common problem encountered (65.5% of consumers), followed by addition of chemicals (18%), physical dirt (13.5%), milk turning sour (6%) and clotting (3%). There was a significant association between supplier and contamination of milk ($X^2 = 89.827$, df=20, $p<0.001$). Direct sales from farmer to consumer and farmer-trader-consumer channels had the greatest addition of water, dirty milk and perceived chemical contamination.

Table 4.2: Problems associated with milk suppliers as perceived by consumers

<table>
<thead>
<tr>
<th>Source of milk (response among consumers in numbers)</th>
<th>Farmer</th>
<th>Trave</th>
<th>Dairy</th>
<th>Milk</th>
<th>Shop</th>
<th>Total</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adulteration on</td>
<td>79</td>
<td>55</td>
<td>12</td>
<td>15</td>
<td>5</td>
<td>214</td>
<td>65.5</td>
</tr>
<tr>
<td>Physical dirt</td>
<td>22</td>
<td>11</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>44</td>
<td>13.5</td>
</tr>
<tr>
<td>dirt</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Addition 8 17 2 5 11 15 58 18 of chemicals
Milk turns 0 1 0 0 3 2 6 6 sour
Milk clots 0 0 0 0 3 0 3 3 on boiling

N = 100 %
325

4.1.4 Consumer preferences

Figure 4.2 shows that majority of consumers (households, hotels and institutions) preferred fresh unpasteurized milk (63%) compared to fresh pasteurized (25%) and Ultra Heat Treated (UHT), (12%) milk.

Figure 4.2: Preferences for milk products

Preference for raw (fresh unpasteurized) milk was highest in Busia, followed by Vihiga and Bungoma, while fresh pasteurised milk was popular in Kakamega and Bungoma. UHT was preferred mostly in Bungoma and Vihiga (Figure 4.3).
Figure 4.3: Preferences for milk products in Counties

From interviews, households and institutions preferred unpasteurised milk due to its low price while fresh pasteurised milk and UHT were most preferred in hotels (Figure 4.4).

Figure 4.4: Preferences for milk products among consumers.

There was also a significant association between consumers and preferred attribute ($X^2 = 38.333$, df=8, $p<0.001$) since out of the consumers interviewed
(N=382), 56% preferred quality, 27% price, 9% quantity, 5% packaging while 3% would go for reliability as preferred attribute influencing choice of milk supplier (Figure 4.5).

![Figure 4.5: Preferred attribute for milk supplier](image)

4.1.5 Perceptions on milk supply and consumption in Counties

Figure 4.6 shows that all the four counties experienced low supply of milk. There was a significant association between the counties and low milk supply ($X^2 = 8.510, df = 3, p<0.05$). Ninety two percent (N=354) of the consumers experienced low milk supply for a period of three months between December and March.

![Figure 4.6: Perceptions on whether consumers experienced low milk supply](image)
Seventy eight percent of consumers said their milk consumption had increased during the previous five years while twenty two percent had no increase.

Eighty six percent of the consumers would increase milk consumption during the next five years compared to fourteen percent who would not increase (Figure 4.7).

![Figure 4.7: Consumer perceptions on whether milk consumption had increased](image)

Figure 4.7: Consumer perceptions on whether milk consumption had increased

Figure 4.8 shows there was a significant association between counties and increase in milk consumption in the next five years ($X^2 = 15.093$, df=3, $p<0.05$).

![Figure 4.8: Perceptions on whether milk consumption would increase in Counties](image)

Figure 4.8: Perceptions on whether milk consumption would increase in Counties
4.1.6 Performance of dairy cooperatives

a) Status of cooperatives

Some parameters on the performance of selected cooperatives in the region are shown in Table 4.3. Out of 11841 registered members, only 1,017 (8.6%) were active. The results also show that out of the region’s total installed cooler capacity of 27,600 litres; the average daily intake was 2,420 litres (8.8%). The buying price ranged from KES 30 (milk delivered to processor) to KES 55 per litre, while the selling price ranged from KES 37 (processor) to KES 60 (direct sales to consumers) with an average of KES 43.60 (Table 4.3). It was revealed from interviews that only one cooperative delivered milk to a processor while seven out of the ten cooperatives relied on households as main buyers.
### Table 4.3: Parameters on performance of dairy cooperatives

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Busia</th>
<th>Bungoma</th>
<th>Kakamega</th>
<th>Vihiga</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nambale</td>
<td>Funyula</td>
<td>Kitinda</td>
<td>Naitiri</td>
</tr>
<tr>
<td>Registered suppliers</td>
<td>210</td>
<td>300</td>
<td>9000</td>
<td>1300</td>
</tr>
<tr>
<td>Active suppliers</td>
<td>101</td>
<td>16</td>
<td>50</td>
<td>300</td>
</tr>
<tr>
<td>Capacity of cooler(l)</td>
<td>2500</td>
<td>0</td>
<td>10000</td>
<td>5000</td>
</tr>
<tr>
<td>Intake /day (lit)</td>
<td>350</td>
<td>50</td>
<td>250</td>
<td>800</td>
</tr>
<tr>
<td>Quantity sold/day</td>
<td>300</td>
<td>50</td>
<td>250</td>
<td>800</td>
</tr>
<tr>
<td>Buying Price KES /lit</td>
<td>55</td>
<td>45</td>
<td>40</td>
<td>30</td>
</tr>
<tr>
<td>Selling Price KES /lit</td>
<td>60</td>
<td>50</td>
<td>50</td>
<td>37</td>
</tr>
</tbody>
</table>
b) Costs and gross margins for cooperatives

Table 4.4 shows the costs, revenues and gross margins in the ten cooperatives across the four counties. Five out of the ten cooperatives had negative gross margins, meaning that operational costs are more than revenue received. This situation is explained further in the chapter on Discussion.

Table 4.4: Costs and gross margins for dairy cooperatives

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Busia</th>
<th>Bungoma</th>
<th>Kakamega</th>
<th>Vihiga</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nambale</td>
<td>Funyula</td>
<td>Naitiri</td>
<td>Kimili</td>
</tr>
<tr>
<td>Revenue/month (KES)</td>
<td>540000</td>
<td>75000</td>
<td>375000</td>
<td>888000</td>
</tr>
<tr>
<td>Variable costs/month (KES)</td>
<td>543834</td>
<td>75335</td>
<td>325200</td>
<td>747150</td>
</tr>
<tr>
<td>GM</td>
<td>-3834</td>
<td>-335</td>
<td>49800</td>
<td>140850</td>
</tr>
</tbody>
</table>

Costs items included: milk purchases (quantity x price), rent, Licences (KDB, County government), electricity and salaries.

Revenue = milk sales (quantity x price).
4.1.7 SWOT analysis of the milk market

The Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis of the milk market are shown in Table 4.5. The analysis was carried out from interviews with key informants, consumer survey and observations in the four counties. Availability of milk coolers in cooperatives, good accessibility and conducive environment for milk production are strengths which could be optimised to take advantage of high milk prices and a growing demand. Inadequate milk supplies, low quality of milk, unorganised milk market are weaknesses which should be addressed to mitigate the threat of competitors from outside and safety concerns.

Table 4.5: SWOT of milk market in Western Kenya

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk coolers available for storage</td>
<td>High milk price</td>
</tr>
<tr>
<td>Good environment for milk production</td>
<td>Growing demand</td>
</tr>
<tr>
<td>Good accessibility</td>
<td>Urbanization</td>
</tr>
<tr>
<td><strong>Weaknesses</strong></td>
<td><strong>Threats</strong></td>
</tr>
<tr>
<td>Inadequate milk supply</td>
<td>Competition from outside suppliers</td>
</tr>
<tr>
<td>Low milk quality</td>
<td>Safety concerns due to milk contamination</td>
</tr>
<tr>
<td>Underutilized milk coolers</td>
<td></td>
</tr>
<tr>
<td>Un organized milk market</td>
<td></td>
</tr>
<tr>
<td>Absence of milk processing plant in the region</td>
<td></td>
</tr>
</tbody>
</table>

4.1.8 Making choices on markets

Table 4.6 shows the ranking of the four milk markets studied. The ranking integrated the results in Table 4.1 and Figure 4.5, and interviews with the County livestock departments. The procedure followed is described in Section 3.9.1. In terms of quality, cooperatives bought milk of higher quality than institutions, hotels
and households. As for pricing, households paid better price than the rest of the buyers. Cooperatives also had more capacity to buy large quantities of milk, were more reliability and had an organized structure compared to the other milk buyers. Therefore cooperatives were ranked first while institutions, hotels and households were ranked second, third and fourth respectively. Cooperatives had the advantage of contractual arrangements with suppliers as well as huge cooler capacity, but their main disadvantage was low payment to farmers and mismanagement. Institutions had contracts with suppliers but were few and scattered. Households and hotels paid better prices to suppliers but purchased low volumes. Household buyers had a further disadvantage of being unreliable. Therefore the best option milk market (buyer) which farmers or stakeholders could target in an upgrading strategy is the cooperative.

Table 4.6: Ranking of milk markets

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Milk markets / buyers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Households</td>
</tr>
<tr>
<td>Quality</td>
<td>1</td>
</tr>
<tr>
<td>Price</td>
<td>4</td>
</tr>
<tr>
<td>Quantity</td>
<td>1</td>
</tr>
<tr>
<td>Reliability</td>
<td>2</td>
</tr>
<tr>
<td>Packaging</td>
<td>1</td>
</tr>
<tr>
<td>Availability of organized structure</td>
<td>1</td>
</tr>
<tr>
<td>Total weights</td>
<td>10</td>
</tr>
<tr>
<td>Rank</td>
<td>4</td>
</tr>
</tbody>
</table>

Legend
Weights: 1= very low, 2= low, 3= average, 4= good
4.2 Variables influencing milk production and level of commercialization

This section presents results on household, farm and herd characteristics; the status and variables influencing milk production; and the level of commercialization on smallholder dairy farms.

4.2.1 Household demographics

Table 4.7 shows a summary of selected household demographics in Butula and Butere Sub Counties. The mean age of dairy farmers was 52 years. Most of farmers had at least primary (45%) and secondary level of education (30%). About 45% of respondents earned less than KES 5,000 per month while 39% earned between KES 5 000 to KES 10 000. Overall, 84% earned less than KES 10,000 while only 16 % earned more than KES 10,000.

The main sources of income were sale of milk (47.9%), sale of crops (26.2%) and salary (13.9%).

Table 4.7: Selected demographics in Butula and Butere

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Butula (N=227)</th>
<th>Butere (N=173)</th>
<th>Total Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of head of household (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>51</td>
<td>53</td>
<td>52</td>
</tr>
<tr>
<td>N=391</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education level (%) N=382</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>8.10</td>
<td>6.50</td>
<td>7.30</td>
</tr>
<tr>
<td>Primary</td>
<td>48.30</td>
<td>41.30</td>
<td>44.80</td>
</tr>
<tr>
<td>Secondary</td>
<td>30.10</td>
<td>30.70</td>
<td>30.40</td>
</tr>
<tr>
<td>College</td>
<td>9.10</td>
<td>15.50</td>
<td>12.30</td>
</tr>
<tr>
<td>University</td>
<td>4.30</td>
<td>6.10</td>
<td>5.20</td>
</tr>
<tr>
<td>Monthly income (KES) (%) N=395</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$&lt;5000</td>
<td>45.50</td>
<td>45.00</td>
<td>45.25</td>
</tr>
</tbody>
</table>
### Main source of income (%)

<table>
<thead>
<tr>
<th>Source of Income</th>
<th>Butula</th>
<th>Butere</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sale of crops</td>
<td>29.6</td>
<td>22.8</td>
<td>26.2</td>
</tr>
<tr>
<td>Salary</td>
<td>9.7</td>
<td>18.1</td>
<td>13.9</td>
</tr>
<tr>
<td>Retail business</td>
<td>7.1</td>
<td>7.7</td>
<td>7.4</td>
</tr>
<tr>
<td>Wages</td>
<td>0.9</td>
<td>0.6</td>
<td>0.75</td>
</tr>
<tr>
<td>Rent</td>
<td>0.9</td>
<td>2.3</td>
<td>1.6</td>
</tr>
<tr>
<td>Sale of milk</td>
<td>49.6</td>
<td>46.2</td>
<td>47.9</td>
</tr>
<tr>
<td>Others</td>
<td>2.2</td>
<td>2.3</td>
<td>2.25</td>
</tr>
</tbody>
</table>

#### 4.2.2 Selected farm characteristics

Table 4.8 shows the means and frequencies of selected farm characteristics in Butula and Butere. The average land size was 3.9 acres, with mean land size allocated to fodder being 1.14 acres respectively. Land allocated to fodder in Butula was 1.34 acres while in Butere it was 0.94 acres and this difference was significant ($F_{1, 349} = 11.981, P<0.05$). Inventory on ownership of dairy equipment as an indicator of level of mechanization showed that the most common equipment was hand sprayer for tick control (64.4%). Only about 4.7% of the farms possessed chaff cutter for fodder, while 0.3% owned hand milking machine. None of the farms owned a tractor. About one third of the farms (31%) did not own any equipment. The marketing outlets used by farmers were individuals (64.5%), traders (15.8%), hotels (13.5%) and institutions (4.2%). Cooperatives were the least popular marketing channel used by only 2% of the farms.
Table 4.8: Selected farm characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Butula (N=227)</th>
<th>Butere (N=173)</th>
<th>Total N=(400)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm size (acres(^1))</td>
<td>4.03</td>
<td>3.78</td>
<td>3.90</td>
</tr>
<tr>
<td>Land allocated to fodder* (acres)</td>
<td>1.34</td>
<td>0.94</td>
<td>1.14</td>
</tr>
<tr>
<td>Ownership of dairy equipment (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chaff cutter</td>
<td>5</td>
<td>4.3</td>
<td>4.65</td>
</tr>
<tr>
<td>Hand milking machine</td>
<td>0</td>
<td>0.6</td>
<td>0.3</td>
</tr>
<tr>
<td>Sprayer</td>
<td>63</td>
<td>65.8</td>
<td>64.4</td>
</tr>
<tr>
<td>Tractor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>None</td>
<td>32</td>
<td>29.3</td>
<td>30.65</td>
</tr>
<tr>
<td>Marketing channels (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individuals</td>
<td>68.40</td>
<td>60.60</td>
<td>64.50</td>
</tr>
<tr>
<td>Cooperative</td>
<td>1.10</td>
<td>2.90</td>
<td>2</td>
</tr>
<tr>
<td>Traders</td>
<td>13.30</td>
<td>18.30</td>
<td>15.80</td>
</tr>
<tr>
<td>Hotels</td>
<td>13.90</td>
<td>13.10</td>
<td>13.50</td>
</tr>
<tr>
<td>Institutions</td>
<td>3.30</td>
<td>5.10</td>
<td>4.20</td>
</tr>
</tbody>
</table>

\(^1\) 1 acre = 0.405 hectares  
* p<0.05

4.2.3 Herd characteristics and performance

The mean herd size for 400 dairy farms was 2.46 with a minimum of one and a maximum of eight animals. The number of farms with milking (lactating) cows was 291 (72.6%) as shown in Table 4.9.

a) Herd Composition

The results showed that the herd size ranged from 1-8 animals with a mean of 2.46, while a proportion of 36.4% and 15% of the animals were lactating cows and heifers.
respectively. About 73% and 37% of the farms had lactating cows and heifers respectively (Table 4.9).

Table 4.9: Herd structure on smallholder farms in the study area

<table>
<thead>
<tr>
<th>Herd compositio</th>
<th>No of farm</th>
<th>% of total farm</th>
<th>Mean</th>
<th>StdDev</th>
<th>Min</th>
<th>Max</th>
<th>Total no of animal</th>
<th>Proportion n (%) of animals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herd size</td>
<td>400</td>
<td>100</td>
<td>2.46</td>
<td>1.33</td>
<td>1</td>
<td>8</td>
<td>995</td>
<td>100</td>
</tr>
<tr>
<td>Male calves</td>
<td>107</td>
<td>26.8</td>
<td>1.12</td>
<td>0.36</td>
<td>1</td>
<td>3</td>
<td>120</td>
<td>12.1</td>
</tr>
<tr>
<td>Female calves</td>
<td>132</td>
<td>33</td>
<td>1.14</td>
<td>0.37</td>
<td>1</td>
<td>3</td>
<td>150</td>
<td>15</td>
</tr>
<tr>
<td>Immature bulls</td>
<td>40</td>
<td>10</td>
<td>1.23</td>
<td>0.57</td>
<td>1</td>
<td>3</td>
<td>49</td>
<td>4.9</td>
</tr>
<tr>
<td>Heifers 1-2 yrs</td>
<td>148</td>
<td>37</td>
<td>1.15</td>
<td>0.46</td>
<td>1</td>
<td>4</td>
<td>169</td>
<td>17</td>
</tr>
<tr>
<td>Steers</td>
<td>6</td>
<td>1.5</td>
<td>1.13</td>
<td>0.52</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td>0.8</td>
</tr>
<tr>
<td>Bulls</td>
<td>18</td>
<td>4.5</td>
<td>1.17</td>
<td>0.71</td>
<td>1</td>
<td>1</td>
<td>18</td>
<td>1.8</td>
</tr>
<tr>
<td>Lactating cows</td>
<td>291</td>
<td>72.6</td>
<td>1.24</td>
<td>0.50</td>
<td>1</td>
<td>3</td>
<td>362</td>
<td>36.4</td>
</tr>
<tr>
<td>Dry cows</td>
<td>106</td>
<td>26.7</td>
<td>1.12</td>
<td>0.33</td>
<td>1</td>
<td>2</td>
<td>119</td>
<td>12.0</td>
</tr>
</tbody>
</table>
b) **Herd performance**

Table 4.10 shows the herd performance.

i) **Milk yield**

The mean milk yield per cow per day was 6.5 litres with a range of 1-20 litres. About 54% of the farms produced less than 5 litres of milk per cow per day, while 36% and 7% produced 6-10 and 11-15 litres respectively. Only about 4% of the farms produced more than 15 litres per cow per day. The highest (peak) production among the study farms was 40 litres.

ii) **Lactation period**

The mean lactation period was 7.67 months (230 days) with a range of 5-12 months (150-210 days). The majority of farms (77.8%) had a lactation period of 5-7 months. This finding means that the cows are drying up too early before the desired normal lactation period of 305 days.

iii) **Calving interval**

The mean calving interval was 14.77 months (443 days) with a range of 12-36 months (365-1080 days).

iv) **Age at first calving**

The mean age at first calving was 28.15 months with a range of 24-38 months.
Table 4.10: Herd performance in Butula and Butere Sub Counties

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Butula</th>
<th>Butere</th>
<th>Overall</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herd size</td>
<td>2.53</td>
<td>2.38</td>
<td>2.46</td>
<td>1.33</td>
<td>1</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>No. of milking cows</td>
<td>1.3</td>
<td>0.7</td>
<td>1</td>
<td>0.63</td>
<td>0</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Av milk yield/cow/day* (litres)</td>
<td>6.47</td>
<td>6.47</td>
<td>6.47</td>
<td>3.88</td>
<td>1</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Peak production* (months)</td>
<td>12.4</td>
<td>11.18</td>
<td>11.79</td>
<td>6.54</td>
<td>2</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>lactation period* (months)</td>
<td>7.9</td>
<td>7.44</td>
<td>7.67</td>
<td>1.6</td>
<td>5</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Av calving interval* (months)</td>
<td>14.4</td>
<td>15.3</td>
<td>14.77</td>
<td>3.9</td>
<td>12</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Age at first calving* (months)</td>
<td>27.72</td>
<td>28.72</td>
<td>28.15</td>
<td>3.9</td>
<td>24</td>
<td>38</td>
<td></td>
</tr>
</tbody>
</table>

*No of farms: Butula =166 (73%)
Butere = 125 (72%)

v) Performance indicators

Table 4.11 shows performance indicators on smallholder farms in Butula and Butere Sub counties. About 89% of the farms produced less than 10 litres of milk per cow per day; 78% of the farms recorded a lactation period of 5-7 months; 91% of the farms had a calving interval of 12-18 months, while about 65% of the farms recorded the age at first calving of 24-28 months.

Table 4.11: Performance indicators of dairy cows on smallholder farms

<table>
<thead>
<tr>
<th>Milk yield/cow/day (litres)</th>
<th>No of farms</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td>156</td>
<td>53.6</td>
</tr>
<tr>
<td>6-10</td>
<td>104</td>
<td>35.7</td>
</tr>
<tr>
<td>11-15</td>
<td>20</td>
<td>6.9</td>
</tr>
<tr>
<td>&gt; 15</td>
<td>11</td>
<td>3.8</td>
</tr>
<tr>
<td>Total</td>
<td>291</td>
<td>100</td>
</tr>
</tbody>
</table>
Mean milk yield/cow/day = 6.47 ± 3.88

Lactation period (months)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5-7</td>
<td>238</td>
<td>77.8</td>
</tr>
<tr>
<td>8-10</td>
<td>39</td>
<td>11.7</td>
</tr>
<tr>
<td>11-12</td>
<td>29</td>
<td>10.5</td>
</tr>
<tr>
<td>Total</td>
<td>306</td>
<td>100</td>
</tr>
</tbody>
</table>

Mean lactation period = 7.67 ± 1.6 months (230 days)

Calving interval (months)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>12-18</td>
<td>290</td>
<td>90.9</td>
</tr>
<tr>
<td>19-24</td>
<td>32</td>
<td>6.9</td>
</tr>
<tr>
<td>25-30</td>
<td>3</td>
<td>0.9</td>
</tr>
<tr>
<td>31-36</td>
<td>4</td>
<td>1.3</td>
</tr>
<tr>
<td>Total</td>
<td>329</td>
<td>100</td>
</tr>
</tbody>
</table>

Mean calving interval = 14.77 ± 2.61 months

Age at first calving (months)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>24-28</td>
<td>139</td>
<td>65</td>
</tr>
<tr>
<td>29-33</td>
<td>49</td>
<td>22.9</td>
</tr>
<tr>
<td>34-38</td>
<td>23</td>
<td>12.1</td>
</tr>
<tr>
<td>Total</td>
<td>214</td>
<td>100</td>
</tr>
</tbody>
</table>

Mean age at first calving = 28.15 ± 3.9 months

---

vi) Types of cattle breeds kept by farmers

Tables 4.12 and 4.13 show common cattle breeds kept and their milk yields.

The common breeds kept for milk production were exotic cattle-zebu crosses (40.9% of animals) and Friesians (35.2%), followed by Aryshires (22%), while Jerseys were kept on 1.9% of the farms (Table 4.12).
Table 4.12: Dominant improved cattle breeds kept in the study area

<table>
<thead>
<tr>
<th>Cattle breed</th>
<th>No. of farms</th>
<th>Total no of animals</th>
<th>Proportion (%) of animals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crosses</td>
<td>222</td>
<td>350</td>
<td>40.9</td>
</tr>
<tr>
<td>Friesian</td>
<td>148</td>
<td>301</td>
<td>35.2</td>
</tr>
<tr>
<td>Aryshire</td>
<td>127</td>
<td>189</td>
<td>22</td>
</tr>
<tr>
<td>Jersey</td>
<td>15</td>
<td>16</td>
<td>1.9</td>
</tr>
</tbody>
</table>

In terms of breed performance, Friesians produced a higher mean yield of 7.6 litres/day compared to Aryshires at 7.0 kg, while Jerseys produced 6.1 litres per day. Crosses produced the lowest yields at 3.9 litres. There were significant differences in milk production between exotic breeds and crosses (p<0.05) as shown in Table 4.13.

Table 4.13: Mean milk yields of different cattle breeds in the study area

<table>
<thead>
<tr>
<th>Cattle breed</th>
<th>No of farms</th>
<th>Milk yield /cow/day (litres)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Min</td>
</tr>
<tr>
<td>Friesian</td>
<td>76</td>
<td>7.6</td>
</tr>
<tr>
<td>Aryshire</td>
<td>68</td>
<td>7.0</td>
</tr>
<tr>
<td>Jersey</td>
<td>15</td>
<td>6.1</td>
</tr>
<tr>
<td>Crosses</td>
<td>111</td>
<td>3.9</td>
</tr>
</tbody>
</table>

Pair wise comparisons*

<table>
<thead>
<tr>
<th>Breed(^b) (I)</th>
<th>Breed (J)</th>
<th>Mean difference (I-J)</th>
<th>Std error</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friesian</td>
<td>Aryshire</td>
<td>0.6</td>
<td>1.087</td>
<td>0.997</td>
</tr>
<tr>
<td></td>
<td>Crosses</td>
<td>3.7(^a)</td>
<td>0.0878</td>
<td>0.001</td>
</tr>
<tr>
<td>Aryshire</td>
<td>Friesian</td>
<td>-0.6</td>
<td>1.087</td>
<td>0.997</td>
</tr>
<tr>
<td></td>
<td>Crosses</td>
<td>3.1(^a)</td>
<td>1.153</td>
<td>0.008</td>
</tr>
<tr>
<td>Crosses</td>
<td>Friesian</td>
<td>-3.7(^a)</td>
<td>0.878</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Aryshire</td>
<td>-3.1(^a)</td>
<td>1.153</td>
<td>0.008</td>
</tr>
</tbody>
</table>

* The farm sizes were unequal. Jersey was dropped due to sample size less than 30.
The mean difference in milk yields was significant at 0.05 level.

