Descriptive analysis of the Dairy – Crop mixed farming system in Wundanyi Division of Taita District, Kenya

A thesis submitted to the University of Nairobi in partial fulfilment of the requirements for the award of a Masters of Science Degree in Livestock Production Systems

Dr Patrick Mwambi Mwanyumba, B.V.M. (University of Nairobi)

Department of Animal Production, Faculty of Veterinary Medicine

April 2010

Declaration

"I declare that this thesis is a record of my own work and has not been presented for an award in any other academic institution":

-- Date: 9-4-2010

Dr Patrick Mwambi Mwanyumba

"This thesis has been submitted with our approval as University Supervisors":

-- Date: 9/4/2010

Prof. M. S. Badamana

-- Date: 9/4/2010

Dr R. G. Wahome

Dedication

To my late Father, Mzee Alfred Mwanyumba

and his life partner,

my Dear Mother, Anastansia Kitawa.

This one is for you.

Acknowledgements

I thank our Lord Almighty God for his bounties, grace and sustenance in my life.

I am grateful to my supervisors for their support and guidance – Professor M. S. Badamana for his quiet and kind words of wisdom and encouragement and Dr R. G. Wahome who has been my mentor from the beginning.

My wife, Phoebe, and our children, Fred, Herbert, Cathy and Martin, have been a source of great strength even as they went through their own academic struggles. I love them and I thank them.

Without Professor Agnes Mwang'ombe of the University of Nairobi and the Irish Aid Project of the University of Cork, I would not have gone in this direction, let alone managed to pay for such a long study. I thank them from the bottom of my heart.

Many thanks go to our course lecturers, my classmates and other college friends for the education and the atmosphere.

Lastly, I thank my project farmers, field research assistants and all those who assisted me in the project. Without their cooperation, I should have gotten stuck along the way.

Table of Contents **Page**

List of tables

List of figures

List of appendices

List of abbreviations

A.I. -------------	Artificial Insemination
ANOVA -------	Analysis of variance
ASAL-----------	Arid and Semi-Arid Lands
CDA ------------	Coast Development Authority
G.D.P------------	Gross Domestic Product
HH --------------	Household
HPI -------------	Heifer Project International
ILRI ------------	International Livestock Research Institute
KFSSG---------	Kenya Food Security Steering Group
KSh--------------	Kenya Shillings
NEPAD --------	New Partnership for Africa's Development
NESC-----------	The National Economic and Social Council of Kenya
PC --------------	Principal Component
PCA ------------	Principal Component Analysis
PRA ------------	Participatory Rural Appraisal
PRSP------------	Poverty Reduction Strategy Paper
SAPs------------	Structural Adjustment Programs
SD --------------	Standard Deviation
SPSS -----------	Statistical Package for Social Sciences
SSA ------------	Sub-Saharan Africa
TLU ------------	Tropical Livestock Units

Abstract

This study was carried out to analyse the mixed crop-dairy farming system in the highlands of Wundanyi Division, Taita District, Kenya. The aims of the study were to identify the farmers' objectives; to determine resource availability and allocation; to identify the constraints, coping strategies and opportunities; and to get the trends of the farming system activities, performance and interactions. The study was undertaken over an eleven months period to capture the activities and trends in the two rainy seasons in the area. The initial data was collected using participatory rural appraisal (PRA) and a structured questionnaire survey in nine villages. This was followed by a dynamic study involving a sample of thirty farms where data was collected twice per month using direct measurements and observations. The results pointed at a subsistence livelihood with a low level of technology adoption and general farm management such as fodder and breeding management. Farms are small with a mean of 2.3 acres and the farm area devoted to food crops was 52.7% and that to forage crops 24.1%, but the majority of farmers (69.9%) produce their own fodder. Animal health technicians, extension officers and inseminators are few and far from reach and this is a real constraint to technology extension and implementation. The dairy cow is the most important livestock and cattle formed the bulk of the Total Livestock Units with 89.1%. Mean milk production per day was 7 litres and the price was KSh 20 (US$ 0.25) per litre. High cost of cattle artificial insemination (A.I.) services was ranked the most important problem in livestock production followed by low production, pests and diseases, low milk prices, inadequate fodder in the dry season and lack of milk cooling facilities. There is room for improvement in optimization of resources and productivity and the strategy should be to move beyond coping strategies towards exploitation of the identified opportunities namely training, credit, increased fodder production and preservation, improved breeding and value addition of milk, among others.