F statistic for effect of breed was significant ($F_2, 270 = 6.905, p<0.001$).

*Only farms with one type of breed producing milk were selected*

### 4.2.4 Status of value chain variables

This section presents the results on assessment of the status of value chain variables.

The variables included: fodder, dairy meal, AI, extension advice, research technologies, credit, linkages, returns from milk sales, socio cultural perceptions on dairy, policy needs and constraints faced by farmers in dairy production.

**a) Use of fodder**

The results shown in Table 4.14 indicate farmers' over rely on Napier grass (98%) as the main source of roughage, mainly grown on own farm (90%). There were four common types of feeding systems practised: zero grazing (stall-feeding, 66%), semi grazing (24%), tethering (6%) and open grazing (4%). Only about6% of the farms had conserved feeds compared to 94% who did not.

**Table 4.14 : Main fodder, sources, feeding systems used and evidence of conserved feed on smallholder dairy farms**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Butula (%)</th>
<th>Butere (%)</th>
<th>Total No of farms</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main fodder</td>
<td>Napier grass</td>
<td>98</td>
<td>98</td>
<td>392</td>
<td>98.0</td>
</tr>
<tr>
<td></td>
<td>Natural pasture</td>
<td>2</td>
<td>2</td>
<td>8</td>
<td>2.0</td>
</tr>
<tr>
<td>Source of fodder</td>
<td>Own farm</td>
<td>92</td>
<td>88</td>
<td>355</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Roadside grass</td>
<td>0</td>
<td>0.6</td>
<td>1</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>Purchase from outside</td>
<td>6.7</td>
<td>8.8</td>
<td>30</td>
<td>7.8</td>
</tr>
</tbody>
</table>
Grazing system

<table>
<thead>
<tr>
<th>Grazing system</th>
<th>Butula (%)</th>
<th>Butere (%)</th>
<th>Total farms (F)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rented land</td>
<td>1.7</td>
<td>2.4</td>
<td>8</td>
<td>2.0</td>
</tr>
<tr>
<td>Zero grazing</td>
<td>71</td>
<td>62</td>
<td>267</td>
<td>66</td>
</tr>
<tr>
<td>Semi grazing</td>
<td>22</td>
<td>27</td>
<td>95</td>
<td>24</td>
</tr>
<tr>
<td>Open grazing</td>
<td>4</td>
<td>4</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>Tethering</td>
<td>4</td>
<td>13</td>
<td>8</td>
<td>6</td>
</tr>
</tbody>
</table>

Evidence of conserved feed

<table>
<thead>
<tr>
<th>Evidence of conserved feed</th>
<th>Butula (%)</th>
<th>Butere (%)</th>
<th>Total farms (F)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>4</td>
<td>8</td>
<td>22</td>
<td>6</td>
</tr>
<tr>
<td>No</td>
<td>96</td>
<td>92</td>
<td>378</td>
<td>94</td>
</tr>
</tbody>
</table>

b) Use of Dairy meal and Other protein feeds

The extent of use of dairy meal and other protein feeds is presented in Table 4.15.

The majority of farms (69%) used dairy meal compared to 31% who did not use.

The reasons for non use of dairy meal as perceived by farmers were: expensive (59%) no increase in milk yield 13%, not available 13% and others (15%). Other protein feeds used as substitute for dairy meal indicated that sweet potato vines was used by majority of farmers (67%) as presented in Table 4.15.

Table 4.15: Use of dairy meal and other protein feeds

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Butula (%)</th>
<th>Butere (%)</th>
<th>Total no. of farms (F)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy meal</td>
<td>Yes</td>
<td>70</td>
<td>68</td>
<td>274</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>30</td>
<td>32</td>
<td>122</td>
<td>31</td>
</tr>
<tr>
<td>Reason for not using dairy meal</td>
<td>Expensive</td>
<td>62</td>
<td>56</td>
<td>46</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>No increase in yield</td>
<td>12</td>
<td>14</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Not available</td>
<td>12</td>
<td>14</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>14</td>
<td>17</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>Other protein feeds</td>
<td>Sweet potato vines</td>
<td>69</td>
<td>65</td>
<td>254</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>Desmodium</td>
<td>20</td>
<td>20</td>
<td>76</td>
<td>20</td>
</tr>
</tbody>
</table>
Lucerne 4 4 15 4
Others 1 3 7 2
(Calliandra, leuceana, Milk weed)
None 6 8 25 7

c) Access to artificial insemination and breeding services

Table 4.16 shows the use of AI, breeding services and knowledge on the type of semen used in AI on smallholder dairy farms. Butula had 93 (42%) farms using AI compared to 65 (38%) farms in Butere. Overall, only 40% of farms used AI in the study area. Bull service was used by 41% of the farms in Butula compared to 40% in Butere. Only about 18% of the farms had knowledge on the type of semen used to serve their cows compared to 82% who did not know (Table 4.16).

Table 4.16: Use AI and breeding services

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Butula (%)</th>
<th>Butere (%)</th>
<th>Total No of farms</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of AI</td>
<td>Yes</td>
<td>42</td>
<td>38</td>
<td>158</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>58</td>
<td>108</td>
<td>62</td>
<td>60</td>
</tr>
<tr>
<td>Reason for non use</td>
<td>Expensive</td>
<td>12</td>
<td>12</td>
<td>29</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Not available</td>
<td>15</td>
<td>17</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Repeated service</td>
<td>27</td>
<td>24</td>
<td>63</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Long distance</td>
<td>4</td>
<td>4</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Use of bull</td>
<td>40</td>
<td>41</td>
<td>99</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Knowledge of type of semen</td>
<td>Yes</td>
<td>20</td>
<td>16</td>
<td>65</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>80</td>
<td>144</td>
<td>84</td>
<td>82</td>
</tr>
</tbody>
</table>
C(i) Source of breeding stock used by farmers

About 62% of the farms in both Butula and Butere obtained breeding stock through donations by NGOs operating in the area, 22% purchased from Rift Valley, 11% from neighbours, while 3% from upgrading of local cows (Figure 4.9). The results mean that the study area did not have a local source of breeding stock.

Figure 4.9: Sources of dairy cattle breeding stock in the study area

C (ii) Problems associated with breeds

The common problems associated with breeds were low milk production, cows not coming on heat, reproductive disorders, frequent treatment and cows with bad temper (Table 4.17)
Table 4.17: Problems associated with breeds as perceived by farmers

<table>
<thead>
<tr>
<th>Problem</th>
<th>Frequency</th>
<th>Proportion of farms (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low milk production</td>
<td>92</td>
<td>46</td>
</tr>
<tr>
<td>Cow does not easily come on</td>
<td>41</td>
<td>20.5</td>
</tr>
<tr>
<td>heat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reproductive disorders</td>
<td>33</td>
<td>16.5</td>
</tr>
<tr>
<td>Cow needs frequent treatment</td>
<td>32</td>
<td>16</td>
</tr>
<tr>
<td>Cow has bad temper</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

n = 200

Table 4.18 presents the price bands for dairy cows as per potential milk yield. Only 1% of the farmers were willing to pay to acquire a high yielding dairy cow compared to 86% who could only afford a low yielder.

Table 4.18: Price at which the farmers were willing to pay to acquire a high yielder dairy cow

<table>
<thead>
<tr>
<th>Price bands (KES)</th>
<th>Frequency (N=389)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 000 - 70 000*</td>
<td>305</td>
<td>86</td>
</tr>
<tr>
<td>71 000 - 100 000</td>
<td>78</td>
<td>13</td>
</tr>
<tr>
<td>&gt;100 000</td>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>

* The calculated mean price obtained from respondents was KES 47,000. Price bands are defined by the level of milk production: Low yielders cost up to KES 70,000; Medium yielders KES 71,000-100,000 while high yielders cost more than KES 100,000.
d) Access to extension advice

Table 4.19 presents use of extension advice on smallholder farms. The main sources of extension were Government staff, farmer groups and Agrovet dealers, while for those farmers who did not use extension advice said that it was neither reliable nor available. The priority training needs by farmers were on disease control and how to feed a dairy cow. The most common sources of training used by farmers were farmer groups, NGOs and exchange visits.

Table 4.19: Use of extension advice

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Butula (%)</th>
<th>Butere (%)</th>
<th>No of farms</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main source of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>extension advice</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(N=342)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agrovet</td>
<td>14</td>
<td>17</td>
<td>51</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>GoK</td>
<td>52</td>
<td>50</td>
<td>176</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td>Neighbour</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Farmer group</td>
<td>30</td>
<td>29</td>
<td>101</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>3</td>
<td>9</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Reason for not</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>seeking extension</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>advice (N=74)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expensive</td>
<td>13</td>
<td>12</td>
<td>9</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Not available</td>
<td>25</td>
<td>26</td>
<td>19</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Not reliable</td>
<td>38</td>
<td>35</td>
<td>27</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Long distance</td>
<td>20</td>
<td>18</td>
<td>14</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>8</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Training needs of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>farmers (N=392)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How to feed dairy cow</td>
<td>27</td>
<td>33</td>
<td>115</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Disease control</td>
<td>45</td>
<td>42</td>
<td>170</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>A.I service</td>
<td>6</td>
<td>6</td>
<td>25</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Source of dairy</td>
<td>7</td>
<td>4</td>
<td>21</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>breeds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marketing</td>
<td>7</td>
<td>9</td>
<td>81</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Heat detection</td>
<td>7</td>
<td>6</td>
<td>4</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>
Source of dairy training commonly used by farmer
Formal training Farmer group NGOs (N=316)
    19 32 26 19 Exchange visit
    training 17 30 17 17 Agricultural
commonly used by farmer (N=316)
    54 106 87 58 3 4 1
by farmer by farmer
commonly used by farmer (N=316)

\[ \chi^2 = 16.980, \text{df}=4, p<0.05 \]

e) Access to improved research technologies and services

Table 4.20 shows the use of improved research technologies on smallholder farms.
Fifty per cent of the farms used at least one technology from research institutes while 50% did not. The main reasons for not using improved technologies were: not aware (57%) and not available (35%). There was a significant association between Sub Counties and reasons for not using research technologies \( (X_2 = 16.980, \text{df}=4, p<0.05) \). The main sources of improved technologies were NGOs, KARI and ATCs.
Priority technology needs by farmers were on disease control, feed analyses, fodders varieties, breeds and protein feeds.

**Table 4.20: Use of improved research technologies**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Butula (%)</th>
<th>Butere (%)</th>
<th>No of farms</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of at least one improved research technology (N=396)</td>
<td>Yes</td>
<td>50</td>
<td>50</td>
<td>197</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>50</td>
<td>50</td>
<td>199</td>
<td>50</td>
</tr>
</tbody>
</table>
f) Access to credit and financial services

Table 4.21 shows access to credit and financial services on smallholder farms. Only about 8% of the farms had obtained credit during previous five years, while 92% had not. The main reasons for not using credit were: Fear land may be auctioned (41%), high interest rates (29%) and inaccessibility (22%). The main source of financing dairy enterprise was own savings (77%). Priority needs for credit were: to improve on feeds (39%), to purchase another cow (34%) and to improve on housing (16%).

Table 4.21: Use of credit by farmers

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Butula (%)</th>
<th>Butere (%)</th>
<th>No of farms</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whether farmer has</td>
<td>Yes</td>
<td>8</td>
<td>8</td>
<td>32</td>
<td>8</td>
</tr>
<tr>
<td>obtained credit</td>
<td>No</td>
<td>92</td>
<td>92</td>
<td>365</td>
<td>92</td>
</tr>
<tr>
<td>during past five years</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(N=397)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reason for not</td>
<td>Not accessible</td>
<td>22</td>
<td>21</td>
<td>75</td>
<td>22</td>
</tr>
<tr>
<td>obtaining credit (N=346)</td>
<td>High interest rates</td>
<td>31</td>
<td>28</td>
<td>103</td>
<td>29</td>
</tr>
<tr>
<td>:-------------------------</td>
<td>---------------------</td>
<td>----</td>
<td>----</td>
<td>-----</td>
<td>----</td>
</tr>
<tr>
<td></td>
<td>Fear land may be auctioned</td>
<td>39</td>
<td>64</td>
<td>43</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>8</td>
<td>8</td>
<td>27</td>
<td>8</td>
</tr>
<tr>
<td>Source of financing for dairy enterprise N=393</td>
<td>Own savings</td>
<td>77</td>
<td>76</td>
<td>301</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>Cooperative</td>
<td>0.5</td>
<td>1</td>
<td>3</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>society</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Bank loan</td>
<td>0</td>
<td>0.5</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Micro finance</td>
<td>2</td>
<td>2</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Merry-go-round</td>
<td>20</td>
<td>20</td>
<td>78</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmer credit needs (N=400)</td>
<td>Buy another cow</td>
<td>32</td>
<td>36</td>
<td>136</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Improve on feeds</td>
<td>39</td>
<td>39</td>
<td>156</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Improve housing</td>
<td>17</td>
<td>14</td>
<td>63</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Invest in equipment</td>
<td>5</td>
<td>5</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Purchase other dairy inputs</td>
<td>7</td>
<td>6</td>
<td>25</td>
<td>6</td>
</tr>
</tbody>
</table>

*Amount invested in dairy farm per month (N=367): Minimum= KES 200, Maximum = KES 15 000, Mean = KES 4 234, Std dev = 3 540

g) Economic returns: Decision making and use of revenue from milk sales

Table 4.22 presents decision making and use of revenue from milk sales on smallholder farms. On 73% of the farms, the decision maker on use of revenue from milk sales was mainly the man while 27% was the woman. About 40% of the farms spent revenue from milk sales on paying school fees, 27% on other household needs while 25% invested back on the dairy enterprise.
Table 4.22: Use of revenue from dairy enterprise

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Butula (%</th>
<th>Butere (%)</th>
<th>No of farms</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision maker on use of income from milk sales (N=337)</td>
<td>Head of household (man)</td>
<td>73</td>
<td>74</td>
<td>247</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>Spouse (woman)</td>
<td>27</td>
<td>26</td>
<td>90</td>
<td>27</td>
</tr>
<tr>
<td>How revenue from milk sales is spent (N=343)</td>
<td>Buy food</td>
<td>9</td>
<td>10</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Pay school fees</td>
<td>40</td>
<td>40</td>
<td>142</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Use on other household needs</td>
<td>26</td>
<td>28</td>
<td>89</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Invest back in dairy</td>
<td>25</td>
<td>25</td>
<td>84</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

h) Linkages with buyers and service providers

Table 4.23 shows linkages with buyers and service providers. Regular payment of either cash or after two weeks were the main reasons farmers perceived attracted linkages with buyers, while provision of dairy farming advisewas the main reasons for linkages with service providers.

Table 4.23: Linkages with buyers and service providers

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Butula (%</th>
<th>Butere (%)</th>
<th>No of farms</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attraction of linkages with milk buyers (N=370)</td>
<td>Cash payment</td>
<td>45</td>
<td>57</td>
<td>196</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>Payment after two weeks</td>
<td>28</td>
<td>31</td>
<td>114</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Higher milk price</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Provision of credit</td>
<td>14</td>
<td>4</td>
<td>17</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Provision of inputs</td>
<td>9</td>
<td>6</td>
<td>30</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Milk collection</td>
<td>2</td>
<td>1</td>
<td>7</td>
<td>2</td>
</tr>
</tbody>
</table>
Attraction of Provision of credit 7 5 21 6
linkages with Provision of inputs 10 31 125 21
service providers N=389 Provision of dairy
farming advice 79 61 233 70
Other N=389 Provision of dairy

i) Socio cultural perceptions

Table 4.24 shows enterprise preference and perceptions on community attitude towards keeping grade cattle. Dairy, poultry and food crops were the most preferred enterprises while about 73% of respondents agreed that community attitude towards keeping grade cattle negatively affected milk production.

Table 4.24: Socio cultural perceptions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Butula (%)</th>
<th>Butere (%)</th>
<th>No of farms</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprise preference</td>
<td>Dairy</td>
<td>62</td>
<td>63</td>
<td>243</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>Poultry</td>
<td>16</td>
<td>15</td>
<td>62</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Food crops</td>
<td>12</td>
<td>12</td>
<td>50</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Cash crops</td>
<td>5</td>
<td>5</td>
<td>19</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Zebu cattle</td>
<td>4</td>
<td>5</td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td>Community attitude toward keeping grade</td>
<td>Strongly disagree</td>
<td>18</td>
<td>15</td>
<td>58</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Disagree</td>
<td>3</td>
<td>5</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Neutral</td>
<td>8</td>
<td>8</td>
<td>32</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Agree</td>
<td>42</td>
<td>42</td>
<td>166</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>Strongly agree</td>
<td>32</td>
<td>30</td>
<td>124</td>
<td>31</td>
</tr>
</tbody>
</table>

N=392
N= 394
j) Policy and infrastructure

Table 4.25 shows the policy and infrastructure needs. Favourable policy on access to service provision (extension, research) and inputs were the main policy needs while farm equipment (mechanization) was the most important infrastructural need.

Table 4.25: Policy and infrastructure needs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Butula (%)</th>
<th>Butere (%)</th>
<th>No of farms</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmers’ Policy needs (N=395)</td>
<td>Access to inputs</td>
<td>32</td>
<td>37</td>
<td>134</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Access to service provision</td>
<td>44</td>
<td>38</td>
<td>164</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>Access to credit</td>
<td>11</td>
<td>10</td>
<td>43</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Access to linkages</td>
<td>12</td>
<td>12</td>
<td>46</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Access to higher returns</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Infrastructure with large influence on milk production (N=394)</td>
<td>Good road</td>
<td>13</td>
<td>11</td>
<td>48</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Electricity</td>
<td>3</td>
<td>2</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Water</td>
<td>13</td>
<td>17</td>
<td>57</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Farm equipment</td>
<td>52</td>
<td>55</td>
<td>209</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Milk processing plant</td>
<td>20</td>
<td>15</td>
<td>70</td>
<td>17</td>
</tr>
</tbody>
</table>
v) **Problems with the quality of various dairy inputs**

Table 4.26 presents survey results on perception of quality of different dairy inputs. About 70% of the farms had experienced problems with quality of inputs. The most common inputs with quality problems were: AI services, feeds and drugs. In the feeds category, dairy meal was perceived to have more quality problems, while in the drugs category acaricides were identified as having more quality problems. Repeated services and cow not getting pregnant were the most frequent problems related to AI service, while low milk production, cow not easily coming on heat, diseases and reproductive disorders were identified as common problems with breeds.

**Table 4.26: Problems with quality of inputs**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Butere (%)</th>
<th>Butula (%)</th>
<th>No of farms</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whether farmer has experienced</td>
<td>Yes</td>
<td>69</td>
<td>72</td>
<td>272</td>
<td>71</td>
</tr>
<tr>
<td>quality problems with inputs</td>
<td>No</td>
<td>31</td>
<td>28</td>
<td>115</td>
<td>29</td>
</tr>
<tr>
<td>N=387</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of inputs with frequent</td>
<td>Feeds</td>
<td>26</td>
<td>32</td>
<td>84</td>
<td>29</td>
</tr>
<tr>
<td>quality problems</td>
<td>Drugs</td>
<td>20</td>
<td>18</td>
<td>55</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Small equipment</td>
<td>13</td>
<td>14</td>
<td>40</td>
<td>14</td>
</tr>
<tr>
<td>N=294</td>
<td>AI service</td>
<td>34</td>
<td>31</td>
<td>96</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Breeding cow</td>
<td>7</td>
<td>6</td>
<td>19</td>
<td>6</td>
</tr>
<tr>
<td>Category of feeds with frequent</td>
<td>Dairy meal</td>
<td>53</td>
<td>49</td>
<td>116</td>
<td>51</td>
</tr>
<tr>
<td>quality problems</td>
<td>Maize germ</td>
<td>20</td>
<td>23</td>
<td>49</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Forages</td>
<td>14</td>
<td>13</td>
<td>31</td>
<td>14</td>
</tr>
<tr>
<td>N=227</td>
<td>Other</td>
<td>13</td>
<td>13</td>
<td>31</td>
<td>13</td>
</tr>
<tr>
<td>Category of drugs with frequent</td>
<td>Acaricides</td>
<td>36</td>
<td>34</td>
<td>67</td>
<td>35</td>
</tr>
<tr>
<td>quality problems</td>
<td>Dewormers</td>
<td>15</td>
<td>15</td>
<td>29</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Trypanocides</td>
<td>20</td>
<td>19</td>
<td>37</td>
<td>19</td>
</tr>
</tbody>
</table>
I) Dairy production constraints

Table 4.27 presents survey results on dairy production constraints. High cost of inputs (23%), source of breeding stock (17%), diseases (16%), unreliable AI services (16%), inadequate feeds (13%) were the most important dairy production constraints.

Table 4.27: Constraints encountered in dairy production

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Butula (%)</th>
<th>Butere (%)</th>
<th>No of farms</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy production constraints</td>
<td>Source of breeding stock</td>
<td>18</td>
<td>16</td>
<td>70</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Inadequate feeds</td>
<td>14</td>
<td>12</td>
<td>53</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Diseases</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Unreliable AI</td>
<td>15</td>
<td>16</td>
<td>62</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Inaccessible credit</td>
<td>8</td>
<td>8</td>
<td>33</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Inadequate management skills</td>
<td>6</td>
<td>8</td>
<td>26</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>High cost of inputs</td>
<td>22</td>
<td>24</td>
<td>91</td>
<td>23</td>
</tr>
</tbody>
</table>
J) Level of commercialization among smallholder dairy farmers

The results of the HCI shown are in Table 4.28. The results of household input commercialization index ranged from 0 (subsistence i.e do not participate at all in either input or output market) to 1 (net buyer) with the mean of 0.32. This means that the level of input market participation in the study area is low. Output market index was 0.46 (46%) which is moderate. The mean variable cost per cow per month was KES 7,789. With the average milk yield of 6.5 litres per day, this translates to 195 litres per month. Hence the cost of production per litre was KES 40. Overall HCI found in the study was 0.39. This means that the level of commercialization in the area was moderate.

Table 4.28: HCI among smallholder dairy farms

<table>
<thead>
<tr>
<th>Variable</th>
<th>No</th>
<th>Mean</th>
<th>StdDev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable costs/cow/month (KES)</td>
<td>291</td>
<td>7789.42</td>
<td>4584.56</td>
<td>200</td>
<td>12828</td>
</tr>
<tr>
<td>Variable Gross output/cow/month</td>
<td>291</td>
<td>10446.50</td>
<td>9025.61</td>
<td>1604.6</td>
<td>64584.61</td>
</tr>
<tr>
<td>Variable Gross margin/month</td>
<td>291</td>
<td>2657.08</td>
<td>9061.37</td>
<td>-5563.34</td>
<td>54176.86</td>
</tr>
<tr>
<td>Input market commercialization index (IMHCI)</td>
<td>291</td>
<td>0.32</td>
<td>0.27</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Output market commercialization index (OMHCI)</td>
<td>291</td>
<td>0.46</td>
<td>0.34</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
4.2.5 Strength of relationship between variables and milk yield

Results of correlation analysis (Table 4.29) showed that there was a significant and positive correlation between the dummy variables of fodder, dairy meal, AI, credit, group membership, policy, research technologies, and average milk yield on farms. This means that the presence of these variables increases milk yield, while in their absence, milk yield also decreases. Extension dummy had positive correlation but it was not significant. The dummy for economic returns from milk sales had a significant but negative correlation, meaning returns from milk sales had a corresponding decrease in average milk yield. This may be attributed to results shown in Table 4.22 in which revenue from milk sales was mainly used to pay school fees and other household needs instead of investing back in the dairy farm, hence the inverse relationship. Attitude dummy was not significant and had negative correlation, meaning the presence of community attitude decreased average milk yield.

Table 4.29: Correlation Analysis (Pearson) of variables with average milk yield

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>Dependent variable</th>
<th>Correlation coefficient (r)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fodder dummy</td>
<td>Average milk yield</td>
<td>0.599</td>
<td>0.000*</td>
</tr>
<tr>
<td>Dairy meal dummy</td>
<td>Average milk yield</td>
<td>0.656</td>
<td>0.000*</td>
</tr>
<tr>
<td>Extension dummy</td>
<td>Average milk yield</td>
<td>0.568</td>
<td>0.251m</td>
</tr>
<tr>
<td>Research dummy</td>
<td>Average milk yield</td>
<td>0.338</td>
<td>0.000*</td>
</tr>
<tr>
<td>Artificial insemination dummy (AI)</td>
<td>Average milk yield</td>
<td>0.334</td>
<td>0.000*</td>
</tr>
<tr>
<td>Credit dummy</td>
<td>Average milk yield</td>
<td>0.519</td>
<td>0.000*</td>
</tr>
<tr>
<td>Economic returns dummy</td>
<td>Average milk yield</td>
<td>-0.145</td>
<td>0.014**</td>
</tr>
<tr>
<td>Group membership dummy</td>
<td>Average milk yield</td>
<td>0.627</td>
<td>0.000*</td>
</tr>
<tr>
<td>Linkage with traders</td>
<td>Average milk yield</td>
<td>-0.043</td>
<td>0.469m</td>
</tr>
</tbody>
</table>
4.2.6 Multiple linear regression analysis

The results of multiple linear regression are shown in the Table 4.30 below. The results of the collective effect in the model with all the eleven potential variables showed that extension dummy, linkage with traders dummy and community attitude dummy were not significant predictors, and hence were dropped from the model. These results mean that the presence of variables of extension, linkages with traders and community attitude could not explain the variation in milk yields on smallholder farms in the study area.