Chapter 1 General introduction, justification and objectives

It is recognized that there is a general lack of quantitative information on the livestock sector globally and that there is a need for this information on livestock production systems. Information on the importance and structure of the livestock production systems of the world and resulting trends would be of great help in analyzing issues and identifying priorities in the livestock sector (Fujita, 1995). The general lack of knowledge concerning what goes on in complex small holder mixed systems is, in some respects, hard to comprehend (Thornton and Herrero, 2001). The analysis of farming systems is very important to the subject of development; the farm is a major decision point in agricultural development; it is both an ecosystem and an independent unit of economic activity (Ruthenberg, 1980).

In Kenya, there was no systematic characterization of the smallholder agricultural sector and its dairy subsector between the 1977 farming systems descriptions of Jaetzold and Schmidt and the 1990s (Staal et al., 1997). Since then, such studies have mostly been done in the Central Highlands, the Rift Valley, Western Kenya and the Lower Coast regions (Murithi, 1990; Echessah, 1994; Mose, 1995; Staal et al., 1997; Kilungo, 1999; Waithaka et al., 2002; Bebe, 2003; Mburu et al., 2007; Lanyasunya et al., 2006).

Pomareda (1994) recommends that ongoing diagnosis is the basic way to acquire knowledge regarding the evolution of production systems, the livestock sector, and in particular the different social groups engaged in production and that such diagnoses should not be limited to specific, isolated regions.

In Taita District, Wundanyi division has the highest rain-fed arable potential. This potential, particularly for dairy and horticulture, which was also recognized by Jaetzold and Schmidt (1983), has not been fully exploited. The estimated milk production in Taita Taveta District is 7,340, 000 lts/year from 25,000 dairy cattle, while the consumption and requirements are 2.5 million lts/yr and 23 million lts/yr respectively (District Livestock Production Office).

Wundanyi division can be the main source of milk in the District and also make a big contribution to the overall dairy production in Coast Province. However, the different sources of income to the smallholder mixed crop-dairy farmers have not been documented and quantified. The interaction and relationship between the different farming activities and how they separately and collectively contribute to household livelihoods is therefore not known and best intervention points for performance improvement cannot be determined.

Therefore, this study was designed with the broad objective of investigating the activities, performance and interactions of the dairy-crops farming system in the area and specifically to identify the farmer's farming objectives; to determine resource availability and allocation; to identify the constraints, coping strategies and opportunities; and to get a quantitative and qualitative measure and trends of the farming system activities, performance and interactions.

References

Bebe B. O., 2003. Herd dynamics of smallholder dairy in the Kenya Highlands. Phd Thesis, University of Wageningen.

District Livestock Production Office, Taita, 2008. Personal Communication with Mr Nyambu, January 2008.

Echessah P. N., 1994. An economic analysis of the constraints in the production and marketing of milk in Kilifi District of the Coast Province of Kenya. MSc Thesis, University of Nairobi.

Fujita T. In Sere C. and Steinfeld H., 1995. World Livestock Production Systems, Current Status, Issues and Trends. FAO Animal Production and Health Paper No. 127. pp 1.

Jaetzold R. and Schmidt H., 1983. Farm Management Handbook of Kenya, Vol. 11- Natural Conditions and Farm Management Information, Part C, East Kenya (Eastern and Coast Provinces), Ministry of Agriculture, Kenya.