Table 4.30: Multiple linear regression results (model with all 11 variables)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Standardized coefficient (β)</th>
<th>T</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeds dummy (fodder)</td>
<td>0.243</td>
<td>5.501</td>
<td>0.000*</td>
</tr>
<tr>
<td>Dairy meal dummy</td>
<td>0.211</td>
<td>3.896</td>
<td>0.000*</td>
</tr>
<tr>
<td>Extension dummy</td>
<td>0.038</td>
<td>1.008</td>
<td>0.314ns</td>
</tr>
<tr>
<td>Research dummy</td>
<td>0.184</td>
<td>4.969</td>
<td>0.000*</td>
</tr>
<tr>
<td>Artificial insemination dummy (AI)</td>
<td>0.164</td>
<td>4.316</td>
<td>0.000*</td>
</tr>
<tr>
<td>Credit dummy</td>
<td>0.171</td>
<td>3956</td>
<td>0.000*</td>
</tr>
<tr>
<td>Economic returns dummy</td>
<td>-0.101</td>
<td>-2.503</td>
<td>0.013**</td>
</tr>
<tr>
<td>Group membership dummy</td>
<td>0.150</td>
<td>2.682</td>
<td>0.008*</td>
</tr>
<tr>
<td>Linkage with traders dummy</td>
<td>-0.014</td>
<td>-1.362</td>
<td>0.718ns</td>
</tr>
<tr>
<td>Attitude dummy</td>
<td>-0.11</td>
<td>-0.300</td>
<td>0.718ns</td>
</tr>
</tbody>
</table>
Policy dummy  
Adjusted $R^2 = 0.636$

$F_{11, 291} = 47.115$

$P < 0.001$

Constant 1.259

Std error 0.796

*P<0.01, **P<0.05, ns = Not significant

4.2.7 **Collective effect of variables after removal of non significant variables**

The criterion for retention of variables in the final model was based on two parameters: Significance of the variable in the full model and, importance of variable as identified through key informant interviews and focus groups. The results are shown in Table 4.31.

The final model showed that the adjusted $R^2$ was 0.639. This means that the variables in the model collectively explained 63.9% of the variance observed in milk production in the study area. The remaining variance (36.1%) could be due to other factors beyond the scope of this study. ANOVA test ($F_8, 291= 65.089$) showed that $P$ value was less than 0.001 meaning that the model is highly significant and hence a good fit. All the eight variables were highly significant.

**Table 4.31: Collective effect of variables in the final model**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>T</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>(Constant)</td>
<td>1.765</td>
<td>0.457</td>
<td></td>
<td>3.859</td>
</tr>
<tr>
<td>Fodder dummy</td>
<td>1.903</td>
<td>0.341</td>
<td>0.245</td>
<td>5.578</td>
</tr>
<tr>
<td>Dairy meal dummy</td>
<td>1.643</td>
<td>0.422</td>
<td>0.210</td>
<td>3.888</td>
</tr>
<tr>
<td>AI dummy</td>
<td>1.303</td>
<td>0.296</td>
<td>0.167</td>
<td>4.406</td>
</tr>
<tr>
<td>Credit dummy</td>
<td>1.416</td>
<td>0.353</td>
<td>0.172</td>
<td>4.016</td>
</tr>
<tr>
<td>Policy dummy</td>
<td>0.901</td>
<td>0.339</td>
<td>0.111</td>
<td>2.656</td>
</tr>
<tr>
<td>Research dummy</td>
<td>1.472</td>
<td>0.289</td>
<td>0.187</td>
<td>5.093</td>
</tr>
</tbody>
</table>
4.2.8 Stepwise regression analysis

Stepwise regression was done to determine the effect of each individual variable on milk yield (Table 4.32). The criteria used to determine order of entry into the model was: strength of correlation of the predictor with milk production and importance of the variable as identified by stakeholders through key informant interviews and focus group discussions. Using these criteria, Fodder was entered first followed by Dairy meal, Research technologies, Credit, AI, Membership of group, Policy and finally Returns. The results are shown in Table 4.31.

**Step 1:** The variable of Feeds dummy was added to the equation of regression. The multiple correlation coefficient (R) was 0.599 and the adjusted coefficient of determination (R²) was 0.357. This variable explained 35.7% of the variation related to milk production.

The regression equation in the first step was:

\[ Y = 3.982 + 0.599 \times \text{Feed dummy} \]

**Step 2:** Dairy meal variable was entered at second step of analyzing regression equation. The multiple correlation coefficients (R) was 0.656 and the adjusted
coefficient of determination ($R^2$) increases to 0.510. The 15.3% of the variance in milk production was accounted for by dairy meal. Regression equation for second step was:

$$Y = 2.973 + 0.344 \times \text{Feed dummy} + 0.468 \times \text{dairy meal}$$

**Step 3:** The variable of research technologies was added to the equation of regression. The multiple correlation coefficient ($R$) was 0.740 and the adjusted coefficient of determination ($R^2$) was 0.543. This variable explained 3.3% of the variation related to milk production.

The regression equation at step three was:

$$Y = 2.551 + 0.335 \times \text{Feed dummy} + 0.430 \times \text{dairymeal} + 0.192 \times \text{Research}$$

**Step 4:** The variable of Credit was added to the equation of regression. The multiple correlation coefficient ($R$) was 0.740 and the adjusted coefficient of determination ($R^2$) was 0.574. This variable explained 3.1% of the variation related to milk production.

The regression equation at step four was:

$$Y = 1.929 + 0.307 \times \text{Feed dummy} + 0.347 \times \text{dairymeal} + 0.181 \times \text{Research} + 0.208 \times \text{Credit}$$

**Step 5:** The variable of AI was added to the equation of regression. The multiple correlation coefficient ($R$) was 0.762 and the adjusted coefficient of determination ($R^2$) was 0.604. This variable explained 3.0% of the variation related to milk production.

The regression equation at step five was:

$$Y = 1.324 + 0.273 \times \text{Feed dummy} + 0.324 \times \text{dairymeal} + 0.188 \times \text{Research} + 0.213 \times \text{Credit} + 0.180 \times \text{AI}$$
Step 6: The variable of Group was added to the equation of regression. The multiple correlation coefficient (R) was to 0.794 while the adjusted coefficient of determination (R²) 0.623. This variable explained 1.9 % of the variation related to milk production.

The regression equation at step six was:

\[ Y = 1.104 + 0.263 \times \text{Feed dummy} + 0.212 \times \text{dairymeal} + 0.196 \times \text{Research} + 0.166 \times \text{credit} + 0.150 \times \text{AI} + 0.209 \times \text{Group} \]

Step 7: The variable of Policy was added to the equation of regression. The multiple correlation coefficient (R) was 0.800 while the adjusted coefficient of determination (R²) 0.631. This variable explained 0.8 % of the variation related to milk production.

The regression equation at step seven was:

\[ Y = 0.850 + 0.241 \times \text{Feed dummy} + 0.2220 \times \text{dairymeal} + 0.199 \times \text{Research} + 0.161 \times \text{credit} + 0.150 \times \text{AI} + 0.158 \times \text{Group} + 0.114 \times \text{Policy} \]

Step 8: The variable of Returns was added to the equation of regression. The multiple correlation coefficient (R) was 0.805 while the adjusted coefficient of determination (R²) was 0.639. This variable explained 0.8 % of the variation related to milk production.

The regression equation at step eight was:

\[ Y = 1.765 + 0.245 \times \text{Feed dummy} + 0.210 \times \text{dairymeal dummy} + 0.187 \times \text{Research dummy} + 0.172 \times \text{credit dummy} + 0.167 \times \text{A dummy} + 0.147 \times \text{Group dummy} + 0.111 \times \text{Policy dummy} - 0.098 \times \text{Returns dummy} \]
Table 4.32: Variance explained by individual predictors on milk yield

<table>
<thead>
<tr>
<th>Step</th>
<th>Variable</th>
<th>Multiple correlation coefficient (R)</th>
<th>Determination Coefficient R²</th>
<th>Adjusted R²</th>
<th>Variance explained (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fodder Dummy</td>
<td>0.599</td>
<td>0.359</td>
<td>0.357</td>
<td>35.7</td>
</tr>
<tr>
<td>2</td>
<td>Dairy meal Dummy</td>
<td>0.656</td>
<td>0.430</td>
<td>0.510</td>
<td>15.3</td>
</tr>
<tr>
<td>3</td>
<td>Research technologies Dummy</td>
<td>0.740</td>
<td>0.548</td>
<td>0.543</td>
<td>3.3</td>
</tr>
<tr>
<td>4</td>
<td>Credit Dummy</td>
<td>0.762</td>
<td>0.580</td>
<td>0.574</td>
<td>3.1</td>
</tr>
<tr>
<td>5</td>
<td>Artificial insemination Dummy (AI)</td>
<td>0.781</td>
<td>0.610</td>
<td>0.604</td>
<td>3.0</td>
</tr>
<tr>
<td>6</td>
<td>Group membership Dummy</td>
<td>0.794</td>
<td>0.630</td>
<td>0.623</td>
<td>1.9</td>
</tr>
<tr>
<td>7</td>
<td>Policy Dummy</td>
<td>0.800</td>
<td>0.640</td>
<td>0.631</td>
<td>0.8</td>
</tr>
<tr>
<td>8</td>
<td>Returns Dummy</td>
<td>0.805</td>
<td>0.649</td>
<td>0.639</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Feeds (Fodder) and dairy meal (concentrate) together accounted for 51% of the variance.

4.2.9 Collinearity diagnostics

Table 4.33 shows the diagnosis of collinearity among the eight variables. There was no evidence of Multi collinearity problems since the standard indicators of Tolerance, Variance inflation factor, Eigen and condition index values were within the normal range. According to Stevens (2002), Tabachnick and Fidell (2001) and DeMaris (2004), evidence of multicollinearity exist when T<0.1, VIF>10, Eigenvalue = 1, Condition index =30.
Table 4.33: Collinearity diagnostics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Tolerance (T)</th>
<th>Variance Inflation Factor (VIF)</th>
<th>Eiglen value</th>
<th>Condition Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeds Dummy (fodder)</td>
<td>0.647</td>
<td>1.545</td>
<td>0.567</td>
<td>3.441</td>
</tr>
<tr>
<td>Dairy meal Dummy</td>
<td>0.427</td>
<td>2.342</td>
<td>0.427</td>
<td>3.596</td>
</tr>
<tr>
<td>Research Dummy</td>
<td>0.927</td>
<td>1.078</td>
<td>0.062</td>
<td>10.448</td>
</tr>
<tr>
<td>Artificial insemination Dummy</td>
<td>0.872</td>
<td>1.147</td>
<td>0.263</td>
<td>5.058</td>
</tr>
<tr>
<td>Credit Dummy</td>
<td>0.680</td>
<td>1.470</td>
<td>0.352</td>
<td>4.371</td>
</tr>
<tr>
<td>Group membership Dummy</td>
<td>0.403</td>
<td>2.484</td>
<td>0.250</td>
<td>5.181</td>
</tr>
<tr>
<td>Policy Dummy</td>
<td>0.711</td>
<td>1.407</td>
<td>0.098</td>
<td>8.273</td>
</tr>
<tr>
<td>Returns Dummy</td>
<td>0.941</td>
<td>1.063</td>
<td>0.173</td>
<td>6.223</td>
</tr>
</tbody>
</table>

4.2.10 Ranking of variables using focus group discussions and key informant interviews

Tables 4.34 presents a summary of pair wise ranking of the eleven value chain variables perceived to be important in influencing milk production by farmer groups in six divisions of Butula and Butere, and the officials of the Livestock Department. Farmer groups ranked fodder, dairy meal, availability of AI service, access to credit and use of improved research technologies as the most important variables while the officials of the Livestock Department ranked fodder, community attitude, extension advice, dairy meal and availability of AI service as the most important variables. Thus the qualitative approaches produced a different ranking order suggesting they could be inadequate when used alone to rank variables of importance.
Table 4.34: Summary of results of pair wise ranking of value chain factors influencing milk production on small holder farms

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Butula Marachi West</th>
<th>Butula Marachi Central</th>
<th>Butula Marachi East</th>
<th>Butere</th>
<th>Lunza</th>
<th>Shiatsala</th>
<th>Total scores</th>
<th>Overall Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fodder</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Dairy meal</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>Availability of AI service</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>16</td>
<td>3</td>
</tr>
<tr>
<td>Extension advice</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>32</td>
<td>6</td>
</tr>
</tbody>
</table>
| Use of improved research
telechnologies                      | 4                   | 6                      | 6                   | 4      | 7     | 4         | 31           | 5            |
| Access to Credit                 | 5                   | 4                      | 5                   | 6      | 5     | 5         | 30           | 4            |
| Group membership                 | 7                   | 8                      | 7                   | 7      | 4     | 7         | 40           | 7            |
| Linkage with buyers              | 10                  | 10                     | 9                   | 11     | 10    | 11        | 61           | 10           |
| Higher returns from milk
sales                                      | 9                   | 9                      | 10                  | 9      | 9     | 9         | 55           | 9            |
| Favourable policies              | 8                   | 7                      | 8                   | 8      | 8     | 8         | 47           | 8            |
| Community attitude               | 11                  | 11                     | 11                  | 10     | 11    | 10        | 64           | 11           |

Legend: 1 = highest, 11 = lowest
The top five constraints ranked by both the livestock department and farmer groups were all similar. These were: source of breeding stock, high cost of inputs, unreliable AI service, diseases and inadequate feeds (Table 4.35).

Table 4.35: Ranking of constraints limiting milk production on smallholder farms

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Livestock department</th>
<th>Farmer groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of local source of breeding stock</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>High cost of inputs</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Inadequate feeds</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Unreliable AI services</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Diseases</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Inadequate management skills</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Inaccessible credit</td>
<td>7</td>
<td>6</td>
</tr>
</tbody>
</table>

Legend: 1 = highest, 7 = lowest
4.3 Sources of inefficiencies in the milk value chain

This section presents results of interviews carried out to assess sources of inefficiencies in the milk value chain and the capacity of stakeholders involved in dairy development in Butula and Butere Sub Counties. The stakeholders at different levels of the value chain were selected based on the eight important predictors of milk production identified using multiple regression analysis (Tables 4.31 and 4.32).

4.3.1 Input supply

a) Inadequate A.I and breeding services

Table 4.36 shows characteristics of A.I providers, the capacity and constraints faced by A.I providers. Butula had two A.I providers while Butere had four. The ratio of A.I providers to dairy cattle was 1:1700 and 1:650 in Butula and Butere respectively. The main sources of inefficiency were identified as unavailability of semen, lack of liquid nitrogen, repeated services and inadequate number of A.I providers.

Table 4.36: Characteristics of artificial insemination providers

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>No of A.I providers</td>
<td>Butere (4), Butula (2)</td>
</tr>
<tr>
<td>Distance</td>
<td>Average distance covered by inseminator</td>
<td>40 km</td>
</tr>
<tr>
<td>Size of clients*</td>
<td>No of farmers per month</td>
<td>30-100</td>
</tr>
<tr>
<td>Span of control</td>
<td>Ratio of inseminators to dairy cattle population</td>
<td>Butula 1: 1700, Butere 1: 650</td>
</tr>
<tr>
<td>Type of semen</td>
<td>Semen used in A.I service</td>
<td>Local: KAGREC @ KES 1500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Imported: @ KES 2500-3500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sexed: @ KES 5000</td>
</tr>
<tr>
<td>Complaints on AI service</td>
<td>Farmer perceptions about quality of AI</td>
<td>Constraints</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td></td>
<td>Bull calf---------------------- 50%</td>
<td>Unavailability of semen---------39%</td>
</tr>
<tr>
<td></td>
<td>Repeats----------------------- 35%</td>
<td>Lack of liquid nitrogen-----------24%</td>
</tr>
<tr>
<td></td>
<td>Poor quality calf------------------15%</td>
<td>Repeated service------------------- 22%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>low /defaulted payment by farmers---&lt;15%</td>
</tr>
</tbody>
</table>

*Only 39.8% of dairy farmers use AI services in the region while the rest use bull service (Wanjala and Njehia, 2014)

KAGREC: Kenya Animal Genetic Resource Centre (Formerly CAIS)
1 USD = KES 85 (May, 2014)

b) **Types of improved feed technologies developed by Research stations**

Tables 4.37 presents results of a case study of KALRO Kakamega.

The results showed that KALRO had developed various pastures, legumes, fodder trees and feed technologies for enhancing milk production. However due to lack of commercial orientation and effective dissemination strategy, there were inadequate commercial quantities at the station hence the inability of dairy farmers in the region to access them as shown earlier in Table 4.20.
### Table 4.37: Dairy feed technologies developed by KALRO Kakamega

<table>
<thead>
<tr>
<th>Type of feed</th>
<th>Problem addressed</th>
<th>Acres or quantity on station</th>
<th>Inefficiencies</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pastures</td>
<td>Lack of sufficient quantity and quality fodder</td>
<td>10 acres of Napier grass</td>
<td>No commercial plots available. Only farmers in trial sites were made aware through on farm trial sites but there was lack of sustainability due to short project duration. Lack of agribusiness orientation and effective dissemination strategy. Inadequate funding for livestock programmes.</td>
<td>Growing number of dairy farmers in the region. High milk prices. Devolved County government functions.</td>
</tr>
<tr>
<td>Legumes</td>
<td>Lack of protein feed</td>
<td>1 acre</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fodder trees</td>
<td>Lack of protein feed</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local Total mixed ration</td>
<td>Fortification of crop residues (maize stover, sugar cane tops, bean hulls, rice straw, calliandra) as alternative roughage</td>
<td>None</td>
<td>No commercial quantities available. Only a few feed blocks for demonstration.</td>
<td>Plenty of crop residues on smallholder farms. Abundance of sugarcane tops in the region and molasses from sugar companies in the region.</td>
</tr>
</tbody>
</table>
c) Low quality of commercial dairy meal in the market

Table 4.38 shows results from agrovet dealers in Butula and Butere sub Counties. Three types of dairy meal were sold in agrovets. However, examination of labels on bags of dairy meals from sixteen companies found in agrovet dealers revealed that the protein content of dairy meal or ingredients are not indicated by manufacturers and therefore unknown to both dealers and farmers. Dairy meal and drugs were the inputs perceived by agrovet dealers to have frequent quality problems.

**Table 4.38: Analysis of commercial concentrate (dairy meal) from agrovet dealers**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy clientele</td>
<td>No. of dairy farmers served by agro dealer per month.</td>
<td>Range from 150 in rural to 1500 in large town dealers</td>
</tr>
<tr>
<td>Dairy meal sales</td>
<td>No. of bags (70 kg) sold per month.</td>
<td>10-100 bags (rural/urban respectively)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Farmers prefer low price ordinary Dairy meal.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level of protein content of dairy meal or ingredients are not indicated on bags by suppliers (16 companies) and therefore unknown to both dealers and farmers</td>
</tr>
<tr>
<td>Quality problems</td>
<td>Inputs with frequent quality problems.</td>
<td>Dairy meal and drugs</td>
</tr>
<tr>
<td>Constraints</td>
<td>Main constraint faced by agro dealers</td>
<td>Multiple licences totalling KES 22000 per year--------------------------38%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High cost of inputs--------29%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lack of own transport------18%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>inaccessible credit--------10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low quality inputs Dairy meal/drugs--5%</td>
</tr>
</tbody>
</table>

Table 3.39 shows that the findings of the analysis of the quality of commercial dairy meal from selected large and smallholder farms in different parts of the country
revealed that the crude protein (CP) level was below the KEBS standard of 14%-16% for most samples.

Table 4.39: Analysis of commercial concentrate (dairy meal) on small and large scale farms

<table>
<thead>
<tr>
<th>Source</th>
<th>DM g/kg (%)</th>
<th>CP g/kg(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemusian farm* (LS)</td>
<td>88.10</td>
<td>2.51</td>
</tr>
<tr>
<td>Tatton farm* (LS)</td>
<td>90.61</td>
<td>15.71</td>
</tr>
<tr>
<td>Laikipia university* (LS)</td>
<td>87.50</td>
<td>4.03</td>
</tr>
<tr>
<td>Small holder farms Embu (n=12)**</td>
<td>89.40</td>
<td>12.0</td>
</tr>
</tbody>
</table>

Source: *Egerton University; **Katiku et al., 2014.

LS = Large scale farm

4.3.2 Sources of inefficiencies in production

Farmer groups identified inefficiencies and issues limiting milk production as shown in Table 4.40:

a) Feeds- inadequate quantity and quality of feeds

Reliance on Napier grass; manual processing of feeds due to lack of information on pulveriser technology (motorised feed processor); lack of knowledge on utilization of crop residues; improved pastures; feed formulation and fortification technologies were the sources of inefficiencies associated with feeds. This situation resulted into low milk yields.

b) Lack of local source of breeding stock: Breeding stock were sourced from Rift Valley or provided by NGOs through donations due to lack of breeding farms in the region as presented earlier in Figure 4.9.
c) **Inadequate management skills among farmers**

Inadequate skills on how to feed a dairy cow, disease control and agribusiness led to low milk yields and low commercialization of farms. Poor heat detection and timing was found to be the main problem leading to repeat AI services and high proportion of bull calves, hence the use of AI was low. This result is consistent with the farm survey shown earlier in Table 4.16 in which about 40% of the farms used AI.

d) **Poor financing of dairy enterprise by dairy farmers**

Fear to acquire credit and usage of milk sales on family needs instead of investing back on the dairy farm led to poor financing of dairy enterprise.

**Table 4.40: Inefficiencies in farmer groups**

<table>
<thead>
<tr>
<th>Institution</th>
<th>Parameter</th>
<th>Inefficiency</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Feeds</td>
<td></td>
<td>Availability of energy and protein feed technologies in research institutions.</td>
</tr>
<tr>
<td></td>
<td>Credit</td>
<td>Fear to take loans.</td>
<td>Availability of many financial schemes/ agents.</td>
</tr>
<tr>
<td></td>
<td>Management skills</td>
<td>Inadequate skills on how to feed a dairy cow hence low milk yields, short lactation period. Lack of agribusiness skills.</td>
<td>Availability of expertise in livestock department.</td>
</tr>
<tr>
<td></td>
<td>Disease control</td>
<td>Inadequate control of tick borne diseases.</td>
<td>Disease control strategies available.</td>
</tr>
<tr>
<td></td>
<td>Usage of AI services</td>
<td>Low AI use (40%)</td>
<td>Growing population of dairy cattle.</td>
</tr>
</tbody>
</table>
4.3.3 Inadequate management and business skills in cooperatives

The main function of milk cooperatives in the value chain is collection, bulking and collective marketing.

Table 4.41 presents results on assessment of inefficiencies in ten cooperatives in Busia, Bungoma, Kakamega and Vihiga counties of Western Kenya. The results on management showed that in 90% of the cooperatives, the officials were above 50 years of age and lacked financial and agribusiness skills. 70% of the cooperatives were indebted and with a history of disputes, while only 30% had developed a strategic plan. Member commitment was very low (9%) with majority being free riders. All the cooperatives had not embraced the six modern roles necessary in a competitive business environment.

Table 4.41: Selected parameters on management, traditional and modern roles among cooperatives

<table>
<thead>
<tr>
<th>Management</th>
<th>Description</th>
<th>Percent of Cooperatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of education of officials</td>
<td>School certificate</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>A level</td>
<td>30</td>
</tr>
<tr>
<td>Age</td>
<td>&lt; 50 yrs</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>&gt;50 yrs</td>
<td>90</td>
</tr>
<tr>
<td>Competency</td>
<td>Training in financial/agribusiness skills</td>
<td>0</td>
</tr>
<tr>
<td>Disputes</td>
<td>History of leadership wrangles</td>
<td>70</td>
</tr>
<tr>
<td>Interference</td>
<td>External interference by politicians</td>
<td>30</td>
</tr>
<tr>
<td>Indebtedness</td>
<td>Indebted to farmers, creditors</td>
<td>70</td>
</tr>
<tr>
<td>Vision</td>
<td>Availability of strategic/business plan</td>
<td>30</td>
</tr>
<tr>
<td>Traditional roles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulking/chilling</td>
<td>Availability of cooler</td>
<td>90</td>
</tr>
<tr>
<td>Milk testing</td>
<td>Availability of milk testing equipment</td>
<td>90</td>
</tr>
</tbody>
</table>
alcohol test, lactometer

<table>
<thead>
<tr>
<th>Other services</th>
<th>Provision of extension services/ input supply</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Member commitment</td>
<td>Active members</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Free riders</td>
<td>91</td>
</tr>
</tbody>
</table>

**Modern roles**

<table>
<thead>
<tr>
<th>Logistics</th>
<th>Own transport</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality assurance</td>
<td>Availability of quality / traceability system</td>
<td>0</td>
</tr>
<tr>
<td>(QA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Processing and value addition</td>
<td>Product differentiation</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Packaging / Certification by Kebs</td>
<td>0</td>
</tr>
<tr>
<td>Contract with buyers</td>
<td>Forward integration with consumers</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>( supermarkets etc)</td>
<td></td>
</tr>
<tr>
<td>Service Diversification</td>
<td>Backward integration: Input supply,</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>extension, information exchange</td>
<td></td>
</tr>
<tr>
<td>Professional managers</td>
<td>Technical and financial managers</td>
<td>0</td>
</tr>
</tbody>
</table>

4.3.4 Consumption

The main inefficiencies at consumption level the high preference for raw milk and small volumes of milk purchased by households who are the main buyers of milk from farms.