Kilungo J. K., 1999. An economic analysis of smallholder dairy production in Kiambu District, Kenya. Phd Thesis, University of Nairobi.

Lanyasunya T. P., Rong W. H., Mukisira E. A. and Abdulrazak S. A., 2006. Performance of Dairy Cows in Different Livestock Production Systems on Smallholder Farms in Bahati Division, Nakuru District, Kenya. Pakistan Journal of Nutrition 5 (2): 130-134, 2006 ISSN 1680-5194.

Mburu L. M., Wakhungu J. W. and Kang'ethe W. G., 2007. Characterization of smallholder dairy production systems for livestock improvement in Kenya highlands. Livestock Research for Rural Development 19 (8) 2007.

Mose J. I., 1995. An economic analysis of dairy production systems in Nyamira District, Kenya. MSc Thesis, University of Nairobi.

Murithi F. M., 1990. Efficiency of resource use in smallholder milk production: the case of Meru Central dairy farmers, Kenya. MSc Thesis, University of Nairobi.

Pomareda C., 1994, Contributions of Research on Livestock Systems to a Livestock Development Policy. In Ruiz M. E. (Comp.), 1994. Animal Production Systems Research, Methodological and Analytical Guidelines, Inter-American Institute for Cooperation on Agriculture, Costa Rica. pp 284.

Ruthenberg H., 1980. Farming Systems in the Tropics. 3rd Ed. Clarendon Press, Oxford. pp 2.

Staal S J., Chege L., Kenyanjui M., Kimari A., Lukuyu B., Njubi D., Owango M., Tanner J., Thorpe W. and Wambugu M., 1997. Characterization of Dairy Systems Supplying the Nairobi Milk Market. A Pilot Survey in Kiambu District for the Identification of Target Groups of Producers. Kenya Agricultural Research Institute, Nairobi; International Livestock Research Institute, Nairobi; Livestock Production Department, P.O. Box 728 Kiambu.

Thornton P. K. and Herrero M., 2001. Integrated Crop-livestock Simulation Models for Scenario Analysis and Impact Assessment. Agricultural Systems 70 (2001) 581-602. pp 582.

Waithaka M. M., Nyangaga J. N., Staal S. J., Wokabi A. W., Njubi D., Muriuki K. G., Njoroge L. N. and Wanjohi P. N., 2002. Characterization of dairy systems in the western Kenya region, Report of Dairy and Crop Characterization Activities in Western Kenya. Smallholder Dairy Project, Ministry of Agriculture and Rural Development, Nairobi; Kenya Agricultural Research Institute, Nairobi; International Livestock Research Institute, Nairobi; Department for International Development-UK (DFID).

Chapter 2 Literature review

2.1 The livestock revolution and its implications for smallholder agriculture

A revolution is taking place in global agriculture due to the increasing population growth, urbanization and income growth, especially in developing countries, which are fuelling a massive global increase in demand for food of animal origin. The course of these events over the next 20 years has been described as the "Livestock Revolution". This revolution has profound implications for our health, livelihoods and environment and the stakes for the poor in developing countries are enormous (Delgado et al., 1999). This is because using agriculture as the basis for economic growth in the agriculture-based countries requires a productivity revolution in smallholder farming (The World Bank, 2008). In addition, agricultural expansion is an essential process of the development process, not only to feed the growing population, but also because most of the people in poor countries make their living from the land (Upton, 2000).

In Africa, although milk production has been increasing over the years, demand has also increased and the gap between these two is widening up. Due to population growth and increase in per capita consumption, demand for milk is expected to increase, even more, in the future years. Increasing milk production to satisfy demand is therefore a challenge to African dairy systems. Some countries have been able to make enormous increases in production over recent years, showing that there is a potential for the dairy industry (Ndambi et al., 2007).