4.3.5 Meso level: Service provision

Access to credit: Capacity of financial institutions

Interviews with three types of financial institutions: Commercial banks, Microfinance and Savings and Credit Societies Cooperative - SACCO found that they charged high interest rates at 17.5%, 12.5% and 12% respectively. In addition they
required collateral security or group guarantors. Financial institutions lacked specialised credit tailored to priority needs of farmers which had been identified as purchase of dairy cows and feed improvement.

4.3.6 Macro level: Policy

The main inefficiencies identified at the policy level were the lack of dairy strategic plan by the livestock departments in the counties. This situation has led to previous / ongoing projects implemented by various organizations not focused on increasing milk production: A summary of the results is shown in Tables 4.42 and 4.43.

a) Lack of dairy strategic plan in the County Livestock department

Table 4.42 shows the capacity of Livestock Department. Butula had eight while Butere had twelve livestock service providers. The main inefficiencies facing the Department were identified as:

1. Lack of Dairy strategic plan in Busia County (Butula) and Butere (Kakamega County)------ 25%

2. Low funding by National/County government--------------------------------------- 30%

3. Inadequate facilitation--------------------------------------------------------- 24%

4. Weak linkages with research institutions in technology dissemination and feedback--- 21%
Table 4.42: Service providers in the livestock department

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Butula</th>
<th>Butere</th>
</tr>
</thead>
<tbody>
<tr>
<td>Livestock officers</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Veterinary surgeons</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Animal health assistants</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Frontline extension staff</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>A.I providers</td>
<td>2 (private)</td>
<td>4 (private)</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Dairy strategic Plan</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td>Funding (%)</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Facilitation: Transport, ICT</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td>Linkages with Research institutions</td>
<td>Very weak</td>
<td>Weak</td>
</tr>
<tr>
<td>Linkages with NGOs</td>
<td>Strong</td>
<td>Very strong</td>
</tr>
</tbody>
</table>

b) Lack of focus on milk production by past and on-going projects dairy development projects in Butula and Butere

Table 4.43 shows past and ongoing dairy development projects in Butula and Butere. The projects are implemented by NGOs. The results indicate none of the NGOs is addressing the low milk production in the area. Moreover, little information exists on contribution of previous projects on increasing milk production.

Table 4.43: Past and ongoing dairy development projects

<table>
<thead>
<tr>
<th>Type of project</th>
<th>Lead organization</th>
<th>Main objective</th>
<th>Duration/achievements</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-going projects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Send a cow</td>
<td>Heifer Project</td>
<td>Supply dairy cows</td>
<td>10 years from 2007</td>
</tr>
<tr>
<td>Western Kenya community demand driven and flood</td>
<td>Special programmes</td>
<td>Supply dairy cows for Poverty reduction</td>
<td>10 years from 2012</td>
</tr>
</tbody>
</table>
mitigation project

**Past projects**

<table>
<thead>
<tr>
<th>Project</th>
<th>Country/Agency</th>
<th>Area</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Livestock development project</td>
<td>Finland/GoK</td>
<td>Dairy development</td>
<td>10 years</td>
</tr>
<tr>
<td>National dairy development project</td>
<td>Netherlands/GoK</td>
<td>Dairy development</td>
<td>15 years</td>
</tr>
<tr>
<td>National Agriculture and livestock expansion programme</td>
<td>World Bank/GoK</td>
<td>Capacity building of extension officers</td>
<td>5 years (1999-2004)</td>
</tr>
<tr>
<td>Smallholder Dairy Development Project</td>
<td>GOK/KARI/IRI/DFID</td>
<td>Technology dissemination</td>
<td>5 years</td>
</tr>
<tr>
<td>Millenium development goals</td>
<td>Ministry of Planning</td>
<td>Poverty reduction</td>
<td>2 years</td>
</tr>
<tr>
<td>Njaa marufuku</td>
<td>Ministry of Agriculture</td>
<td>Poverty reduction</td>
<td>5 years</td>
</tr>
</tbody>
</table>
4.4 Evaluation of Potential upgrading strategy and impact model

This section integrates the results obtained in the assessment of milk markets, survey of smallholder farms and inefficiencies in the value chain into a potential upgrading strategy for addressing the milk deficit problem. The main issues addressed are: What strategy? What should be the goal of upgrading? Which interventions; which actors? What would be their role? What impact? The section is organized as follows: the first section presents a theoretical overview of steps involved in upgrading. This is then followed by a proposed vision for upgrading the milk value chain; evaluation of the priority areas of intervention and upgrading objectives, selection of stakeholders based on predictor variables and their roles are presented in a matrix. An anticipated impact model for increasing milk yields is evaluated and anticipated results for Butula, Butere and Western Kenya as a whole are presented. The type of feeds and feed rations needed across farms is determined. Visualization of impact on different institutions and changes are proposed.

GTZ (2008) and Trienekens (2011) suggest that formulating a strategy to upgrade a value chain has two dimensions. First, what the actors in a value chain must do to become more competitive and to generate greater value added, and secondly, the role of external facilitators such as service providers and policy, regulatory and development agencies. The steps to be followed are: i) Developing a vision and strategy for upgrading to provide direction and anticipated change targeting specific market opportunities; ii) setting objectives and upgrading plan; ii) identifying actors implementing the upgrading strategy; and iv) anticipating the impact of upgrading.
4.4.1 Vision for upgrading the milk value chain in Western Kenya

Following the assessment of markets, farms and stakeholders, the vision for upgrading the milk value chain in Western Kenya would be as follows:

*To be the leading sector in Western Kenya for generation of income among smallholder farmers.*

This vision could be reached by improving the structure and performance of the milk value chain through increasing milk production and collective marketing.

The rationale for this vision is presented later in the chapter on discussions.

4.4.2 Upgrading objectives

The intervention areas are based on predictor variables identified in this study.

i) **Fodder**

The step wise model showed that the presence of fodder alone explained 35.7% of the variance in milk production, while the final model showed that a one unit increase in fodder would increase milk yields by 0.245 units. Therefore improving availability and utilization of high energy quantity and quality of fortified fodder (pastures, crop residues and fodder trees) on smallholder farms is a key upgrading objective.

ii) **Dairy meal**

Dairy meal was the second most important predictor in the model and explained 15.3% of the variance. Optimal protein nutrition is important in increasing milk yields for dairy cows (Chamberlain and Wilkinson, 2002). However, analysis of agrovet dealers, market samples and interviews revealed quality concerns. Two options are suggested in the upgrading strategy: Access by farmers to high quality dairy meal. This option would hold only when farmers source this input from the
same source such as a cooperative. However the high cost would limit utilization due to the low income status of farmers in the study area. Legumes of equivalent protein content (16%) such as desmodium, sweet potato vines, calliandra, lucerne) would be a cheaper option.

iii) **Use of improved dairy technologies.**
Research technologies were identified in the model as significant predictor of milk production. Assessments of farms revealed about 57% were not aware of existence of improved technologies. Priority research technology needs as identified by farmers were disease control packages and fodder varieties. A case study of KARI Kakamega also showed that the institution had developed many dairy productivity enhancing technologies. Hence this objective would be important in an upgrading strategy.

iv) **Access to Credit**
Credit was identified as an important predictor of milk production. However only 8% of farmers had used credit due to fear of losing land and high interest rates. The analysis showed that priority needs for credit were: purchase of dairy cows and improving feeds. Access to credit could be enhanced through an interlocked transaction arrangement tied to delivery of milk to farmer organization such as a cooperative (Govereh et al, 1999, *Sunday Nation* August 10, 2014). This would ensure a win-win situation for both the loaning organization and farmers. Thus access to credit would be an important objective in an upgrading strategy.

v) **Artificial insemination**
The analysis revealed Al is an important predictor. However, there was low usage (39.8%) of Al due to problems associated with its availability and high incidence of repeats. The following statements by a lady farmer in Butula in a focus group
discussion, and one of the AI providers interviewed in Butere summarise the problem of AI in the region.

"After waiting for 24 hours, I had to let a local Zebu bull serve my cow since there was neither AI nor a grade bull in this village" (Lady farmer, Butula).

"Just look around our herds and you will see very few female calves. Why are we having a high proportion of male calves born out of AI service? (Focus group discussion, Butula)

"It takes three things for conception to succeed using AI: The farmer, the cow and the inseminator. In this area, farmers have little knowledge on heat detection, the cows are poorly fed, while some inseminators have inadequate experience. To make AI efficient and effective, four things should be addressed: Availability of liquid nitrogen, semen testing lab, more inseminators and training farmers on dairy cow management skills" (AI technician, Butere)

Thus AI is an important objective in the upgrading strategy.

vi) Group membership

Membership to a group was an important predictor in the model. Vertical and horizontal linkages have been shown to enhance farmers' access to technologies, services, information, important in making production and marketing decisions (Olwande and Mathenge, 2010 Agwu et al., 2011). Moreover, the days of extension officers visiting individual households ended in the 1990s following liberalization (Karanja 2003). In addition to acquisition of services, there is the added advantage of group learning, innovation, sharing resources and policy advocacy (Leeuwis, 2004). Innovation through group membership could be illustrated using a case example of Angeline from Butula (consent was sought and given to use her case in this thesis).

'I have six children. Before Heifer project gave me a cow, I was extremely poor. All my children were out of school, I had only one grass thatched house and without even a pit latrine. I used to provide for my family through casual jobs. When I received this cow in 2007, I decided to try out different feed formulations to see if I could get more milk to enable me help my family.
First unlike other members of the group, I would dry Napier grass in the sun and feed it the next day mixed with dry desmodium, natural grass, callindra and four kg of dairy meal per day. I got 30 litres of milk after milking three times a day. Next I added to this ration a weed common in this area which cows like so much. Milk yield increased to 34 litres per. I again increased dairy meal to six kg and the yield increased to 40 kg. My fellow group members have only achieved maximum of 20 litres. This is a true story and even the newspaper reporters have been here. Today my first born is at the university and I have two children in secondary school. My home is also improved- I have semi permanent house, houses for my sons and have built a pit latrine” (Angeline, Butula)

Thus group membership and strengthening of linkages is an important field of upgrading in this study.

vii) Policy

Policy issues identified in this study were the need for a county dairy strategic plan to provide direction and guide dairy development; availability of a local source of breeding; the need for an AI centre equipped with liquid nitrogen, semen, a laboratory and, inspectorate to safeguard quality of commercial dairy meal. As one of the county directors of livestock said in an interview:

“There is plenty of idle land in local Agricultural Training Centres such as Bukura and Busia which could be used to raise good dairy animals for farmers. Dairy cows purchased from Rift Valley and being donated are of questionable quality since no farmer can sell their best milk cows. The key to increasing milk production in this region lies in access to good breeding stock, feed fortification, improving availability of AI services, training farmers in management skills and organised milk marketing” (Sub County livestock office)

Thus the need for supportive policy by the County Governments in an upgrading strategy is critical in creating an enabling environment for increased milk production

Viii) Restructuring dairy cooperatives into business entities

The results on assessment of milk markets (buyers) showed that dairy cooperatives were the best market in an upgrading strategy aimed at increasing milk production. Cooperatives had an advantage of being able to absorb large volumes of milk since they have coolers (some up to 5000 litres), delivery is contractual and are reliable.
Milk from cooperatives was of better quality to consumers since it was tested. However the analyses revealed that cooperatives were not popular with farmers due to low payment, delayed/ default in payment and mismanagement. Cooperatives had a large proportion of members as free riders, lacked professional managers, had poor financial status. Most of the cooperatives had weak linkages with farmers, buyers and service providers. There was little value addition since the only product sold was raw milk.

One KDB official interviewed summarised the challenges facing cooperatives in Western Kenya as follows:

"Most cooperatives in this region have collapsed since they operate as mere milk collection centres. They are not in business" (KDB official, Kakamega)

Based on these results a vertical coordination is a better strategy to upgrade cooperatives into business entities so that they become chain leaders and an attractive milk buyer. Restructuring is necessary at four levels:

- Management and membership - As pointed out in the preceding chapter, due to weaknesses inherent in the Cooperative Act, this study proposes the restructuring of management and membership into a SACCO or limited company. This is a business structure managed by professionals with the sole aim of making profits on behalf of members. Membership is by share capital and there would be no room for free riders (Bijman, 2007; Ton et al., 2008; Olson, 2009).

- Input supply and information exchange: Backward integration with farmers to provide: input supply, A.I and breed procurement services, extension services, feed supply, improved technology, credit, attractive price, regular payment and information exchange.
Product upgrading through quality control, processing, value addition, packaging and branding.

Contract marketing: Vertical linkages (chain partnerships). Forward integration with buyers through contract marketing of milk, price negotiations, product upgrading and diversification.

4.4.3 Implementing actors

The selection of stakeholders in the proposed upgrading strategy is based on the identified fields of upgrading derived from the study. Table 4.44 depicts stakeholders and roles.
Table 4.44: Stakeholder and roles in the proposed upgrading strategy

<table>
<thead>
<tr>
<th>Vision</th>
<th>Strategy</th>
<th>Areas of upgrading</th>
<th>Stakeholder</th>
<th>Role</th>
<th>Duration</th>
<th>Expected output</th>
</tr>
</thead>
<tbody>
<tr>
<td>To be the leading sector in Western Kenya for generation of income among smallholder farmers.</td>
<td>Process and product upgrading through vertical and horizontal networks</td>
<td>Fodder</td>
<td>Farmers</td>
<td>Diversify feed resources on farm. Utilization of high energy and protein fortified feeds. Training on dairy cow management and agribusiness skills</td>
<td>3 years</td>
<td>Farmers using standard feed regimes. Increased milk yields</td>
</tr>
<tr>
<td>Mission: To improve the structure and performance of the milk value chain through increasing milk production and collective marketing.</td>
<td>Dairy meal</td>
<td>KEBS</td>
<td>Monitor quality of dairy meal in the market</td>
<td>5 years</td>
<td>High quality dairy meal sold by agrovetdealers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Credit</td>
<td>Financial SACCO</td>
<td>Provide financial credit to farmers through restructured dairy Cooperative</td>
<td>5 years</td>
<td>Dairy farm improvement: more cows, feed availability, cow structures, mechanization</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Group membership</td>
<td>Farmers</td>
<td>Form clusters for collective acquisition of</td>
<td>5 years</td>
<td>Viable dairy business groups established</td>
<td></td>
</tr>
<tr>
<td>Services, technologies and marketing, agribusiness skills training</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>A.I &amp; breeds service</strong></td>
<td>County government</td>
<td>Establish A.I and breeding farms</td>
<td>5 years</td>
<td>Local source of dairy breeding stock established in Western Kenya</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Research technologies</strong></td>
<td>KALRO</td>
<td>Commercialization of improved dairy technologies through partnerships with farmer organizations</td>
<td>5 years</td>
<td>Improved pastures, legumes, fortified feed technology, disease control packages utilised on majority of smallholder farms.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Policy</strong></td>
<td>County government</td>
<td>Formulate dairy strategic plan to guide dairy development by all stakeholders</td>
<td>5 years</td>
<td>Stakeholders collaborating on dairy projects to increase milk production</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dairy cooperatives</strong></td>
<td>Restructured cooperatives</td>
<td>Vertical coordination (governance) of farm programs, input supply, milk production, collection, processing and marketing</td>
<td>5 years</td>
<td>Increased milk production on smallholder farms, increased milk intake by dairies, chain partnerships established; milk deficit problem reduced</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.4.4 Anticipated impact of model on milk production

The multiple linear regression model was highly significant \( (F_{8, 291} = 65.089, p<0.001) \) and explained 63.9% of the variance. Fodder and dairy meal together accounted for 51% variance underscoring the relative importance of these two predictors in an intervention programme.

The model showed that when fodder is present, one unit increase could have the potential to increase milk yield by 0.245 units.

The predicted milk yield on presence of fodder alone, holding all other variables constant would be:

\[
1.76 + 0.245 \times 1 = 2.010 \text{ litres (the value of fodder here is a dummy denoted by 1)}
\]

The predicted value \( y \) (average milk yield) when all the eight significant variables are present would be:

\[
Y = 1.76 + (0.245 \times \text{fodder}) + (0.210 \times \text{Dairy meal}) + (0.16 \times \text{AI}) + (0.172 \times \text{credit}) + (0.111 \times \text{policy}) + (0.187 \times \text{Research}) + (0.147 \times \text{Group membership}) + (-0.098 \times \text{Returns})\]

Substituting the predictors with value of 1:

\[
Y = 1.76 + (0.245 \times 1) + (0.210 \times 1) + (0.16 \times 1) + (0.172 \times 1) + (0.111 \times 1) + (0.187 \times 1) + (0.147 \times 1) + (-0.098 \times 1) = 2.906
\]

The variables used were qualitative and hence the predicted yield of 2.906 is based on the value of one unit for all predictors. If the variables were numeric, as in a practical application, then the predicted value of \( Y \) would be much higher.
**Target:** Address the milk deficit estimated of 177 million litres per year.

i) **Impact of model at farm level on milk production**

This study established a baseline of 6.5 litres per cow per day. The model predicts about 3.0 litres, hence average yield per cow per day would be $6.5 + 3.0 = 9.5$ litres. An estimated average yield of 10 litres per cow per day across the farms is used in calculating anticipated impact. In practice though, depending on the genetic potential of the cow and level of management, some farms could even have a peak production of 40 litres per cow per day as shown in the baseline results on herd performance (Table 4.10).

From the results obtained earlier, 53.5% of farms produced less than 5 litres per cow per day, while 35.7% produced between 5 to 10 litres of milk. Thus 89.2% of farms in the region produced less than 10 litres.

a) **Butula Sub County**

Butula Sub County has 3400 dairy animals. The analysis showed that 36.4% were lactating cows. This means the estimated number of lactating cows is $36.4\% \times 3400 = 1,138$ cows.

Current total milk production per day in the Sub County $= 6.5 \times 1,138 = 7,397$ litres.

Production/ lactation days $= 7,397 \times 230 = 1,701,310$ litres.

Anticipated impact of upgrading in Butula would be:

$1138 \text{ cows} \times 10 \text{ litres} = 11,380$ litres per day.

Due to improved management, the assumed lactation length will be the conventional standard lactation days for dairy cows of 305 days (Chamberlain and Wilkinson, 2002).
Hence total production per 305 days will be: \(11380 \times 305 = 3,470,900\) litres.  
Production per year will be = Production per lactation / calving interval *365  
\(3,470,900 / 440 \times 365 = 2,879,269\) litres.

b) Butere Sub County

Butere Sub County has 2,600 dairy animals. This means the estimated number of lactating cows is 36.4% * 2,600 = 946 cows.  
Current total milk production per day = 6.5 * 946 = 6,149 litres.  
Production/ lactation days = 6123 * 230 = 1,408,290 litres.  
Anticipated impact of upgrading in Butere  
946 cows * 10 litres = 9,460 litres/day  
Hence production per 305 days will be: 9,460 * 305 = 2,885,300 litres.  
Production per year will be = Production per lactation / calving interval *365  
\(2,885,300 / 440 \times 365 = 2,393,488\) litres.

c) Western Kenya region

Western Kenya Counties of Busia, Bungoma, Kakamega and Vihiga have total of 192,000 dairy animals (FAO, 2011). The estimated number of lactating cows is given by 36.4% * 192,000 = 69,888 cows.  
Current total milk production per day = 6.5 * 69,888 = 454,272 litres.  
Production per lactation days = 452,175 * 230 = 104,000 250 litres.  
Production per year will be = Production per lactation / calving interval *365  
\(104,000 250/440 \times 365 = 86,272,935\) litres.  
Anticipated impact of upgrading in Western Kenya region:  
69,888 cows * 10 litres = 698,880 litres per day
Due to improved management, the assumed lactation length will be the conventional standard lactation days for dairy cows (305 days).

Hence production per 305 days will be: 698, 880 * 305 = 213,154,400 litres.

Production per year will be = Production per lactation / calving interval * 365
213,154,400 / 440 * 365 = 176,821,264 litres.

Current milk production per year in the region (grade cattle + zebu cattle + goats) is 215 million litres (Provincial livestock production office Kakamega, 2011).

This means the quantity of milk from zebu cattle and goats is 215,000,000 - 86,272,935 = 128,727,065 litres per year. Therefore expected total milk production in the region will be (grade cattle + zebu cattle + goats) = 176,821,264 + 128,727,065 = 305,548,329 litres per year.

From this study, estimated regional demand is 392,000,000 litres. Therefore deficit will be reduced from 177,000,000 litres per year to 86,451,671 litres per year i.e (392,000,000 - 305,548,329).

This means the intervention based on the model (1 unit increase in predictor variables) has potential to reduce the milk deficit problem by: 90,548,329 / 177,000,000 * 100 = 51%.

ii) Feed ration needed across farms to produce 10 litres of milk

Generally a dairy cow will need feed nutrients to provide for both her maintenance and milk production (KARI, 2010). It is possible to estimate milk yield from available feeds if four things are known: body weight, feed requirements of the cow, feed intake (dry matter) and feed value or ration quality (Chamberlain and Wilkinson, 2002).

Assumptions used in calculation
Body weight = 500kg

Feed intake (DM) of 0.5 (ration quality) = 12 kg or about 2.5% body weight

Feed requirements

Feed intake and value

Table 4.45 presents requirements for a cow yielding 10 litres per day.

**Table 4.45: Nutritional requirements for 10 litres production, 500kg cow, 4% fat.**

<table>
<thead>
<tr>
<th>ME(MJ/kg)</th>
<th>CP (g/kg DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance</td>
<td>57.2</td>
</tr>
<tr>
<td>Production, 10 kg</td>
<td>5.53*10 = 55.3</td>
</tr>
<tr>
<td>Total feed requirements</td>
<td>112.5</td>
</tr>
</tbody>
</table>

Source: Chamberlain and Wilkinson, 2002; KARI, 2010

Table 4.46 shows a ration needed to produce 10 litres of milk.

**Table 4.46: Feed types, intake and value**

<table>
<thead>
<tr>
<th>Type of feed</th>
<th>Ration (DM intake/kg)</th>
<th>Feed value ME(MJ/kg)</th>
<th>Feed value CP (g/kg DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Napier (wilted)</td>
<td>6</td>
<td>6*11.2 = 67.2</td>
<td>97*6 = 582</td>
</tr>
<tr>
<td>Maize germ</td>
<td>3</td>
<td>3*14.5 = 43.5</td>
<td>115*3 = 345</td>
</tr>
<tr>
<td>Sweet potato vines (wilted)</td>
<td>3</td>
<td>3*13.9 = 41.7</td>
<td>184*3 = 552</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>152.4</td>
<td>1479</td>
</tr>
</tbody>
</table>

Source: Chamberlain and Wilkinson (2002); KARI, 2010

N/B: Napier grass and maize germ are the main sources of energy while sweet potato vines are the main source of protein. The feeds must be combined (fortified) in such a way that at least 75% are high energy feeds (ME(MJ/kg)) such as Napier grass, Rhodes grass, natural pasture, hay, crop residues while 25% are protein feeds.
(CP (g/kg DM) like Sweet potato vines, Desmodium, Cotton seed cake, Bean husks, Lucerne, Brewer’s grains, Sunflower heads (KARI, 2010; KARI, 2012).

iii) Ration evaluation
From the proposed feed ration, the calculated energy (ME) value is 152.4 ME (MJ/kg) compared to 112.5 ME (MJ/kg). This is sufficient to produce 10 litres of milk. The calculated protein (CP) value is 1479 compared to 756 g/kg DM. This is more than the cow’s requirements although physiologically the effective protein source will be the sweet potato vines (Chamberlain and Wilkinson, 2002).

According to KARI technical handbook (2010), cows producing more than 7 litres will yield an extra 1.5 litres per day for every 1 kg commercial dairy meal.

iv) Anticipated impact of model on different stakeholders

a) Increased milk supply in cooperatives
Capacity of coolers in the region = 27,600 litres/day.
Hence number of cows needed to supply milk will be 27600 / 8 litres = 2938 cows
(2 litres are generally used for home consumption).

b) Impact on agrovets (Butula / Butere combined)
i) Dairy meal trade per month: Total no. of lactating cows * Quantity of dairy meal used/cow/day * 30 days, i.e 2084 * 4 * 30 = 250,080 kg (i.e 3573, Seventy kg bags) @ 2400 = KES 8 575 200

ii) Acaricide trade: 2084 * 700 = 1 458 800

Total dairy meal and acaricide trade per month = KES 10 034 000.

c) Impact on KALRO
Increased demand for dairy productivity enhancing technologies.
4.5 Business case for Western Kenya Region

This business case uses the results obtained from the anticipated impact described above to estimate the costs and benefits of the proposed intervention. The following parameters are estimated in this section: expected annual milk yield per cow; number of cows needed to cover the milk deficit in the region; cost of extra number of cows; expected annual revenue.

4.5.1 Addressing the 177 million litres milk deficit

Current annual milk production by grade cattle alone = 86,272,935 litres (KES 4.4 billion) while annual deficit = 177,000,000 million litres

Hence quantity of milk which should be produced by grade cattle to cover deficit = 86,272,935 + 177,000,000 = 263,272,935 litres, i.e (KES 13 billion)

Expected annual yield per cow using the model = 10 litres * lactation period / calving interval * 365 days, i.e 10*305 / 440 *365 = 2530 litres per cow per year, i.e KES 126,500 (current production per cow per year is about 1240 litres, i.e KES 62,000). Hence the number of cows required will be: 263,272,935 / 2530 = 104,060. Current herd size (lactating cows) is 69,888. Therefore 34,172 extra cows are needed.

4.5.2 Cost-Benefit analysis of intervention

Table 4.47 presents costs and benefits of a five year intervention on smallholder farms to increase milk production using one acre feed model. The main cost items are 34,172 cows at a cost of KES 70,000 each, Establishment of Napier grass on 104060 acres intercropped with desmodium, an AI centre equipped with liquid nitrogen plant, semen and a laboratory, feed pulverizers for processing feeds and training on dairy cow management skills. The total cost of the
intervention over five years is estimated to be KES 4.0 billion. The main benefits include sale of milk beginning in the second and third years in which half of the cows will be assumed to calve, while in years four and five, a calving rate of 80% is envisaged. Manure is a benefit that is accrued every year in which one cow produces 365 wheelbarrows of manure per year at a cost of KES 365,000. The other benefit will be calves begging from the second year. The total benefits of the intervention over five years are estimated to be KES 56.56 billion.

Table 4.47: Costs and benefits for the proposed intervention

<table>
<thead>
<tr>
<th>Costs (KES '00 000 000)</th>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cows @ 34 172 * 70,000</td>
<td></td>
<td>2.4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Napier grass establishment 104 060 acres @ KES 7500</td>
<td></td>
<td>0.78</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Desmodium establishment 0.25* 104060 @ KES 10000</td>
<td></td>
<td>0.26</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>A.I centre (liquid nitrogen plant, semen bank, lab)</td>
<td></td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Feed pulverizers (5203 @70,000)</td>
<td></td>
<td>0.36</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Training @ 104 060 * 1000</td>
<td></td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total costs / year</td>
<td></td>
<td>4.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Total program costs in 5 years = 4.0

Benefits (KES '00 000 000)

<table>
<thead>
<tr>
<th>Benefits (KES '00 000 000)</th>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk sales</td>
<td></td>
<td>0</td>
<td>6.5</td>
<td>6.5</td>
<td>10.2</td>
<td>10.2</td>
</tr>
<tr>
<td>Manure (1 w/ manure barrow<em>365</em>100*104060)</td>
<td></td>
<td>3.8</td>
<td>3.8</td>
<td>3.8</td>
<td>3.8</td>
<td>3.8</td>
</tr>
<tr>
<td>Calf @ 15000*104060</td>
<td></td>
<td>0</td>
<td>0.8</td>
<td>0.8</td>
<td>1.28</td>
<td>1.28</td>
</tr>
<tr>
<td>Total benefits / year</td>
<td></td>
<td>3.8</td>
<td>11.1</td>
<td>11.1</td>
<td>15.28</td>
<td>15.28</td>
</tr>
</tbody>
</table>

Total program benefits in 5 years = KES 56.56
4.5.3 Net Present Value

Table 4.48 presents an estimation of the Net Present Value (NPV) of the proposed intervention. The NPV measures the net financial benefits of the program. A positive NPV indicates that the benefits outweigh the costs. The NPV was 34.30 meaning the intervention is feasible and should be considered.

Table 4.48: Anticipated Net Present Value of the intervention

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefits</td>
<td>3.8</td>
<td>11.1</td>
<td>11.1</td>
<td>15.28</td>
<td>15.28</td>
<td>56.56</td>
</tr>
<tr>
<td>Costs</td>
<td>4.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4.0</td>
</tr>
<tr>
<td>B-C</td>
<td>-0.2</td>
<td>11.1</td>
<td>11.1</td>
<td>15.28</td>
<td>15.28</td>
<td>52.56</td>
</tr>
<tr>
<td>Discounted factor (12%)</td>
<td>1.12</td>
<td>1.25</td>
<td>1.40</td>
<td>1.57</td>
<td>1.76</td>
<td>7.1</td>
</tr>
<tr>
<td>SACCO rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discounted annual cash flows</td>
<td>-0.92</td>
<td>8.88</td>
<td>7.93</td>
<td>9.73</td>
<td>8.68</td>
<td>34.30</td>
</tr>
<tr>
<td>SUM NPV= KES 34.30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Financial figures are in ’00 000 000

4.5.4 Cost-Benefit Ratio and Internal Rate of Return

Table 4.49 compares the Benefit-Cost Ratio (BCR), Return on investment or Internal Rate of Return (IRR) and NPV. The calculated BCR is 14.14 meaning a return of KES 14.14 for very KES 1 invested. The IRR is 12.14 meaning the investment will generate a return that amounts to 1214% of the cost of investment. Hence the intervention should be considered.

Table 4.49: Comparing Benefit-Cost, Internal Rate of Return and Net Present Value

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Costs</th>
<th>Benefit - Cost Ratio (BCR)</th>
<th>Internal Rate of Return (IRR)</th>
<th>Net Present Value (NPV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>56.56</td>
<td>4.0</td>
<td>14.14</td>
<td>12.14</td>
<td>34.30</td>
</tr>
</tbody>
</table>
CHAPTER FIVE

5 DISCUSSION

5.1 Introduction

This chapter presents a discussion of the results obtained as per the four study objectives. The significance of the results is also reviewed in light of previous studies and attempts are made to draw similarities and differences. Where necessary, technological, socio economic and policy implications are emphasized. The discussion is organized along four thematic areas: structure and performance of milk market; important predictors of milk production; priority interventions for upgrading structure and performance of the milk value chain; and a proposed impact model.

5.2 Structure and Performance of milk market

5.2.1 Suppliers and channels

The findings of this study showed that farmers and travelling traders were the main suppliers of milk in the region accounting for about 58% of total milk traded (Figure. 4.1). Considering that cooperatives and milk bars together account for 12%, the informal channel which deals in raw milk controlled over 70% of marketed milk in the region. These results are consistent with several studies done in the country and in Eastern Africa (National dairy Master Plan, 2010; Omore et al., 2000, Muriuki et al., 2003) and, in India and Pakistan (Staal et al., 2008; Garcia et al., 2003) indicating the dominance of the informal channel in milk market. The dominance of informal channel has been driven by two main factors: liberalization of trade (Karanja 2003) and consumer preferences for raw milk (Ouma et al., 2000). The informal channel also offers higher farm gate prices to producers and cheaper
prices to consumers (Ouma et al., Garcia, 2003). According to the officials of the Livestock department and Kenya dairy board, the milk market in the Western region is largely unorganized and without a chain leader such as a processor, due to its informal nature. This in itself is a point of weakness as it affects quality. Lack of coordination and governance structures have been reported by Ruben et al. (2007) as a key issues affecting performance of tropical food chains, especially quality management.

### 5.2.2 Performance: Quantity and price

The results obtained showed 53% of the milk marketed comes from outside the region with acute shortages of milk experienced for a period of three to four months between December and March. About 92% of consumers surveyed in the four counties reported experiencing low milk supply (Figure 4.6). With a population of 4.3 million people (GOK, 2009), using FAO recommendations for milk consumption of 0.25 litres/person per day, the demand for milk in the region is about 392 million litres per annum against a production of 215 million litres/annum (Western Province livestock annual report, 2011). Therefore the region's milk deficit is about 177 million litres per annum. From this study, 53% of milk comes from outside, which translates to 94 million litres. This implies that the Counties of Busia, Bungoma, Vihiga and Kakamega are predominantly milk deficient. In terms of milk price, consumers bought one litre of raw milk at KES 60 (Table 4.1) whereas milk cooperatives paid between KES 45 and KES 55 per litre of milk delivered by farmers (Table 4.3). In Central Kenya the same quantity is sold at KES 35, while Cooperatives and major processors buy raw milk at between KES 27-34 (Daily Nation, December 4, 2013).
Globally, one litre of raw milk is sold at between KES 30-33 in the European Union, KES 29 in both USA and South Africa (IFCN, 2013). Thus, some of the reasons why insufficiency of milk has been persistent in a region that offers the highest milk price in the country and even in the World, yet farmers are not responding to favourable market signals by increasing production is discussed later in section 5.3.

5.2.3 Quality of marketed milk

Problems associated with milk suppliers as perceived by consumers were as shown in Table 4.2. There was a significant association between marketing channel and contamination of milk (p<0.001). Direct sales from farmer to consumer and farmer-trader-consumer channels were perceived to be the most contaminated. This is due to the fact that these channels had no quality checks. This finding was confirmed by the dairy board officials from interviews and they attributed this to informal marketing as well as limited certification of all market actors due to inadequate staff. The problem with adulteration is that it cheats the consumer by increasing the volume. Together with physical dirt and addition of chemicals, ostensibly to preserve milk over long distances, the risk to public health through bacterial contamination and drug residues is real. Thus the quality of milk and safety concerns are major problems in Western Kenya milk market. A study by Omore et al (2000) through the smallholder dairy Project (SDP), identified similar critical control points along the dairy value chain which to date have not been adequately addressed through policy and quality surveillance system.

According to the World Health Organization (WHO) and FAO (2004) quality guidelines, milk for trade should be free from antibiotic residues and pesticides, a
total bacterial count and somatic cell count of less than 100,000 per ml and 500,000 cells per ml respectively in addition to specified butter fat and protein levels. Nationally, KEBS has adopted these international standards mainly for export trade, but implementation locally still poses a challenge since milk payment system is based on quantity and not quality (Omondi, 2009). Thus the findings of this study show that quality of marketed milk is a problem that needs to be addressed not only in Western Kenya but nationally.

5.2.4 Consumer preferences

A high proportion of consumers (households, hotels and institutions) preferred fresh unpasteurised milk (63%) compared to fresh pasteurized (25%) and UHT (12%) milk (Figure 4.2), (P<0.001). A previous study by Ouma et al (2000) reported high consumer preference for raw milk traded through informal channel than other dairy products. There was also a significant association between consumers and preferred attribute (P<0.001) since out of the respondents surveyed (N=385), 56% preferred quality, 27% price, 9% quantity, 5% packaging while 3% preferred reliability as attributes influencing choice of milk supplier (Figure 4.5). About 87.5% of the respondents interviewed would increase milk production in the next five years (Figure 4.7). The implication of this result is that a milk marketing strategy in the region should prioritize quality of milk.

5.2.5 Performance of dairy cooperatives in the region

The cooperatives channel accounted for only 5% of the market share. The findings also revealed that only 8.8% capacity of the region’s milk coolers is utilized. Out of total of 27,600 litres capacity, cooperatives received only 2,420 litres of milk on daily basis delivered by farmers (Table 4.3). In addition, our visits and
informal interviews established that coolers in all cooperatives surveyed were either grossly underutilized, broken down and had power supply disconnected due to inability to pay bills. Despite the huge idle capacity, more coolers were still being supplied in the region by development agencies. It is suggested that in a milk deficit region such as Western Kenya, the investment policy and priority is to target and focus on increasing volumes and capacity building of both farmers and cooperatives on management / agribusiness skills rather than the populist direction of provision of coolers.

The study also revealed that cooperatives bought milk from farmers at an average of KES 43.60, which as already mentioned, is the highest price offered by cooperatives in the country. A gross margin analysis revealed that 50% of cooperatives had a negative gross margin (Table 4.4). This finding lends credibility on sentiments in the previous chapter expressed by one KDB official. These findings further suggest the need for restructuring dairy cooperatives into viable business entities. Constraints facing cooperatives were identified as: low milk supply, farmer apathy, delayed or defaulted payments, mismanagement, low technical, financial and business skills among officials, competition from other buyers and high operational costs. Farmer apathy which affects milk supply, manifested in the high numbers of inactive members (91.5%) is a real problem in many cooperatives. This common problem is referred in the literature as the "free rider" problem (McMillan, 1979; Olson and Cook, 2009).

Similar results have been reported in Kenya by Limo et al (2011) and Ortmann and King (2007) on South African Cooperatives. Prakash (2000), in a review of cooperatives in Japan, argues that cooperatives are neither social clubs nor charity organizations and should be managed in a business-like manner. To be
efficient and remain relevant and competitive in the post liberalization era, cooperatives must upgrade from horizontal to vertical coordination through embracing modern functions. Bijman (2007) suggests that such modern functions include quality guarantees, enhancing logistics, information exchange, process and product innovation. A discussion of this new role for cooperatives is presented later in this chapter.

5.2.6 SWOT analysis of the milk market

The findings from the results of the SWOT analysis of the milk market are shown in Table 4.5. They show that the main strengths of the Western Kenya milk market is the availability of coolers for milk storage which at the moment are not being fully utilized by local farmers to take advantage of prevailing opportunities of high milk prices, unmet demand and growing population. The biggest weakness was found to be inadequate milk supply. The low quality milk is another weakness and in addition to idle capacity, if not urgently addressed could not only expose the market to threat of competition from milk that comes from outside the region but also lead to total collapse of key market institutions such as the farmer cooperatives. Indeed, it will take only one entrepreneur any part of the globe supplying adequate quantities of quality milk at a lower price to run local suppliers out of business.

5.2.7 Cooperatives as the better option milk buyers

As defined before, a value chain is a market oriented approach and a target market must first be identified before upgrading by actors is commenced (Trienekens, 2011).

This study identified and analysed four main milk markets/ buyers which included households, hotels, institutions and cooperatives (Table4.6). The findings
showed that though households and hotels offered better prices, these markets were unsustainable, scattered and unable to absorb increased volumes in an upgrading strategy designed to increase milk production since the study revealed that the mean volume bought by households, hotels and institutions were one litre, five litres and twenty three litres respectively. Based on these findings it is argued that cooperatives, though comparatively buy milk at lower prices in the region are the better option.

Globally, cooperatives have been shown to be successful in enhancing farmers’ access to markets. Bijman et al (2012) reviews the successful performance of cooperatives in the Netherlands based not only on profits but also market share and member satisfaction. Rajendran and Mohanty (2004) and Stall et al (2008) showed how cooperatives enhanced milk production in India to become the World leader, while locally the Githunguri case is a success example of collective marketing.

However, for the case of Western Kenya the multiple challenges facing cooperatives must first be addressed to position them as market leaders. Propositions on how this could be done are discussed later in the section on upgrading.

5.3 Relationships between value chain variables and milk production on smallholder farms

5.3.1 Household demographics

Household characteristics in the study area presented in Table 4.6. They showed that the mean age was 52 years, a trend that is common County wide, meaning primary production is carried out by a relatively elderly generation. Omondi (2009) found that the youth both in the Netherlands and Kenya had
negative attitude towards dairy farming as dirty work, low income undertaking, lack of start-up capital, no land ownership and failure by parents to pay them when they work on the farm. For Agriculture and indeed dairy to grow and contribute towards the goal of Vision 2030 (GOK, 2007), there is need for affirmative initiatives to renew the interest of the youth in primary production.

About 84.3% of respondents had a monthly income of less than KES 10,000, meaning that the majority of small holder farmers were in the low income category. This finding has implications on farmers’ participation in the input markets since it limits purchase of essential inputs necessary in increasing milk production.

5.3.2 Farm characteristics

The study found that the average farm size in the area was 3.9 acres, while land allocated to fodder was 1.14 acres (Table 4.8). This finding indicates that there is potential to increase milk production through optimization of available land resource, a key factor in production.

The study also found there was a very low level of mechanization since the main dairy equipment owned by majority of farmers (64%) was a plastic container used as sprayer for tick control. Only 5% possessed chaff cutter for feeds while 31% of respondents did not own any equipment. Mechanization simplifies and enhances farm operations.

The dominant marketing channel used by farmers was direct sales to households (64.5%), followed by traders (15.3%), hotels (13.5%) and institutions (4.2%), while cooperatives were the least popular (4.2%). This is consistent with findings from market analysis already discussed in the preceding section.
5.3.4 Herd characteristics and performance

The results for herd characteristics and performance shown in Tables 4.9 to 4.13 revealed that the mean milk yield per cow per day was 6.5 litres with about 89% of the farms producing less than 10 litres of milk per cow per day. The yields were relatively low when compared to the national average. A recent study by USAID (2012) showed that in the high potential areas of Central (Kabete) and Rift Valley (Kericho), the average yield had increased from 6.4 litres per cow per day to 16.75 litres per cow per day and 12.61 litres per cow per day following implementation of Kenya Dairy Sector competitive programme.

The low milk yields and short lactation length (230 days) observed in this study could be attributed to inadequate nutrition characterised by low quantity and quality of feeds. The association between feeds, yield, and lactation length has been reported in various studies (Staal et al. 2003; Msanga et al., 2000; Chamberlain and Wilkinson, 2002).

5.3.5 Cost of production and level of commercialization

The findings presented in Table 4.28 revealed that the mean variable costs per cow per month was KES 7,789. With the average milk production of 6.5 litres per day, this translates to 195 litres per month. Hence the cost of production per litre was KES 40. This is almost twice the cost in Central Kenya of KES 21.5, 19.3 and 16.9 in Muranga, Nyeri and Nyandarua Counties respectively (Kilimo Trust Report. 2012). The mean gross margin was KES 2,657, meaning the high cost of production could be attributed to inefficiencies at farm level such as high cost of feeds and the low volumes of milk produced. There is therefore need for capacity building on cost reduction strategies and business skills.
Assessment of level of commercialization showed that household input commercialization index ranged from Zero (subsistence i.e do not participate at all in input markets) to one (net buyer) with the mean of 0.32. This means that the level of input market participation in the study area was low. Output market index was 0.46 (46%) which was moderate. This is consistent with previous findings by Omiti (2006) and Mathenge et al. (2010) who found that the proportion of milk sold by households in rural Kenya was 45.9%. According to Govereh et al. (1999) and Strasberg et al. (1999), the closer the index is to 100%, the higher the degree of commercialization. Overall the HCI found in the study area was 0.39 (39%). This means that the level of commercialization in the area was moderate. These findings have attempted to establish levels of commercialization since previous studies had only indicated that dairy commercialization in the area was low but without empirical evidence (Waithaka et al., 2002, Makokha et al., 2007, Wambugu et al., 2011).

The relevance of measuring the level of smallholder commercialization arises from the interest to make comparisons of households or farms according to their degree of commercialization as an indicator of economic growth (Omiti, 2009). Smallholder commercialization could be seen as the strength of the linkage between farm households and markets at a given point in time. Agricultural commercialization usually takes a long transformation process from subsistence to semi-commercial and then to a fully commercialized agriculture (Pingali and Rosegrant 1995; Gebremedhin and Jaleta, 2010). This is an agenda for further research that could compliment and specify targets for agricultural sector and dairy in particular in line with Vision 2030.
5.3.6 Correlation between value chain variables and milk production

Assessment of eleven value chain variables was done to determine relationship with milk production on smallholder farms (Table 4.29). The findings showed that there was significant and positive correlation between presence of fodder, dairy meal, AI, credit, group membership, policy and research technologies and average milk yields on farms (p<0.001). This means that the presence of these variables increases milk production. Returns from milk sales was significant at 5% level but with negative relationship with milk production, meaning the increase in sales revenue did not necessarily translate into increased production as would be expected. In the study area, majority of farmers used returns from milk sales to pay school fees (40%) and household needs (27%) instead of re-investing on the dairy farm to increase milk production hence negative relationship (Table 4.22). Moreover, 89% of the farmers earned a monthly income of less than KES 10,000, mainly from sale of milk as reported in Table 4.7, while the average gross margin was KES 2657. Hence the negative relationship between returns and milk production could be attributed to these two factors.

There was a positive relationship between extension and milk production but it was not significant. Linkages with traders and attitude were not significant and all had negative relationship with milk production. Though traders offered market for milk, the proceeds are not invested back in dairy. Community attitude towards keeping improved dairy breeds negatively affected milk production and hence the inverse relationship. Though this finding was confirmed by key informants (Table 4.34), the effect was not statistically significant. Thus these findings provide an empirical method for selecting from the value chain system, key variables with linear correlations with milk production.
5.3.7 Important predictors of milk production

The most important predictors of milk production as judged by the strength of beta coefficient (Nimon et al., 2010; Nathans et al., 2012), were: fodder, dairy meal, research, credit, artificial insemination, group membership and policy (Table 4.31). Returns had a significant but negative effect in increasing milk production. Collectively, they explained 63.9% of the variance in milk production in the study area. The beta coefficient for each predictor variable is the change in milk production that would result from one unit change in the predictor variable, keeping all other variables constant. For instance, the coefficient of fodder was positive and significant at 1%. According to the results, holding other variables constant, one unit change in fodder would result in 0.245 unit change in milk production. Similar findings were obtained by Mokhtari et al (2012) in Iran.

5.3.8 Variance explained by individual predictors on milk production

a) Fodder

Using the model, fodder was ranked first and explained 35.7% of the variance. This finding reinforces the important role of fodder in milk production. In both Butula and Butere, the main source of fodder was Napier grass which was used by 98% of farmers (Table 4.14). Napier has low dry matter content of less than 20% and hence cows energy requirements for both maintenance and production cannot be effectively fulfilled, hence low milk production and shorter lactation period reported (Chamberlain & Wilkinson, 2002). Inadequate feed resources both in quantity and quality has been reported in several studies as the main constraint limiting milk production on smallholder farms (Karanja, 2003; Muraguri et al., 2004; Omiti, 2006, FAO, 2011).
Both farmer groups and the livestock officials also ranked fodder as the most important variable perceived to influence milk production (Table 34). There is need therefore to diversify the fodder resource base through use of improved pastures and crop residues. Capacity building on feed conservation technologies will help enhance availability of fodder during dry season since in this study only 13.3% of farmers conserved feeds.

b) Dairy meal

Dairy meal (concentrate) was ranked second and explained 15.3% of the variance. Dairy meal as the most important source of protein for dairy cows is known to significantly increase milk yields (Chamberlain and Wilkinson, 2002; KARI, 2010). In the study area the proportion of farmers who used dairy meal was 69%, while the rest used alternative legumes and fodder trees (Table 4.15). The findings suggest that access to high quality dairy meal has potential to contribute to increased milk production in the study area.

The finding that fodder and dairy meal together explained 51% of the variance out of a total of 63.9%, underscores the very important contribution of feeds in dairy production.

Thus the findings suggest an intervention strategy where the focus is on feeds and feeding.

c) Improved research technologies

The use of improved Research technologies explained 3.3% of the variance, underscoring the importance in increasing milk production. In the study area, 57% and 35% did not use research technologies because they were neither aware of their existence nor available (Table 4.20). Dissemination of improved technologies,
especially those identified by farmers in this study (fodder varieties, feed analysis, disease control, breeding stock) to ensure accessibility, availability and utilization will positively influence milk production.

d) Access to credit
Credit explained 3.1% of variance. In the study area only 8.1% of farmers had used credit in the last five years while 40.8% feared their land might be auctioned (Table 4.21). Inaccessibility and unaffordability of credit has been reported as one of the major constraints limiting agricultural productivity among smallholder farmers (FAO, 2011; Omiti, 2009; Agwu et al., 2012). The analysis showed that if credit was available, priority needs as identified by farmers were improve on feeds (39%), purchase of another dairy cow (34%) and improvement of housing structure. Credit is expected to enhance farmers ability to purchase inputs, upscale operations and hence contribute to more production and greater commercialization (Lerman, 2004; Martey et al., 2012).

e) Artificial insemination services
AI explained 3.0% of variance, meaning that accessibility and availability of AI services had a higher probability of increasing milk production. The findings of this study show that only 39.8% of the farmers used AI while only 18.8% had knowledge of the semen type and bull used for insemination (Table 4.16). Since the liberalization era of 1990s, AI is one of the institutional services that have continued to decline since the private sector has been slow and ineffective in taking it up. Similar findings have been reported by Musalia et al (2010) and Barret, 2007).
f) **Group membership**

Group membership, explained 1.9% of the variance. This means organizing farmers in dairy groups has a higher probability of increasing milk production. Group membership enhances knowledge and experience sharing, learning and innovation besides collective acquisition of services and marketing (Olwande and Mathenge, 2010, Agwu et al., 2012).

**g) Policy**

Policy explained a small variance of 0.8%. Policy environment plays a key role in promoting productivity (Gamba, 2006). In this study farmers identified service provision and inputs as key areas in dairy where supportive policies were needed (Table 4.25).