Kenya has a well developed and functional dairy industry which continues to make an important contribution to the economic and social development. The industry contributes about 50 % of the value of all livestock production, which in turn represents 30 % of agricultural GDP, and meets nearly all the Country's requirements for dairy products. It provides income and employment for large numbers of rural people (Upton, 2000; Thorpe et al., 2000; Muriuki et al., 2001; Moll et al., 2007).

Dairy production is an important source of livelihoods for about 600,000 small-scale farmers in Kenya and dairy animals provide milk; manure; income from sales of calves, heifers and culls as well as insurance and status within the society (Karanja, 2003). Smallholder dairying therefore contributes directly (through milk consumption) and indirectly (through income generation) to both food security and to alleviating poverty of the majority of smallholders in many areas of Kenya, a contribution coming particularly from the crop-dairy cattle systems that dominate smallholder agriculture (Muriuki et al., 2001).

2.2 Importance of crop - livestock systems

Mixed crop–livestock systems provide over 50% of the world's meat and over 90% of its milk. They are the most common form of livestock operation in developing countries and account for 70% of the poor livestock keepers. This integration is going to increase over the next 30 years especially in Sub-Saharan Africa (Thornton and Herrero, 2001).

Integrated farming systems are common especially in rural areas where they combine animals with either annual or perennial crops. Dairy cattle are an important and expanding component of these systems. Milk serves as an immediate and reliable daily source of income to stabilize other farm operations. Thus, dairying in developing countries is considered to be an important instrument of socio-economic change and is identified with rural development (Devendra, 1999).

According to Devendra (1999) there are four broad economic roles of animals in integrated farming systems i.e. diversification of resources and reduction in socio-economic risks; promotion of linkages between system resource components (land, water and crops); generation of value added products (e.g. use of crop residues to produce meat, milk); and contribution to sustainable agriculture and environmental integrity.

Sansoucy (1994), Dalibard (1995) and International Livestock Research Institute (ILRI) (2006) list the multiple roles of livestock specifically as food and household nutrition; regular cash income, income diversification and employment; financing and insurance; draught power; manure for soil conditioning, cooking, feed for other animals and in some cases material for housing; weed control and conversion of marginal and waste products (crop residues, common property resources) into high value products; materials and fibres in form of hides, skins, wool and feathers; and socio-cultural roles.

For dairy production, integrating cattle into crop systems enables farmers to have more control over feed inputs and to complement feed resource use and nutrient cycling which increase overall farm efficiency and reduce vulnerability to market shifts (de Leeuw, 1999). In Kenya, dairy production is combined with maize, beans, vegetables and different cash crops and the system is supported by off-farm income and outside remittances from the extended family (Thorpe et al., 2000).

2.3 The need and potential of increasing livestock production in Kenya

In a survey done in Kiambu District, Karanja (2003) found that most households identified the availability of milk for home consumption, mainly for their children, and availability of manure as the main reasons for keeping dairy animals. Income from milk sales was also considered very critical especially due to the poor performance of other farm enterprises and most households were of the opinion that dairy has a comparative advantage in as far as it helps to ease their cash flow constraints.

Increased productivity in the dairy sector will enhance farm incomes, improve nutrition, reduce poverty and also supply dairy products to the growing urban populations. Despite several factors that negatively affect productivity and performance of the dairy sub-sector, the potential for increasing productivity in the country and especially the smallholder dairy remains great (Karanja, 2003). Apart from population increase, urbanization, increase in incomes and change in food preferences; the combination of low opportunity cost for labour in rural areas, scarcity of land and good markets leads to an intensive dairy production system with high levels of inputs and outputs (Moll et al., 2007).

Upton (2000) observed that options for increasing livestock productivity include shifts from grassland based to mixed and then to landless production systems accompanied by improvement in animal nutrition, disease control, management, marketing and breeding as well as availability of credit and other inputs. He recommended that to achieve this, adaptive research is required to identify smallholder objectives, constraints and appropriate options for improvement and this can best be done by a farming systems approach with greater farmer participation.