**h) Returns**

Returns each explained a small variance of 0.8%. The model showed that returns from milk sales had a probability of increasing milk production, though it was small. The study has shown that due to socio demographic indicators especially low incomes of the survey respondents, revenue were mainly used for paying school fess and household needs, hence the marginal contribution. However with increased volumes of ten litres per cow per day envisaged by the model in this study, the monthly sales revenue would increase from KES 10,000 to KES 15,000 with a higher gross margin of about KES 7,000. This income could enable farmers to invest back in the dairy enterprise. Mathenge et al (2010) also observed that low income households used returns for consumption rather than investing back in agricultural production.
5.3.9 Statistical and practical significance

In general, the results showed that fodder, dairy meal, research technologies, credit, AI, group membership, policy and returns were the most important value chain variables and together explained 63.9% of the variance in milk production. Therefore a posteriori hypothesis from the study findings could be stated as follows: “There is a linear relationship between specific value chain variables and milk production”. Thus the findings suggest five major issues of practical significance relating to identifying interventions in a specific value chain, and in this case, the milk value chain:

i) There was a linear and significant relationship between eight variables and milk production.

ii) Multiple regression model may provide a robust tool for selecting important variables in a value chain system which consists of many components.

iii) The potential impact of selected interventions can be estimated ex ante.

iv) Where resources are limited for carrying out all key interventions identified, assist in prioritization.

v) It assists in selection of stakeholders in an intervention strategy.

Though the potential of identifying variables from many components in a value chain system looks promising from these findings, on farm validation should be carried out with quantifiable values. Secondly, about 36% of the variance was unexplained by the model. It will be worthy investigating the effect of other variables not considered in this study such as environmental factors.
5.4 Priority interventions for upgrading structure and performance

Following the assessment of markets, farms and inefficiencies presented in the preceding results chapter, the potential vision for upgrading the milk value chain in Western Kenya would be formulated as: “To be the leading sector in Western Kenya for generation of income among smallholder farmers”.

This proposition is informed by the analysis which showed that the current structure consisting of actors (farmers, cooperatives, milk bars, traders, consumers); service providers (agrovet dealers, A.I providers, extension department, research institutes, credit institutions) and policy makers (County Government) was unorganized and lacked coordination. As a consequence, the performance of the value chain was characterised by low milk supply, persistent deficit, perceived low quality milk, weak linkages, inefficient dairy cooperatives and institutions. The findings suggest that a vertically coordinated structure in which cooperatives integrate backwards to provide farm supplies, training and extension; and, forwards with buyers through contract farming and marketing arrangements should be established (Figure 5.1).

5.4.1 Visualization model

Figure 5.1 depicts proposition for upgrading the structure and performance of the milk value chain.
Figure 5.1: Potential Model for upgrading structure and performance of milk value chain in Western Kenya
5.4.2 The new value chain structure

The proposition focuses on a new structure of the value chain consisting of five levels: Integrated input supply; dairy farmer business clusters, new structured cooperative (SACCO or limited company), contracted retailers and supportive County Government policy. This structure has been recommended by Trienekens (2011) who reported that value chains in developing countries could upgrade from a structure of many scattered farmers producing for local markets to an upgrade producing for contracted retailers or processors. These producers aim at the emerging supermarket sector (retailers). The volumes are high and delivered by small/medium size producers, organized in cooperatives and/or linked vertically in contracting arrangements (Ton et al, 2008). The structure produces according to national and sometimes international quality and safety standards (Rubenet et al, 2007). The chain leader is the new structured cooperative which governs and coordinates input supply, production, processing, value addition and contract marketing (price negotiations).

i) Restructuring dairy cooperatives into business enterprises

Unlike in the past when they dominated milk marketing, dairy cooperatives are today the least popular marketing channel for milk in Kenya due to history of mismanagement, corruption and delayed payments (Omore et al, 1999, Karanja, 2003; FAO, 2011). However, in this study, analysis of milk markets suggested that cooperatives were the better milk marketing option if restructuring was done. Assessment of the extent to which cooperatives in the area performed modern roles revealed that only 10% provided extension and input supply services. The findings showed that dairy cooperatives in Western Kenya have not taken off on a business
path. When cooperatives are restructured in both management and functions, they can indeed become attractive to farmers and viable business partners in the value chain was the case with Githunguri dairy and also as reported in the Netherlands (Bijman et al., 2012), USA (Olson and Cook, 2009), South Africa (Ortman and King, 2007); North America and Europe (Chaddad and Cook, 2004); India (Rajendran and Mohanty, 2004) and Japan (Prakash, 2000).

According to Cook (1995), a life cycle of a cooperative goes through a five stage process: formation, growth, reorganization, decline or exit as they adapt to changing economic and technological change. The results showed that cooperatives in the region were either in the decline or exit stage due to problems associated with management, financing, free riding and political interference. These problems are inherent in the provisions of the Cooperative Act (2005). The International cooperative Alliance (ICA, 2005) defines a cooperative as “an autonomous association of persons united to meet their economic, social and cultural needs and aspirations through jointly-owned and democratically-controlled enterprise”. This definition assigns certain rights including voting to free riders. Cook (1995) suggests that to survive exit, new generation cooperatives have restructured through mergers, consolidations, acquisitions or converted into another business form.

Olson and Cook (2009) report that the Cooperative in Columbus, Ohio with membership of 45000, majority of whom were free riders, was facing bankruptcy and had to restructure to retain only quality members. Prakash (2000) also reported how Japanese agricultural cooperatives (JAs) went through structural reforms to become major contributors to Japan’s economic and industrial
development. Value chains are about clear criteria for inclusion or exclusion (KIT et al., 2006). Not all actors can be part of a value chain.

With 50% of cooperatives in the region having negative gross margins, cooperatives need changes at four levels: management and membership restructuring; strong input supply and information sharing; product upgrading through quality control, processing, value addition, packaging, branding and; Contract marketing. The findings suggest that management change could entail experienced, trained and professionally qualified staff under the supervision and control of a board of directors. Membership restructuring could entail four areas: closed membership, payment of share capital to ensure every member has a stake, selective incentives in service provision: input supply, training, credit and information sharing, voting rights, quota system allocation of milk deliveries to either individual members or groups such that the cooperative can predict expected quantities of milk intake and marketing. Another new role of the cooperatives would be to facilitate farmers get loans from credit institutions using interlocked transactions (Governor et al., 1999; The Sunday Nation, August 10, 2014).

ii) Integrated input supply
   a) Fodder accessibility, availability and utilization

   The practical significance of fodder accessibility, availability and utilization will be to improve milk production on individual farms across the region and hence contribute to reduction of the deficit often experienced by consumers. This could entail strong partnerships between farmer groups organized in business clusters with research institutes such as KALRO. As shown in Table 4.37, dairy productivity enhancing technologies exist in research institutes yet farmers have limited access to them due to lack of commercial orientation. Agribusiness orientation in research
institutes and partnerships could enhance technology dissemination and thus improve milk production. Capacity building on growing improved pasture and legume varieties, feed fortification technologies, conservation technologies and standard feeding practices could be an integral part of the partnership arrangement.

b) Use of quality dairy meal and/or protein legumes

An assessment of agrodealers showed quality problems associated with dairy meal found in the market. Concerns on the low quality of commercial concentrate have been raised in various studies, reports and stakeholder workshops, but the problem still persist due to weak enforcement of the law (Karanja, 2003; FAO, 2011; Kilimo Trust 2012). Since this is an issue that may require several institutions such as KEBS and Association of feed manufacturers to address, joint purchases from reputable companies through the cooperative could be an option. As mentioned before, organised farmer groups practising organic dairy through use of other documented protein substitutes such as legumes have a chance to access niche markets for organic milk. This option has the added advantage of cutting down the high cost of commercial concentrates.

c) Efficient A.I and breeding services

Problems associated with A.I services as perceived by farmers were high frequency of bull calves, repeated service and poor quality of calves (Table 4.16). Interviews with the A.I providers revealed that lack of semen (39%), unavailability of liquid nitrogen (24%), repeat inseminations (22%) and low payment by farmers (15%) were the key challenges affecting delivery of A.I services in the area (Table 4.36). These findings suggest that the inefficiency of A.I service is an institutional problem not only in Western Kenya but in the whole country, whose origin is traceable from the liberalization policies of 1990s which were hurriedly
implemented and have hitherto continued to affect availability and delivery of services to farmers (Musalia et al 2010; Gamba, 2006; Karanja 2003; Omiti 2002).

From the informal interviews with livestock officers and farmer groups, it was suggested that the four County Governments of Busia, Bungoma, Kakamega and Vihiga could improve A.I services by jointly funding the establishment of a regional A.I centre equipped with liquid nitrogen, semen bank and testing laboratory and a breeding multiplication centre at any of the ATCs. That way, A.I providers could easily access quality semen for onward delivery to smallholder farms. Similarly, the breeding farm could provide a local source of high quality dairy animals for farmers and thus help increase the population of dairy cattle in the region. In the model the cooperatives would provide A.I and breeding stock through its extension program.

iii) Dairy farmer business clusters

In depth focus group interviews with six farmer groups in Butula and Butere identified key challenges to dairy development as shown in Table 4.27. These findings suggest that dairy development in the region is mainly constrained by institutional rather than technological factors. Forging stronger farmer organizations as entry points for input supply, modern technology, credit, marketing, knowledge sharing, innovation and policy advocacy could partly fill this gap. In the model, upgrading the present structure of groups to dairy farmer business clusters focussing on technical and business aspects of dairy production and marketing would have the potential to improve milk production. In the new structure, farmer clusters provide entry points for piloting standard feeds and feeding models, capacity building and service acquisition. Thus milk production could be enhanced through this approach.
iv) Contracted retailers

The results found that only 10% of cooperatives had contracts with retailers (Supermarkets) while the rest sold milk directly to households (Table 4.41). In the proposed structure, cooperatives add value; package and brand milk and hence become attractive business partners with retailers.

v) Supportive County government policy

Due to the lack of strategic plan at the County level to give direction (Table 4.42), activities implemented by NGOs were not focused on increasing milk production (Table 4.43). Funding for the livestock department was also found to be inadequate. These findings reflect a general declining trend in funding for livestock services in Kenya. Financing of the sector in 1960s, 1980s, 1990s and 2000s was at 10%, 7.5%, 35% and 1% of total national budget respectively (GoK, 2010b). Whereas the sector contributes 10% Gross Domestic Product (GDP), its annual budgetary allocation is only 0.25% of GDP. Given that agriculture is the backbone of many African economies, increasing funding to 10% as recommended by NEPAD (2002) would be key to revitalizing the sector (AGRA, 2014; Ochieng, 2007).

In the proposed structure, County governments formulate regional dairy strategic plan to provide a road map for investment in the sector.

5.4.3 Carrying capacity on one acre feed models

The following evaluation estimates the carrying capacity and potential dry matter yield which could be optimised using the model:

The area under fodder in the study location was found to be 1.14 acres (Table 4.8). Type of feed: Napier grass intercropped with desmodium, sweet potato vines pure strand.
A dairy cow weighing 500 kg will consume about 2.5% of body weight (good quality fodder), (Chamberlain and Wilkinson, 2002).

The dry matter requirements per year are given by:

\[ 2.5\% \times 500 \times 365 \text{ days} = 4563 \text{ kg}. \]

Out of these 75% should come from Napier = 3422 kg, while 25% from legumes 1141 kg of DM. But land for fodder is only one acre. According to KARI (2010), the optimal fodder-legume mix should be in the ration 3:1.

Expected Napier yield:

Amount of Napier yield on 3/4 acre is given by \( \frac{3}{4} \times 10000 = 7500 \text{ kg DM/year} \) (Orodho, 2006). This is enough for 1 lactating cow and a heifer.

Expected yield for sweet potato vines:

Yield per acre is about 2600 kg of DM per hectare per year (1200 kg/acre), (Orodho, 2006). Hence for \( \frac{1}{4} \) acre will be: \( \frac{1}{4} \times 1200 = 300 \text{ kg of DM per year} \).

Desmodium yield intercropped with Napier will be:

\[ 3200 \text{ kg/acre} \times \frac{1}{4} = 800 \text{ KG/DM}, \] (KARI, 2010).

Total dry matter from legumes will be:

\[ 300 + 800 = 1100 \text{ Kg of DM per year}. \]

This is enough for one cow. But lactation period is 305 days, meaning there will be a surplus of legumes for heifer and calf.

Since smallholder farmers practice a mixed crop-livestock system, extra fodder from crop residues could even sustain a dry cow. Based on this model the carrying capacity on 1 acre of fodder is 3 animals (cow, heifer and calf).

Thus the findings of this study present an opportunity to pilot the proposed model in order to address the milk deficit problem in Western Kenya.
5.4.4 Cost-Benefit analysis of proposed intervention

The calculated benefit-cost ratio showed that investing in the proposed intervention would result into a benefit of KES 14.14 for every KES 1 invested. The assessment of IRR showed that the investment would generate a return that amounts to 1214% of the costs, while the NPV was 34.30 meaning that the benefits of the investment outweighed the costs. Thus the combined results of this evaluation indicated that the proposed intervention from the study is feasible and should be considered for implementation by stakeholders in Western Kenya to increase milk production on smallholder farms and hence improve the performance of the value chain.
CHAPTER SIX

6 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter is a presentation of a summary of empirical results by the objectives of the study, conclusions and recommendations.

6.1 Restatement of focus of study

The study adopted a value chain perspective to assess the structure and performance of the milk value chain in the Counties of Busia, Bungoma, Kakamega and Vihiga of Western Kenya. The region’s market offers the highest raw milk price in the country yet farmers were not taking advantage by increasing production, hence persistent milk insufficiency. The study investigated which variables in the value chain system influenced milk production on smallholder farms using a linear multiple regression model.

6.2 Summary of empirical results for the four study objectives

A summary of main findings of the study is outlined as follows:

6.2.1 Objective 1: Assessment of milk market opportunities

i) The study found that the main suppliers of milk in the region and their respective market shares were: farmers (35%), travelling traders from outside the region (23%), milk bars 7%, and cooperatives 5% who supplied raw milk; and shops (22%) and supermarkets who dealt in processed milk (8%). Milk supplied directly by farmers and traders were perceived by consumers to have significantly higher contamination (P<0.001).

ii) The main milk buyers were households, hotels, institutions and cooperatives. Households, hotels and institutions bought milk at the highest price of KES 60, while cooperatives bought at a mean price of KES 45. Quality and price
were found to be the most important attributes influencing choice of milk supplier \((p<0.001)\).

iii) The region’s milk deficit was found to be about 177 million litres per year with demand estimated to be 392 million litres per year against an annual production of 215 million litres.

iv) There was very low milk supply in cooperatives with only 8.5% out of the installed cooler capacity of about 27600 litres being utilized. About 50% of cooperatives had negative gross margins. The main challenges facing cooperatives were: mismanagement; delayed payments; lower price compared to competitors; high proportion of free-riders; low technical, financial and business skills.

v) The findings revealed that although households, hotels and institutions bought milk at higher prices, these markets were unsustainable, scattered and unable to absorb high volumes of milk in an upgrading strategy due to the small quantities purchased (one, ten and 23 litres respectively). Considering the parameters of quantity, quality, price and reliability, the dairy cooperatives ranked to be the best milk market.

vi) The main strengths of the Western Kenya milk market was the availability of huge cooler capacity, while the main weakness was low milk supply. The main opportunities were the high milk prices and a growing demand, while the main threat was perceived contamination.
6.2.2 Objective 2: Important value chain variables influencing milk production and level of commercialization in smallholder farms

vi) Relationships between value chain variables and milk production

The study revealed that eight out of eleven variables namely: fodder, dairy meal, AI, credit, group membership, policy and research technologies had a highly significant positive correlation with milk productions (p<0.001). This suggests that as these variables increase, milk production also increases and as they decrease, milk production also decreases. Thus these findings provide an empirical method for selecting from the value chain system, key variables with linear correlations with milk production.

vii) Important predictors of milk production

The most important predictors explaining variations in milk production were: fodder, dairy meal, research, credit, artificial insemination, group membership, improved research technologies, policy and returns. The variables collectively explained 63.9% of the variance observed in milk production in the study area. Fodder and dairy meal had higher beta coefficients and together explained 51% of the variation in milk yield. The model was highly significant (F8, 291,= 65.089, P<0.001). Thus multiple linear regression model may provide a rigorous and quantitative tool in selecting important value chain variables ex ante and would be useful in identifying key intervention areas in an upgrading strategy since it goes a step beyond the qualitative approaches used currently.

6.2.3 Objective 3: Sources of inefficiencies in the value chain

i) Input supply: Inadequate AI services; lack of local source of breeding stock; low quality of commercial dairy meal; and lack of commercialization and limited
scaling up of improved fodder varieties by KALRO were found to be the key inefficiencies at input provision.

ii) **Production:** Low milk yields (6.5 litres per cow per day, 1240 litres per cow per year); short lactation length (230 days); reliance on Napier grass alone as fodder; inadequate dairy cow management skills and low input market commercialization index (0.32) were found to be the key inefficiencies at farm level.

iii) **Collection, bulking and marketing:** The findings revealed that cooperatives had not taken off on a business path; and were not attractive to farmers due to mismanagement and failure to embrace modern functions such as coordination of input supply, extension and contract marketing.

iv) **Consumption:** High annual deficit of 177 million litres per year and low volumes purchased by households were found to be the main inefficiencies at consumption level.

v) **Service provision:** The study found that financial institutions lacked specialised credit to meet dairy farmers’ priority needs.

vi) **Policy:** The study also found that the devolved County Governments lacked dairy strategic plan to guide dairy development and other stakeholders.

6.2.4 **Objective four: Evaluation of potential upgrading strategy to improve structure and performance of the value chain**

i) **Priority interventions**
   
   The study evaluated priority interventions focusing on increasing milk production and collective marketing. Based on empirical results, the study proposed vertical linkages in which cooperatives coordinate farm input supply to marketing. Key interventions proposed are:

   a) Fodder accessibility, availability and utilization on smallholder farms
b) Use of high quality dairy meal and/or protein legumes

c) Establishment of A.I and breeding services

d) Policy: strategic plan to guide dairy development with emphasis on increasing milk production

e) Access and availability of credit through interlocked transactions

f) Formation of dairy farmer business clusters

g) Commercialization and dissemination of improved dairy feed technologies

h) Restructuring dairy cooperatives into business enterprises

iii) Proposition for an impact model

The study evaluated the impact of a potential upgrading model based on a new structure of the value chain consisting of five interventions: Integrated input supply; dairy farmer business clusters, new structured cooperatives (SACCO or limited company); contracted retailers and an enabling County Government policy. The study found that with one acre feed models consisting of fortified Napier grass intercropped with desmodium, sweet potato vines and crop residues, attaining milk yields of 10 litres per cow per day was feasible. The model was found to have a potential of reducing milk deficit in the area by about 51 per cent. The annual milk sales revenue from one cow would increase from KES 62,000 to KES 126,500. This translates to KES 13 billion per year for farmers in the entire Western Kenya region.

iv) Value for money

The study found that to address the deficit of 177 million litres per year, the total cost of increasing milk production on smallholder farms using one acre feed models would be KES 4 billion while the total benefits would be KES 56.56 billion over a five-year period. The calculated Benefit-Cost Ratio, Internal Rate
of Return and the Net Present Value showed that the proposed intervention is feasible and worthy undertaking.

6.3 Conclusions

From empirical results of the study, conclusions for each of the four objectives are formulated:

i) The demand for milk in the Western Kenya milk market is about 392 million litres per year while the deficit is estimated to be 177 million litres per year. The main opportunity is the high milk prices and a growing demand, while the main threat is perceived contamination of milk due to absence of quality control measures in the predominantly informal milk market. Cooperatives when restructured would be the best option market for smallholder farmers in an upgrading strategy.

ii) Eight variables within the value chain system significantly influence milk production on smallholder dairy farms in Western Kenya.

iii) The key sources of inefficiency in the milk value chain in Western Kenya are mainly institutional.

iv) An impact model for improving performance of the milk value chain should consist of five interventions: integrated input supply; dairy farmer business clusters, new structured cooperatives, contracted retailers, supported by an enabling County Government policy on dairy development. The model appears feasible and could increase yields to 10 litres per cow per day, increase intake in cooperatives, while reducing milk deficits by about 51 per cent.

Based on the findings, this study provides a rigorous and quantitative approach for selecting out of many components within the value chain system, a) the most important variables b) estimation of impact before actual implementation c)
identification of key stakeholders in an intervention strategy d) assist in prioritization where resources are limited for carrying out all key interventions identified.

The model has practical significance and should be adopted by the County Governments in Western Kenya to address the milk deficit problem.

6.4 Recommendations

The study identified key areas with important policy implications and further research as follows:

6.4.1 Policy implications

a) County Governments of Busia, Bungoma, Kakamega and Vihiga: The study findings showed that AI services, local source of breeding stock and availability of dairy strategic plan could be key pillars in upgrading the milk value chain. There is need for policy action by County governments to prioritise investment in the sector in the region by developing a strategic plan to guide dairy development with emphasis on increasing milk production, establishment of an AI plant equipped with liquid nitrogen, quality semen and laboratory as well as breeding farms within ATCs for source of dairy cattle. The four County Government could jointly share the cost of addressing the milk deficit problem in the region since the study showed that the return on investment is high.

b) National government

i) Ministry of Agriculture, Livestock and Fisheries: The study found low input household commercialization index. Commercialization takes a transformation process from subsistence, semi commercial and fully commercialization. Based on this study, there is need for the National Government to establish models for dairy input supply to support dairy farmers, and to set targets for levels of
commercialization to be achieved in order to sharpen the anticipated commercial transformation in the sector in line with Vision 2030. For the dairy sector in particular, farmer business cluster models are feasible flagships.

ii) Kenya Bureau of Standards: The study found that dairy meal was an important variable influencing milk production. However the protein content of dairy meal was not labelled on bags. There is need to protect dairy farmers in the country from low quality commercial dairy meal in the market. This could be done through development of code for Good Manufacturing Practices (GMP) and Hazard Analysis Critical Control Points (HACCP) system and an inspectorate unit in Counties to monitor quality of commercial feeds and drugs.

c) Kenya Agricultural and Livestock Research Organization: Research findings are a public good. This study found that there was a significant relationship between research technologies and milk production. However, many dairy productivity enhancing technologies developed were neither available nor accessible by majority of smallholder dairy farmers. There is need for commercialization of technologies through establishment of effective partnerships with farmer organizations and County Governments in Western Kenya.

d) Eastern Africa Agricultural Productivity Project (EAAPP): The Regional Dairy Centre of Excellence (RDCE) is in Kenya at KALRO Naivasha. The project has a mandate to increase dairy productivity among smallholder farmers. In its next phase of activities, the project should implement the findings of this study by piloting the proposed impact model in Western Kenya. EAAPP could facilitate the implementation of specific interventions identified in this study in
partnership with KALRO, County Governments farmer organizations and financial institutions.

6.4.2 Agenda for further research

The units used in this study to predict milk yields using multiple linear regression were dummies. Further research should be carried to validate the model on-farm using known values for variables in the value chain system.
REFERENCES


Productivity and Market Success of Ethiopian Farmers project (IPMS)—International Livestock Research Institute (ILRI), Addis Ababa, Ethiopia.


Jaleta, M., Gebremedhin, B and Hoekstra, D. 2009. Smallholder commercialization:


Omiti, J. 2006. Participatory Prioritization of issues in smallholder agricultural


International Training Course on "Strengthening Management of Agricultural Cooperatives in Asia" held at IDACA-Japan on April 18 2000


Statistical Packages for Social Scientists (SPSS), 2010. IBM 2010


Verkivisser, C.M., Pathmanathan, I and Brownee, A. 2003. Designing and conducting health systems research projects Volume II. World Health


of dairy systems in the Western Kenya region. The Smallholder Dairy (R&D) Project.


Appendix 1  Market study Questionnaires and interview guides for key informants

a) MILK MARKET CONSUMER SURVEY IN WESTERN KENYA

Name of interviewer----------------------------- Mobile No.------------------------ Date--------

(Households, Hotels, institutions (schools/hospitals/colleges/prisons),)

1. a) Name of consumer ---------------------------------- b) Sex 1= male [ ] 2= Female [ ]
    c) Mobile no------------------------ d) County--------------------- e) district--------

2. Consumer type 1= household [ ] 2= hotel [ ] 3 = Institutions
   (school/hospital/prison/police/college etc) [ ]

Quantity, Quality, Price and Suppliers

3. Quantity of milk purchased per day in litres------------------------

4. Average buying Price per litre in KES [ ]

5. Mode of payment
   1= cash [ ] 2= weekly [ ] 3= after two weeks [ ] 4= monthly [ ]

6. Terms of delivery
   1= contract [ ] 2= ad hoc [ ]

7a) Where do you buy your milk? 1= Farmer [ ] 2= travelling trader [ ] 3= cooperative [ ] 4= processor [ ] 5= supermarket [ ] 6= shop [ ] 7= other, specify [ ]
    b) State the quantity of milk bought per day in litres [ ]

c) Where do the milk you buy come from? 1= from suppliers in Western [ ]
   2= from outside Western [ ]

d) State the quantity bought from different suppliers per day
   1= from suppliers in Western [ ] litres 2= Outside Western [ ] litres

e) What is the average buying price/litre of fresh milk which comes from outside Western?[ ]

8. a) Do you check for the quality of milk supplied? 1= Yes [ ] 2= No [ ]
    b) If yes, what test do you use?
       1= visual inspection for color, dirt [ ] 2= clot on boiling [ ] 3= alcohol test [ ]
       4= smell [ ] 5= lactometer [ ] 6= other, specify -------------------------

d) What is main problem do you often find with milk that you buy?
   1= adulteration with water [ ] 2= physical dirt [ ] 3= addition of chemicals [ ] 4=other please
   specify--------

Consumer Preferences

10. What type of milk products do you usually buy? (Tick only one)
    1= Fresh unpasturised milk [ ] 2= Fresh pasturised milk [ ]
    3= Long life- UHT [ ] 4= Value added eg mala, yoghurt [ ]
    6=other, specify--------------------------

11. Rank the following products according to your preferences
Product | Rank 1-5
---|---
Fresh unpasturised milk | I= most purchased
Fresh pasturised milk | 5= least purchased
Long life - UHT | Value added Mala, Yoghurt
Other, specify | 

12. In what packaging do you usually buy milk? 
I= less than 250ml | 2=250 ml | 3= 500 ml | 4= 1 litre | 5= more than 1 litre

13. Distance in (km) from your regular supplier of milk
I= 0-5 km | 2= 6 - 10 km | 3= 11-20 km | 4= more than 20 km

14. a) If you have to select a milk supplier, which of the following attributes would you look for?
| Attribute | Rank 1-5
---|---
Price | I= most preferred
Quantity | 5= least preferred
Quality | 
Packaging | 
Reliability | 

b) Are there substitute products that you would switch to instead of milk?
I=Yes | 2=No

c) If yes, name the substitute


d) At what milk price per litre would you abandon buying milk and then switch to these substitutes?
I=KES 50-75 | 2= KES 75-100 | 3= KES 100-125 | 4= more than KES 125

Consumption trends
15. In your own assessment, has your consumption of milk increased in the last 5 years
I=YES | 2=NO

16. a) In your own assessment, would you say your consumption of milk is likely to go up in the next 5 years
I=YES | 2=NO

b) If yes, what is the reason
I= increased income | 2= increased family demand | 3= health reasons | 4= nutritional value | 5= change in lifestyle | 6= urbanization | 7= other, specify

Low milk supply
17a) Do you at any time of the year experience low supply of milk?
1= Yes [ ] 2= No [ ]
b) If yes, a) For how many months in a year?
c) Which months of the year do you experience low supply of milk?

Constraints faced by milk consumers and intervention
18. What are the main constraints you face as a milk consumer? (list and rank)

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Rank 1-5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1=Most important</td>
</tr>
<tr>
<td></td>
<td>5=Least important</td>
</tr>
</tbody>
</table>

19. In your assessment what intervention should be put in place to address the major constraint mentioned above?

b) MILK MARKET CONSUMER SURVEY: KEY INFORMANT INTERVIEWS: (Ministry of livestock development / Kenya Dairy Board)

Name of informant------------------------- Mobile No------------- Position--------
County------------------------ Date-------------------------

1. What are the main milk marketing systems / arrangements in the area?
2. Trading environment —
   a) Suppliers
      Types and numbers of suppliers?-----------------------------------------------
      Is the product unique or can it be sourced from other suppliers?------------------

b) Buyers
   Who are the main milk buyers?
   Is the product a commodity or is it value added (differentiated?)
   Do these buyers have contracts with suppliers?
   b) Barriers to entry in milk business e.g govt regulations, access to distribution channels, capital requirements, -----------------------------------------
   c) Are there substitute products for milk?, If yes which ones?-----------------------
      ------------------
   d) Competitors in milk trade
   Who else is selling milk in the Western milk market and What competitive advantage do they have over other suppliers?

<table>
<thead>
<tr>
<th>Actor</th>
<th>No. in the region</th>
<th>Market share (%)</th>
<th>Price</th>
<th>Quantity</th>
<th>Quality</th>
<th>regular delivery</th>
<th>Packaging</th>
<th>Distribution network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coops</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self help groups</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local Mini dairies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. Support from local leaders for dairy compared to other enterprises?
4. a) Milk Markets in the County/region
   b) No of dairy cooperatives in the region/County
   c) No of Mini dairies or processors in the region/County
5. Rank market segments in terms of volumes bought

<table>
<thead>
<tr>
<th>Market</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperative</td>
<td></td>
</tr>
<tr>
<td>Processors</td>
<td></td>
</tr>
<tr>
<td>Hotels</td>
<td></td>
</tr>
<tr>
<td>Institutions eg schools, hospitals, colleges etc</td>
<td></td>
</tr>
<tr>
<td>Households</td>
<td></td>
</tr>
<tr>
<td>Traders</td>
<td></td>
</tr>
</tbody>
</table>

6. Distribution channels (maps) i.e flow of milk from farm to consumer
7. Who organizes and coordinates other milk market operators?
8. Who is the overall milk market leader?
9. Buying and selling Price at different stages

<table>
<thead>
<tr>
<th>Stages</th>
<th>Farm gate</th>
<th>Cooperative</th>
<th>Processor</th>
<th>Trader</th>
<th>Retailer eg milk bar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buying price</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selling price</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Channels
- Farmer ➔ household
- Farmer ➔ Hotels/institutions
- Farmer ➔ Cooperative/processor ➔ Consumer
- Farmer ➔ Trader ➔ Consumer

10. Quality in different distribution channels
11. Challenges and opportunities for each market segment
12. Channels Profitable for farmers (segmentation/targeting)
13. a) Overall consumption (demand) volumes last 5 years
Year | 2008 | 2009 | 2010 | 2011 | 2012
--- | --- | --- | --- | --- | ---
Quantity consumed (litres) |   |   |   |   | 

b) In your assessment is consumption of milk likely to go up in the next 5 years? Yes/ No.
If yes, what are the reasons-----------------------------------------------

14. Production volumes last 5 years

Year | 2008 | 2009 | 2010 | 2011 | 2012
--- | --- | --- | --- | --- | ---
Quantity Produced (litres) |   |   |   |   | 

15. Proportion (%) of imported volumes from outside region and its competitive advantage over locally produced milk

16. Estimated market share of imported milk in percentages

17. Months with low milk supply in the year------------------------, Months with high milk supply--------

18. Overall assessment of region’s milk market. What are the reasons for current performance below

a) Growing: Yes/ No
b) Saturated: Yes/ No
c) Stagnant: Yes/ No
d) Diminishing: Yes/ No

19. Trends - Consumer preferences: Price, quantity, quality, reliability, packaging

<table>
<thead>
<tr>
<th>Preference</th>
<th>Rank 1-5 where 1= most important, 5= least important</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

20. Quality standards and type of milk quality checks in each channel

21. Status of value added milk products locally produced

22. What drives the milk market in the region/County?

23. Existing policy/regulation/taxes prevailing in the milk market

24. Key market infrastructures (Storage facilities/ market sheds) for dairy/milk

25. What are the main constraints, possible solution and opportunities in milk marketing

26. SWOT of the milk market in the Western region / County —main weaknesses/constraints/ opportunities/Threats
Internal | External
---|---
**Strengths** | **Opportunities**
1. | 1.  
2. | 2.  
**Weaknesses** | **Threats**
1. | 1.  
2. | 2.  

27. a) What are the main reasons for low milk production in the region?  
b) What should be done to increase milk production and commercialization of smallholder dairy farms in particular?

28. Human population in the region/County (2009 census). (No of households, Males, females, rural, urban)

c) **SURVEY OF DAIRY COOPERATIVES IN WESTERN KENYA**

<table>
<thead>
<tr>
<th>Name of interviewer</th>
<th>Mobile No.</th>
<th>Date</th>
</tr>
</thead>
</table>

1. Name of cooperative | County | district | division |
2. Name of chairman/manager/secretary | Mobile No. |
3. Year when registered |
4. Year began operating |
5. Requirement for membership |
6. Requirements for supplying milk to cooperative  
a) Minimum Quantity |
b) What are the quality requirements? |
c) Consistency in supply | 1= Yes [ ] 2= No [ ] |
d) Contract | 1= Yes [ ] 2= No [ ] |
7. Registered number of milk suppliers |
8. Active number of milk suppliers |
9. Number of collection centres/points |
10. Average distance in km of collection centres/points from cooperative |
11. How is milk delivered to the cooperative?  
1= cooperative vehicle  2= farmers bring milk to cooperative  3=other, please specify |

**Quantity, Quality, Price, Suppliers**

12. a) Quantity of milk bought per day in litres [ ]  
b) Quantity of milk sold per day in litres [ ]
13. a) Average buying Price per litre [ ]  b) average selling price per litre [ ]
14. Terms of payment for suppliers of milk to the cooperative  
1= cash [ ] 2= weekly [ ] 3 after two weeks [ ] 4= monthly [ ]
15. Who are the main buyers of your milk (Forward linkage)?  
1= Households [ ] 2= Institutions (hotels, schools/hospitals) [ ] 3= Traders [ ] 4= Retailers (shops, milk bars, supermarkets) [ ]
16. a) Who are the main suppliers of milk to the cooperative?  
1= Farmers [ ] 2= traders [ ]
3= both farmers and traders [ ]

b) State the quantity bought from different suppliers per day
1= from farmers [ ] litres 3= from traders [ ] litres 4= Other supplier [ ] litres

17. Does the cooperative have a cooler? 1= Yes [ ] 2= No [ ]

18. Capacity of cooler in litres [ ]

19. a) Do you check for the quality of milk supplied? 1= Yes [ ] 2= No [ ]
   b) If yes, what main test do you use?
      1= visual inspection for color, dirt [ ] 2= clot on boiling [ ]
      3= alcohol test [ ] 5= lactometer [ ] 6= other, specify

20. What main problem do you often find with milk that you buy?
   1= adulteration with water [ ] 2= physical dirt [ ]
   3= addition of chemicals [ ]

Consumer requirements

21. a) Who are the main buyers of your milk?
    1= Households [ ] 2= traders [ ]
    3= processor/minidairy [ ]
    4= hotel [ ] 5= institutions (schools, colleges, hospitals) [ ]

   b) Quantity usually purchased.

<table>
<thead>
<tr>
<th>Type of customer</th>
<th>Quantity usually purchased per day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(codes 1, 2, 3)</td>
</tr>
<tr>
<td>Household</td>
<td></td>
</tr>
<tr>
<td>Hotel/restaurant</td>
<td></td>
</tr>
<tr>
<td>Institutions: eg</td>
<td></td>
</tr>
<tr>
<td>Schools/hospitals/college</td>
<td></td>
</tr>
<tr>
<td>Processor/mini dairy</td>
<td></td>
</tr>
<tr>
<td>Trader</td>
<td></td>
</tr>
</tbody>
</table>

   1= < 5 litres 2= 5 - 10 litres 3= More than 10 Litres

Value addition

22. a) Does Cooperative process milk? 1= Yes [ ] 2= No [ ]
   b) If yes, list the types of products and selling price

<table>
<thead>
<tr>
<th>Value added Products e.g</th>
<th>Quantity: 1= glass, Cup= 300ml 2= 500ml, 3= 1 litre</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mala, Yoghurt, ice cream</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Costs

23. List the main variable costs per month incurred on milk business by the cooperative

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost (KES.)</th>
</tr>
</thead>
</table>
24. What other services does cooperative provide to farmers?

28. Who determines the price of milk in the value chain?

I = supplier [ ] 2 = cooperative [ ] 3 = consumer [ ] 4 = other, specify

Constraints faced by cooperative and intervention

29. What are the main challenges or constraints faced by the cooperative (List and rank)

<table>
<thead>
<tr>
<th>Challenge or constraint</th>
<th>Rank 1-5, where 1 = Most important, 5 = Least important</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

30. What policy challenges does your cooperative face?

31. What infrastructural (equipment etc) challenges does your cooperative face?

32. In your assessment, how can the main challenge or constraint faced by the cooperative be solved?

Low milk supply and intervention

33. Do you at any time of the year experience low milk supply?

1 = Yes [ ] 2 = No [ ]

34. If yes, a) For how many months in a year? -- b) which months of the year?

35. What should be done to increase volumes of milk delivered to cooperative?

Appendix 2 Farm assessment questionnaires and interview guides for key informants

a) SURVEY OF VALUE CHAIN FACTORS INFLUENCING MILK PRODUCTION ON SMALLHOLDER DAIRY FARMS IN WESTERN KENYA

SAMPLE SIZE: 400 DAIRY FARMS
SECTION 1: HOUSEHOLD CHARACTERISTICS

1. a) Name of head of household:.................................................... b) Mobile tel no:........................................
   c) County:.......................................................... d) District:........................................................ e) Division:.....................................................

2. Sex 1= Male [ ] 2= Female [ ]

3. Age of Head of household (years):..............

4. How many members are there in the household?:...........................

5. Highest Level of education of Household head:..................................
   1 = None [ ] 2 = Primary [ ] 3 = Secondary [ ] 4 = Tertiary (college) [ ] 5 = University [ ]

6. What is the main occupation of the household head?
   1 = Salaried employment [ ] 2 = Casual employment [ ] 3 = Retail Business [ ]
   4 = Full time farmer [ ] 5 = Others (Specify) [ ]

7. What is your main source of income? (Please tick  then rank on scale 1-7 where 1 = most important, 7 = least important)

<table>
<thead>
<tr>
<th>Source</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sale of farm crops: specify type of main crop</td>
<td></td>
</tr>
<tr>
<td>Salary (employment)</td>
<td></td>
</tr>
<tr>
<td>Retail business</td>
<td></td>
</tr>
<tr>
<td>Wages</td>
<td></td>
</tr>
<tr>
<td>Rent</td>
<td></td>
</tr>
<tr>
<td>Sale of milk</td>
<td></td>
</tr>
<tr>
<td>Others (specify)</td>
<td></td>
</tr>
</tbody>
</table>

SECTION 2: DAIRY FARM CHARACTERISTICS & RESOURCE ENDOWMENT

8. Form of transport owned by household head
   1 = none [ ] 2 = bicycle [ ] 3 = motor bike [ ] 4 = vehicle [ ] 5 = other, specify [ ]

9. Farm land size owned (Acres): [ ]
10. Land size (Acres) allocated to fodder production [ ]
11. Type of grazing system
   1 = Zero grazing [ ] 2 = Semi grazing [ ] 3 = Open grazing [ ]
   4 = Tethering [ ] 5 = other (please specify) [ ]

12. a) Herd size [ ]
    b) Herd structure

<table>
<thead>
<tr>
<th></th>
<th>B1= calves</th>
<th>B2= Young stock</th>
<th>B3 = mature males</th>
<th>B4= Cows</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male calves</td>
<td>Female calves</td>
<td>Immature males</td>
<td>Heifers</td>
</tr>
<tr>
<td>Male calves &lt; 1 year</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female calves &lt; 1 year</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immature males 1-2 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heifers 1-2 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulls</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milking cows</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry cows</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
13. a) Total milk production on the farm/day in litres [ ]
   b) Average milk Production/cow/day (litres) [ ]
   c) Peak production of highest producing cow on the farm (litres) [ ]
   d) Milk production /cow/lactation (No of months cow is in milk) in litres [ ]

14. Calving interval (No. of days taken to produce another calf) ------------------

15. a) Quantity of milk sold per day in litres [ ]
   b) Quantity of milk for home consumption/day in litres [ ]

Milk marketing, transport, dairy farm labor

16. Who is the main buyer of your milk?
   1= None (Home consumption) [ ] 2= Individual Households [ ]
   3= Trader [ ] 4= Cooperative [ ] 5= Hotels [ ] 6= schools/hospitals [ ]
   6= Processor/milk bar

17. a) Average buying price per litre (KES)-------------------------------
   b) If cooperative is main buyer, state why you prefer marketing through cooperative----------------------

   c) If other buyer, state main reason why you don’t sell your milk to cooperative?------------------------

18. What form of transport do you use to get milk to the buyer or nearest market? 1= Walking [ ]
   2= Bicycle [ ] 3= Motor bike [ ] 4= Own vehicle [ ] 5= public vehicle [ ] other, specify----

19. a) Distance from settlement to market (km)-------------------------------
   b) Distance from settlement to nearest all weather road (km)-----------------------

20. No. of years in dairy farming ----------- (years)

21. Type of housing for dairy cow
   1= None [ ] 2= grass roof [ ] 3= iron roof [ ] 4 other, specify--------

22. a) Main enterprise on the farm 1= cash crop farming [ ], state the main one----
   2= food crop [ ] state main one-- 3= poultry [ ] 4= dairy[ ] 5= other, specify

   b) If yes, type of records kept on the farm
   1= Milk production [ ] 2= Milk sales [ ]
   3= inputs [ ] 4= Expenditure [ ] 5= other, specify -----
   6= Diseases [ ] 7=A.I service [ ] 8= other, specify-------

23. a) Does the farm keep dairy records? 1=Yes [ ] 2= No [ ]
   b) If yes, type of records kept on the farm
   1= Milk production [ ] 2= Milk sales [ ] 3= inputs [ ]
   4= Expenditure [ ] 5= other, specify ----
   6= Diseases [ ] 7=A.I service [ ] 8= other, specify-------

24. Source of labour for dairy cows
   1= family member [ ] (specify whether owner, spouse, children or relative) 2= hired labour [ ]
   a) If hired labour, how much do you pay per month KES-------------------
   b) Who is responsible for feeding and milking of dairy cows?
   1= family member [ ] ( specify whether owner, spouse, children or relative)
   2= hired labour [ ]

25. State main dairy equipment owned by household
   1= Feed chaff cutter or pulverizer [ ] 2= hand milking machine [ ]
   3= sprayer for tick control [ ] 4= Tractor [ ] 5 None [ ]

SECTION 3: ACCESS TO DAIRY INPUTS: BREEDS, FEEDS, A.I., DRUGS, WATER

26. a) Type of breed (species) kept------ 1=Friesian[ ] 2= Aryshire [ ]
   3= Jersey [ ] 4= crosses [ ]
   b) Where did you source the breed? 1= A.I upgrading of local cow [ ]
   2= Purchase from breeding farm[ ] 3= neighbor [ ] 4= Donation by NGO [ ]
   5 = other, please specify
   c) Distance in km from home to source of purchased breed-------------------
   d) Price of dairy cow purchased (KES)-------------------------------
   e) What is the main challenge experienced when you want to access an improved dairy breed?
   1= Breeding farm not available in the district [ ] 2= High cost of breed
   3= lack of management skills [ ] 4= Don’t know where to get an improved breed[ ]
   5= other, specify
   f) What price are you willing to pay for a high yielding dairy cow? (KES)-------------------------------

27. Main type of fodder fed to cows 1= Napier grass [ ] 2= fresh natural grass [ ]
   3= Improved grasses [ ] 4= crop residues eg maize stovers [ ] 5= Hay [ ]
   6= silage [ ]
28. a) Where do you get fodder for your dairy cows?
   1= Own farm [ ]  2= Cut and carry [ ]  3= roadside grass [ ]
   4= Purchase from outside [ ]  5= rented land [ ]  6= other, please specify-----------------------
   c) If purchased from outside, state
   i: quantity purchased per day or month-------------------------
   ii: What is the cost of purchased feeds in KES?------------------------

29. Availability of feeds (roughages) increases the volume of milk produced on my farm
   1= Yes [ ]  2= No [ ]

30. a) Do you feed purchased concentrate (dairy meal) on milking cows?
   1= Yes [ ]  2= No [ ]

   If yes,
   b) Quantity of concentrate fed/cow/day (kg)-------------------------
   c) Price of concentrate per kg or bag (KES)------------------------
   d) Source of concentrate---------------------------1= agrovet [ ]  2= cooperative [ ]  3= other, specify-----
   e) If No, State the reason
      1= Expensive [ ]  2= not available [ ]  3= no increase in milk production [ ]  4= distance----(km) 5= other (please specify)-----

31. What protein feed do you give milking cows if no concentrate is fed?----------------------
   1= None [ ]  2= sweet potato vines [ ]  3= Lucerne [ ]  4= desmodium [ ] 5= other, specify-----

32. Use of concentrate increases the volume of milk produced on my farm
   1= Yes [ ]  2= No [ ]

33. Do you use A.I for serving your cows?
   1= Yes [ ]  2= No [ ]

35. a) If yes, state:
   1= Private A.I Technician [ ]  2= GOK veterinary officer [ ]
   3= Agrovet dealer [ ]  4= Other, specify------------------------
   b) Cost of A.I service (KES)--------------------------
   c) Distance from home to A.I provider in km---------------------

36. Use of A.I increases the volume of milk produced on my farm
   1= Yes [ ]  2= No [ ]  3= neutral [ ]  4= agree [ ]  5= strongly agree

37. If No, a) State the reason
   1= Expensive [ ]  2= not available [ ]  3= repeated service [ ]  4= distance----(km) 5= other (please specify)-----
   b) On average how much do you pay for bull service-------------------
   c) Distance to bull service----------------------------------

38. Diseases/animal health problems commonly occurring on the farm in the last three months
   1= None [ ]  2= Ticks and tick borne disease [ ]  3= pneumonia [ ]
   4= worm control [ ]  5= Tryps [ ]  6= reproduction disorders [ ]  7= other, specify

39. Source of water for dairy cows
   1= tap water [ ]  2= borehole [ ]  3= well [ ]  4= streams/river [ ]  5= other, specify

40. a) Do you often have problems with quality of inputs?
   1. Yes [ ]  2= No [ ]

   b) If yes, on which type of inputs
      1= Feeds [ ]  2= drugs [ ]  3= small equipment [ ]  4= A.I service [ ]  5= breed of cow [ ]  6= Other, specify

   c) Identify which specific inputs have frequent quality problems
i) Feeds: 1= dairy meal [ ] 2= brans/germs [ ] 3= forages eg Napier [ ] 4= other, specify

ii) Drugs: 1= acaricides [ ] 2= dewormers [ ] 3= trypanocides [ ] 4= vaccines [ ] 5= other, specify

iii) A.I: 1= Cow needs repeated service [ ] 2= Cow does not get pregnant [ ] 3= Poor quality calf [ ] 4= inexperienced A.I technician [ ]

iv) Breed: 1= low milk production [ ] 2= Cow has frequent diseases / needs treatment [ ] 3= Does not easily come on heat [ ] 4= reproductive disorders 5= cow has bad temper [ ]

SECTION 4: ACCESS TO SERVICE PROVISION: EXTENSION AND RESEARCH

Extension services

41. Do you seek extension advice for your dairy enterprise?
   1=Yes [ ] 2= No [ ]
   a) If yes, state the main source------------------------
      1= Agrovet dealer [ ] 2= GoK staff [ ] 3= neighbor [ ] 4= Farmer group [ ] 5= other (please specify)-----
   b) Distance in km from home to extension provider-------------------------------
   c) Were you involved in any dairy extension programme activity or seek extension advice during the previous year 2011-2012?
      1= Yes [ ] 2= No [ ]
   d) If No, State the reason
      1= Expensive [ ] 2= not available [ ] 3= not reliable [ ] 4=distance--- (km) 5= other (please

42. What kind of dairy farming advice do you often look for?
   1= Feeding [ ] 2= disease central [ ] 3= A.I service [ ] 4= source of dairy breed [ ]
   5= marketing [ ] 6= heat detection / reproductive disorders [ ] 7= other, specify----

43. a) Have you received any training/information (formal or informal) on dairy farming?
   1= Yes [ ] 2= No [ ]
   d) If yes, state the main source
   1= Formal training [ ] 2= farmer group [ ] 3= Neighour [ ] 4= Cooperative [ ] 5= NGO [ ] 6= exchange visit [ ] 7= other, specify--

Access to research technologies and information

44. Advice from extension service increases the volume of milk produced on my farm
   1. [ ] 2. [ ] 3. [ ] 4. [ ] 5. [ ]

45. Do you use at least one technology from research stations for your dairy enterprise?
   1=Yes [ ] 2= No [ ]
   a) If yes, state the source-----------------------------
      1=GoK ATC [ ] 2= KARI [ ] 3= NGOs [ ] 4= other (please specify)------
   b) Distance in km from home to research technology/information provider-------------------------------
   c) If No, State the reason
      1= Expensive [ ] 2= not available [ ] 3= Not aware 4= Distance 5= other, please specify

46. What kind of dairy research technologies/information do you seek for?
   1= Fodder varieties [ ] 2= Protein feeds [ ] 3= feed analysis [ ] 4= breeds [ ]
   5= disease control [ ] 6= other, specify----------
Please place a tick (√) on the number that best describes your level of agreement with the following statements.
1= strongly disagree, 2= disagree 3= neutral, 4= agree, 5= strongly agree
47. Use of research technologies/information increases the volume of milk produced on my farm
1. [ ] 2. [ ] 3. [ ] 4. [ ] 5. [ ]

SECTION 5: ACCESS TO CREDIT & FINANCIAL SERVICES

48. a) What is the main source of financing for your dairy enterprise?
1= Own savings [ ] 2= Cooperative society loan [ ] 3= Bank loan [ ] 4= Micro finance [ ] 5= merry-go-round [ ] 6= other (please specify)------

   b) State the amount of financing invested in your dairy farm per month KES -----------------------

49. a) Did you obtain credit to use on your dairy farm during the last five years
1= Yes [ ] 2= No [ ]

   b) If No, state the reason
1= Not Accessible [ ] 2= High interest rates [ ] 3= tough conditions for borrowing [ ] 4= Fear land may be auctioned 5= Other, specify

c) Which section of the dairy farm would you like to improve if credit was available and accessible
1= buy another cow 2= improve on feeds 3= improve housing structure 4= invest in dairy equipment 5= other, specify

   Please place a tick (√) on the number that best describes your level of agreement with the following statement.
1= strongly disagree, 2= disagree 3= neutral, 4= agree, 5= strongly agree

50. Availability of finances/credit increases the volume of milk produced on my farm
1. [ ] 2. [ ] 3. [ ] 4. [ ] 5. [ ]

SECTION 6: ECONOMIC RETURNS, VALUE ADDED DISTRIBUTION, COST OF PRODUCTION

51 a) Who makes decision on use of incomes from milk sales
1= Head of Household [ ] 2= spouse [ ].

   b) How do you spend income from milk sales?
1= Buy food [ ] 2= pay school fees [ ] 3= Use on other household needs [ ] 4= invest back on dairy farm [ ] 5= other (please specify)------

52. Please indicate the main variable costs of dairy inputs/cow/month------------------

<table>
<thead>
<tr>
<th>Input</th>
<th>Cost (KES.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentrate/ kg</td>
<td></td>
</tr>
<tr>
<td>Feeds (fodder)</td>
<td></td>
</tr>
<tr>
<td>Disease control (drugs/ acaricides) per month</td>
<td></td>
</tr>
<tr>
<td>Hired Labour/ month</td>
<td></td>
</tr>
<tr>
<td>Other services, specify</td>
<td></td>
</tr>
</tbody>
</table>

53. Do high milk prices prevailing in Western Kenya influence your decision to keep dairy cows as a business?
1= Yes [ ] 2= No [ ]

   If no, state the reason-----------------------------

   Please place a tick (√) on the number that best describes your level of agreement with the following statements.
1= strongly disagree, 2= disagree 3= neutral, 4= agree, 5= strongly agree

53. Higher economic returns from milk sales increases the volume of milk produced on my farm
1. [ ] 2. [ ] 3. [ ] 4. [ ] 5. [ ]
SECTION 7: RELATIONS AND LINKAGES

54. Do you belong to a group or cooperative?
   1=Yes 2=No

55.a) Do you have linkages with traders, hotels, milk bar or consumer?
   1=Yes 2=No
   b) Type of relationship
      1= formal -- rules eg contract 2= informal (no rules)
   c) Generally speaking, would you say linkages with these buyers can be trusted?
      1=Yes 2=No

56. In your own assessment, what would attract strong linkages with buyers?
   1= cash payment 2= Payment after two weeks or monthly 3= Higher milk price
   4= provision of financial credit 5= provision of inputs 6) milk collection / transport

57. Do you have linkages with service providers? (Agrovets, extension services, research organizations, NGOs, financial credit institutions)
   a) 1= Yes 2= No
   b) If yes, Please tick which one
      1= Agro vet 2= extension 3= research organization 4= NGO
      5= financial/ credit institution 6= other (please specify)
   c) Generally speaking, would you say linkages with service providers can be trusted?
      1=Yes 2= No

58. In your own assessment, what would attract strong linkages with service providers?
   1= provision of financial credit 2= provision of inputs 3= provision of dairy farming advice
   4= other, specify

Please place a tick (√) on the number that best describes your level of agreement with the following statements.
   1= strongly disagree, 2= disagree 3= neutral, 4= agree, 5= strongly agree

59. Linkage with farmer group or cooperative increases the volume of milk produced on my farm
   1. 2. 3. 4. 5.

60. Linkage with trader, consumer, hotel increases the volume of milk produced on my farm
   1. 2. 3. 4. 5.

SECTION 8: SOCIO CULTURAL PERCEPTIONS

61. Rank the following enterprises on your farm in terms of socio cultural preferences

<table>
<thead>
<tr>
<th>Enterprise</th>
<th>Rank 1-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy</td>
<td></td>
</tr>
<tr>
<td>Zebu</td>
<td></td>
</tr>
<tr>
<td>Cash crops</td>
<td></td>
</tr>
<tr>
<td>Food crops</td>
<td></td>
</tr>
</tbody>
</table>

62. a) Between sugarcane and dairy which enterprise do you prefer?
   1  = sugarcane 2= dairy

b) Why do you prefer sugarcane as main enterprise? (state main reason)
c) If dairy is not main enterprise, state reason why you are not able to engage in dairy as a business
1= Dairy cows easily succumb to death [ ] 2= difficult to manage [ ] 3= too much work [ ]
4= witchcraft from neighbours [ ] 5= other, please specify

62. Please place a tick (✓) on the number that best describes your level of agreement with the following statement.
I= strongly disagree, 2= disagree 3=neutral, 4= agree, 5= strongly agree
Attitude of community towards keeping improved dairy breeds negatively affects the volume of milk produced in Western Kenya

1. [ ] 2. [ ] 3. [ ] 4. [ ] 5. [ ]

SECTION 9: POLICY AND INFRASTRUCTURE
63. Indicate which one of the following infrastructure has the largest positive influence on milk production on your farm
1= Good Road [ ] 2= Electricity [ ] 3= Water [ ] 4= Farm equipment [ ]
4= Availability of dairy Processing factory [ ] 5= Other, (please specify)

64. In which area of dairy production would you like to see favourable policies and regulations?
1= Access to inputs (breeds, feeds, A.I) [ ] 2= Access to service provision (extension, research) [ ]
3= Access to credit/financing [ ] 4= Access to linkages [ ] 5= Access to economic returns [ ]
6= other,(please specify)---

65. Please place a tick (✓) on the number that best describes your level of agreement with the following statements.
I= strongly disagree, 2= disagree 3=neutral, 4= agree, 5= strongly agree
Existence of favourable policy and regulations towards dairy increases the volume of milk produced on my farm

1. [ ] 2. [ ] 3. [ ] 4. [ ] 5. [ ]

SECTION 10: OTHER FACTORS INFLUENCING COMMERCIALIZATION / MILK PRODUCTION
66. Rank the following dairy production constraints/challenges in order of importance on scale of 1-7, where 1= most important 7= least important

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Rank 1-7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source of breeding stock</td>
<td></td>
</tr>
<tr>
<td>Inadequate feeds</td>
<td></td>
</tr>
<tr>
<td>Diseases</td>
<td></td>
</tr>
<tr>
<td>Unreliable A.I service</td>
<td></td>
</tr>
<tr>
<td>Inaccessible credit</td>
<td></td>
</tr>
<tr>
<td>Inadequate dairy management skills</td>
<td></td>
</tr>
<tr>
<td>High cost of inputs</td>
<td></td>
</tr>
</tbody>
</table>

Thank you for sparing your time to participate in this important exercise.

b) INTERVIEW GUIDES FOR LIVESTOCK PRODUCTION OFFICE ASSESSMENT OF SMALLHOLDER FARMS

SECTION 1: GENERAL INFORMATION ON MILK PRODUCTION
1. Human population in the district---------------------------------------------
2. Area sq km---------------------------------------------------------------
3. Rainfall /yr------------------------------------------
4. Grade cattle population in the district---------------------------------------
5. Milk Production trends (last 5 years)----------------------------------------
6. Av. Production/cow/day -----------------------------------------------------
7. Calving interval (average)----------------------------------------------------------------
8. Potential yield when optimized---------------------------------------------
9. Projected yield (District 5 year projection)-------------------------------
10. No of dairy farmers keeping grade cattle in the district------------------
11. No of active/organized dairy groups----------------------------------------

SECTION 2: DAIRY FARM CHARACTERISTICS & RESOURCE ENDOWMENT
1. Av. Land size per smallholder farmer-----------------------------------------
2. Av. Land size (Acres) allocated to fodder production per household----------
3. Common type of grazing system for dairy cows---------------------------------
4. Av herd size of grade cattle-------------------------------------------------
5. Milk production /cow/lactation (No of months cow is in milk) in litres--------
6. Av Calving interval (No. of days taken to produce another calf)---------------
7. Main milk markets for farmers in the district--------------------------------
8. Average buying price per litre (KES)----------------------------------------
9. No of milk cooperatives in the district---------------------------------------
10. Milk marketing through cooperatives----------------------------------------
11. Main reason why farmers don't sell milk to cooperative---------------------
12. Problems faced in marketing of milk?----------------------------------------
13. Status of mechanization of dairy farms eg use of pulverizers for chopping crop residues etc main dairy equipment owned by households----
14. Status of value addition-----------------------------------------------------

SECTION 3: ACCESS TO DAIRY INPUTS: BREEDS, FEEDS, A.I, DRUGS, WATER
1. List the different types of dairy breeds (species) kept and their numbers in the district

<table>
<thead>
<tr>
<th>Breed</th>
<th>Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friesian</td>
<td></td>
</tr>
<tr>
<td>Aryshire</td>
<td></td>
</tr>
<tr>
<td>Jersey</td>
<td></td>
</tr>
<tr>
<td>Crosses</td>
<td></td>
</tr>
</tbody>
</table>

2. Where do farmers Source breeding stock and what is the average price of a medium and high yielding breed?---
3. Constraints faced in accessing breeding stock-----------------------------------------------

**Feeds**
4. Main type of fodder fed to cows----------------------------------------------------------
5. Source of fodder for dairy cows?------------------------------------------------------------
6. Proportion of farmers with own fodder (do not purchase fodder at all)------------------------
7. Proportion of farmers who conserve feeds for use in dry season-----------------------------
8. Usage of crop residues eg stovers--------------------------------------------------------------
9. Proportion of farmers using purchased dairy meal on Milking cows?------------------------------
10. Source of dairy meal

11. If no dairy meal is used, state the reason

12. Alternative protein feeds given to milking cows if no dairy meal is fed

AI services

13. No of AI providers in the district—Public eg GOK, Private

14. Source of semen

15. Types of semen

16. Costs of different types of semen

17. Proportion of farmers using AI

18. Challenges faced by farmers in accessing AI

19. Proportion of farmers using bull service for grade cattle

Animal Diseases

20. Priority diseases/animal health problems commonly occurring on dairy farms

Quality of inputs

21. Type of dairy inputs commonly used by dairy farmers

22. Main input activities and costs

23. Which type of inputs have frequent quality problems
   1= Feeds [ ] 2= Drugs [ ] 3= Small equipment [ ] 4= AI service [ ]
   5= Breed of cow [ ] 6= Other, specify

24. Identify which specific inputs have frequent quality problems
   i) Feeds: 1= Dairy meal [ ] 2= Brans/germs [ ] 3= Forages eg Napier [ ]
       4= Other, specify
   ii) Drugs: 1= Acaricides [ ] 2= Dewormers [ ] 3= Trypanocides [ ]
       4= Vaccines [ ] 5= Other, specify
   iii) AI: 1= Cow needs repeated service [ ] 2= Cow does not get pregnant [ ]
       3= Poor quality calf [ ] 4= Inexperienced AI technician [ ]
   iv) Breed: 1= Low milk production [ ] 2= Cow has frequent diseases/needs treatment
       3= Does not easily come on heat [ ] 4= Reproductive disorders 5= Cow has bad temper [ ]

25. Main constraints in dairy input supply and possible solution

Production

26. Capacity of farmer groups—management
   Technology
   Financing

27. Estimated Costs of producing 1 kg of milk

28. Constraints in production

<table>
<thead>
<tr>
<th>Main constraints in production</th>
<th>possible solution</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Processing and value addition

29. Status of value addition by farmer groups in the district

Marketing
30. Major market players/actors in milk marketing

SECTION 4: SERVICE PROVISION

1. Public and private services supporting dairy input supply, production and marketing

<table>
<thead>
<tr>
<th>Institution</th>
<th>Role/Project</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

31. Reasons why has milk production/cow/day not improved very much despite many past projects to improve dairy in the area? On a scale of 1-100% rate the level of commercialization of dairy farms in the district.

32. What is the main reason for low commercialization of smallholder dairy farms?

33. Why are farmers not responding to high milk prices in the region to improve milk production?

Policy/ institutional framework

34. Which areas in dairy need policy support?

Social cultural

35. What hinders the community from engaging in dairy as a business?

- Rank the following dairy production constraints/challenges in order of importance on scale of 1-7, where 1 = most important 7 = least important

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Rank 1-7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source of breeding stock</td>
<td></td>
</tr>
<tr>
<td>Inadequate feeds</td>
<td></td>
</tr>
<tr>
<td>Diseases</td>
<td></td>
</tr>
<tr>
<td>Unreliable A.I service</td>
<td></td>
</tr>
<tr>
<td>Inaccessible credit</td>
<td></td>
</tr>
<tr>
<td>Inadequate dairy management skills</td>
<td></td>
</tr>
<tr>
<td>High cost of inputs</td>
<td></td>
</tr>
</tbody>
</table>

- Rank the following factors in order of importance in increasing milk production on your farm (1-7, where 1 = most important 7 = least important)

<table>
<thead>
<tr>
<th>Value chain factor</th>
<th>Rank 1-11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breeds</td>
<td></td>
</tr>
<tr>
<td>Feeds</td>
<td></td>
</tr>
<tr>
<td>A.I service</td>
<td></td>
</tr>
<tr>
<td>Advice from extension service</td>
<td></td>
</tr>
<tr>
<td>Use of research technologies/information</td>
<td></td>
</tr>
<tr>
<td>Access to credit services</td>
<td></td>
</tr>
<tr>
<td>Higher economic returns from milk</td>
<td></td>
</tr>
<tr>
<td>Linkages with farmer group or cooperative</td>
<td></td>
</tr>
<tr>
<td>Linkages with traders, hotels consumers</td>
<td></td>
</tr>
<tr>
<td>Favourable policies</td>
<td></td>
</tr>
<tr>
<td>Community attitude towards keeping grade cattle</td>
<td></td>
</tr>
</tbody>
</table>

e) TOPICS FOR FOCUS GROUP DISCUSSIONS
Dairy production on smallholder farms: Low milk production problem

1. Key issues: input supply, production, marketing, service provision—Institutional issues, socio cultural hindrances in keeping grade cattle
2. Identifying and ranking production constraints
3. Ranking factors influencing milk production
4. Suggestions on how to improve milk production and marketing

Appendix 3 Institutional assessment questionnaires

a) RESEARCH INSTITUTIONS——KARI

FEED RESOURCES: Types, Availability, Accessibility and Affordability

Preamble: Western Kenya is a milk deficit region yet the price of raw milk is the highest in the country. Majority of Smallholder farmers do not use and are not even aware of improved feed resources. How could your organization play a leading role in improving milk production in the region with verifiable impact i.e from current level of 6.5 litres/cow day to 12 litres/cow/day?

1. Name of respondent---------------------------Mobile------------------Organization-----------------------------------
2. Types of feed resources: Pastures, forages and legumes on trial on station----------------------------------------
3. Types of feed resources: Pastures, forages and legumes validated and released----------------------------------
4. Methods used in dissemination of the above feed technologies-------------------------------
   1= Work shop 2= field day 3= demo plots 4. on farm hands-on training 4= information brochures 5 other, specify
5. Nutritional value/Yield of roughages and legumes released---------------------

<table>
<thead>
<tr>
<th>Type of feed</th>
<th>DM</th>
<th>TDN</th>
<th>CP</th>
<th>Yield/acre/year (DM)</th>
<th>Year variety was released to farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. Availability, accessibility and affordability

<table>
<thead>
<tr>
<th>Type of feed</th>
<th>Acreage on station</th>
<th>Price/unit measure</th>
<th>No of demo, plots or bulking agents / commercial farmers outside station</th>
<th>Quantity produced by bulking agent /year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. If there are no established commercial plots on station for any of the feeds, state the reasons--------------------------If there are no outside bulking sites or business agents/ commercial farmers for any of the feeds, state the reasons-----------------Other feed technologies: Ration formulations, home made TMRs, crop
residue technologies, low cost feed technologies, feed conservation technologies, mechanization
technologies etc developed and/or released

<table>
<thead>
<tr>
<th>Name of feed technology</th>
<th>Main ingredients</th>
<th>Objective/ Advantages</th>
<th>Status</th>
<th>Other remarks on type of feed technology eg milk production potential</th>
</tr>
</thead>
</table>

8. If there are no established commercial plots on station for any of the above feed technologies, state the reasons. If there are no outside bulking sites or business agents/commercial farmers for any of the feed technologies, state the reasons.

Adoption of research technologies

9. Other dairy production technologies available: feed analysis, breeding of heifers, value addition, mechanization etc.

10. State which technologies a large proportion of farmers have adopted and reasons.

SWOT of institution in feed production, dissemination and training. Internal Strengths and Weaknesses, External Opportunities and Threats

12. Suggest ways on how the institution could strengthen its role in improving milk production and commercial orientation on small holder dairy farms?

b) A.I PROVIDERS

Questionnaire

1. Name of A.I provider ----------- Mobile no. ------------------- District -----------

   Town ---------------------

   A) Year registered --------------

   Highest level of education of owner 1 = none 2 = primary 3 = secondary 4 = college

   5 = university

   b) Training received in A.I

      1 = certificate course [ ] 2. Diploma course 3 = Informal hands on training 4. Other specify

      -------

      1. No of years operating A.I -------

      2. How many A.I providers are in the district? ---------------------

Types of services/ clients/quantity/price/Quality
3. What influences you choice for type of semen stocked?
1= Price [ ] 2= availability [ ] 3= Quality of semen [ ] 4= Other, specify

4. Distance travelled to semen distributor

6a) On average how many dairy farmers do you serve per week [ ]
Average distance covered by AI provider

b) No. of dairy farmers in the area

7. Cost of A.I service to dairy farmer per cow

<table>
<thead>
<tr>
<th>Type of semen</th>
<th>Supplier</th>
<th>Purchase price by AI provider per unit</th>
<th>Cost of AI to farmer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. Do you always have catalogue (history & performance) of bull used in A.I

9. Do farmers always ask for catalogue of bull?

10. What influences farmers choice for type of semen used
1= Price [ ] 2= availability [ ] 3= Quality of semen [ ] 4= Other, specify

11. What is the most common complaint received from farmers?
1= Cow needs repeated service 2= cow does not get pregnant 3= poor quality calf 4= bull calf 5 other, specify

12. Why do we have frequent problems of repeats
Why do we have high proportion of bull calves born in the area following AI service?

13. Distance in km to reach furthest farmer

13. What measures or models could you suggest to improve AI services for easy reach of farmers in the district?

15. What are the main constraints you face as Al Providers? (list and rank)

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Rank 1-5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1= most important</td>
</tr>
<tr>
<td></td>
<td>5= least important</td>
</tr>
</tbody>
</table>

b) In your own assessment what intervention should be put in place to address the major constraint mentioned in above?

c) CAPACITY AND CAPABILITY OF DAIRY COOPERATIVES AS BUSINESS ENTITIES

SURVEY OF MILK DAIRY COOPERATIVES IN WESTERN KENYA
Objective: To assess to what extent cooperatives in the region have adopted modern (vertical coordination) functions in view of changing market conditions

1. Name of cooperative
2. Name of respondent
   Mobile
   Position
   Date

A. Parameters related to management

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of full time salaried employees</td>
<td></td>
</tr>
<tr>
<td>Level of education of key officials: Chairman, secretary, treasurer</td>
<td></td>
</tr>
<tr>
<td>Proportion of women as officials</td>
<td></td>
</tr>
<tr>
<td>Av. age of officials</td>
<td></td>
</tr>
<tr>
<td>No. of years in office. Are elections held regularly?</td>
<td></td>
</tr>
<tr>
<td>History of election disputes or leadership wrangles</td>
<td></td>
</tr>
<tr>
<td>History of political or external interference</td>
<td></td>
</tr>
<tr>
<td>Whether officials have had training in financial and agribusiness skills</td>
<td></td>
</tr>
<tr>
<td>Does cooperative owe members payment of milk delivered in the past?</td>
<td></td>
</tr>
<tr>
<td>History of default in payment to farmers</td>
<td></td>
</tr>
<tr>
<td>Is cooperative indebted to major creditors eg banks?</td>
<td></td>
</tr>
<tr>
<td>Post harvest loses / day in litres</td>
<td></td>
</tr>
<tr>
<td>Quantity of milk not sold per day</td>
<td></td>
</tr>
<tr>
<td>Availability of Strategic Plan</td>
<td></td>
</tr>
</tbody>
</table>

B. Traditional role of dairy cooperatives—horizontal (milk collection, bulking & buying centre)

<table>
<thead>
<tr>
<th>Function/ service</th>
<th>1 = Present</th>
<th>2 = Absent</th>
<th>Other remarks / observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk collection centres with quality checks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Availability of own transport system- milk van/ truck</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hired transport (outsourcing) for milk collection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulking and chilling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collective Marketing of milk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Own building / premise</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk testing equipment- Lactometer, alcohol test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provision of AI services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provision of extension services eg vet services, information on breeding stock</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provision of financial credit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input supply: roughages, dairy meal, minerals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price negotiations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Information sharing platforms- Newsletter, field days etc</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Member commitment— (proportion of active members)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
C. Modern role of dairy cooperatives—Business entity

<table>
<thead>
<tr>
<th>Function/ service</th>
<th>1= Present</th>
<th>2= Absent</th>
<th>Other remarks/ observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistics: Availability of own transport for milk collection and marketing: van/ truck</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk trade accepted Quality tests - Alcohol, delvotest</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality assurance system for homogenous milk: critical control points from Farm to dairy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantity benchmark</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traceability system for milk delivered: Farm ID nos or route Nos</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value addition- diversified products</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product packaging and branding- Registered By KeBS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Availability of Processing milk Plant / facility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Information and knowledge exchange- market, price, quality, quantity ( Newsletter etc), reporting system</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICT facility: Computer, Internet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input supply dept (one stop shop) Dairy meal, roughages, Minerals: usage of uniform inputs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joint farm equipment for members hire eg pulverisers, etc</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financing: Credit from Banks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extension dept: A.I, disease control, capacity building</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share capitalization for members— members buy shares and receive dividends</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professional managers as directors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical managers— level of education: Cert /diploma/ degree / professional training in dairy and milk processing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Member heterogeneity i.e members outside cooperative with shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contract with buyers eg supermarket, companies, institutions ( vertical coordination): minimum contracted quantity delivered per month</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joint ventures— collaborative projects, mergers, strategic alliances</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Appendix 4 Map of study area
a) Map of Butula

**BUTULA SUB-COUNTY MAP**

- **BUMALA**
- **MARACHI WEST**
- **MARACHI CENTRAL**
- **MARACHI EAST**
- **CHENGO**

b) BUTERE SUB-COUNTY MAP
### Appendix 5 Selected SPSS outputs

#### Correlations

<table>
<thead>
<tr>
<th></th>
<th>Average milk production/cow/day in litres</th>
<th>feed_dummy</th>
<th>Dairymeal_dumm y</th>
<th>RESDUMMY</th>
<th>Creditdummy</th>
<th>ADummy</th>
<th>Groupdummy</th>
<th>POLICYDummy</th>
<th>RETURNSDummy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Correlation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.000</td>
<td>.599</td>
<td>.566</td>
<td>.338</td>
<td>.519</td>
<td>.334</td>
<td>.527</td>
<td>.449</td>
<td>-.149</td>
</tr>
</tbody>
</table>

#### Model Summary

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Model Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.915*</td>
<td>.840</td>
<td>.835</td>
<td>2384.566</td>
<td>8</td>
<td>355.696</td>
<td>65.083</td>
<td>.000</td>
</tr>
</tbody>
</table>

#### ANOVA

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Regression</td>
<td>8</td>
<td>355.696</td>
<td>65.083</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>292</td>
<td>5.465</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>290</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Unstandardized Coefficients/Standardized Coef

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coef</th>
<th>Sig.</th>
<th>Predicted milk volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Constant)</td>
<td>1.705</td>
<td>.657</td>
<td>3.959</td>
</tr>
<tr>
<td></td>
<td>feed_dummy</td>
<td>1.903</td>
<td>.341</td>
<td>1.045</td>
</tr>
<tr>
<td></td>
<td>Dairymeal_dumm y</td>
<td>1.643</td>
<td>.422</td>
<td>1.010</td>
</tr>
<tr>
<td></td>
<td>ADummy</td>
<td>1.303</td>
<td>.286</td>
<td>1.067</td>
</tr>
<tr>
<td></td>
<td>Creditdummy</td>
<td>1.416</td>
<td>.353</td>
<td>1.012</td>
</tr>
<tr>
<td></td>
<td>POLICYDummy</td>
<td>.981</td>
<td>.339</td>
<td>.850</td>
</tr>
<tr>
<td></td>
<td>RESDUMMY</td>
<td>1.472</td>
<td>.289</td>
<td>.897</td>
</tr>
<tr>
<td></td>
<td>RETURNSDummy</td>
<td>-.160</td>
<td>.294</td>
<td>-.806</td>
</tr>
<tr>
<td></td>
<td>Groupdummy</td>
<td>1.282</td>
<td>.454</td>
<td>.814</td>
</tr>
</tbody>
</table>
Appendix 6: Publications emanating from study