2.4 Constraints in small-holder dairy production systems

In Kenya, erratic payments, low prices and low sales especially of evening milk as a proportion of total production, unreliable market outlets and inadequate access to animal health and breeding services are some of the constraints that negatively affect productivity and performance of the dairy sub-sector (Karanja, 2003).

Other constraints are high farm input costs; unsupportive land tenure policies; inadequate farmer training and weak research-extension linkage; unavailability of quality feed; inadequate access to credit; withholding of donor aid; poor infrastructure and inappropriate legal and regulatory framework (Omiti and Muma, 2000). According to Devendra (2007), these constraints are reflected in other parts of the developing world and farming systems research is thus important to enable constraints analysis, to understand the complexities of farming systems and to improve productivity.

2.5 The need for farming systems research

It is recognized that there is a general lack of quantitative information on the livestock sector and that there is need for information on the importance and structure of livestock production systems of the world (Fujita, 1995). These would be of great help in analyzing trends and identifying priorities in the sector. The general lack of knowledge concerning what goes on in complex small holder mixed systems is, in some respects, hard to comprehend (Thornton and Herrero, 2001).

The analysis of farming systems is important to the subject of development and the farm is a major decision point in agricultural development being both an ecosystem and an independent unit of economic activity (Ruthenberg, 1980). The systems research approach is crucial as global livestock systems have a wide range of characteristics, physical, institutional and policy environments and therefore need different approaches, strategies, policies, programs and interventions (ILRI, 2006).

Dairying in integrated farming systems is a complex enterprise and potential improvements and increased productivity can only come from a better understanding of the nature and extent of the interactions with the other sub-sectors like crops and natural resources, economic benefits, as well as the impact on the livelihoods of small farmers and the environment (Devendra, 1999). These aspects provide major challenges to research for sustainable dairy development and integrated farming systems in the future.

2.6 Methods of farming systems research

Rey et al. (1993) presented a conceptual framework for the analysis of dairy systems using a production-to-consumption approach. The framework described methodologies for the characterization of dairy production and market linkages to consumption centers.

Ruiz (1994) and Thornton and Herrero (2001) discussed the concepts of characterization, descriptive/scenario analysis, modelling, systems validation, development of alternatives and impact assessment and concluded that these are important stages in a decision making process on whether to change or not to change technologies in farming systems.

Roeleveld (1996) described the methods for participatory collection and analysis of information as farm visits, mapping (e.g. wealth, resources), diagrams (e.g. flow charts, Venn, causal diagrams), calendars (e.g. activity, timelines, trends), preferences and proportions (e.g. wealth ranking, constraint ranking). The author also listed other livestock systems diagnostic methods as use of checklists, formal and informal surveys, herd visits and in-depth studies. On formal surveys and in-depth studies, he stated that monitoring of population dynamics and animal productivity (herd monitoring) is considered by many researchers to be an important diagnostic activity to quantify and verify informal survey findings.

Lelo et al. (1995) summarized the participatory rural appraisal (PRA) experience in Kenya since 1986 into a handbook for field practitioners. Morton et al. (2002) and Devendra (2007) further discussed major issues in participatory methodologies in livestock production research and the rationale and importance of the approaches. These authors described the purpose, methods and application of the steps in the PRA process and emphasized the participation of farmers, researchers, members of the community, extension agents and development agents.

León-Velarde et al. (2008) described the evolution of the farming systems research approach into an expanded development framework that takes into account the chain of activities from the farm level to the processing of products and access to markets. They listed the main methods and procedures utilized in the different phases of participatory agricultural system analysis research. These methods include analysis of secondary information data; static and dynamic surveys; rapid rural appraisal; principal components and cluster analysis; modeling; experiments and farm trials; observations in field days, workshops and extension manuals.

2.7 Some studies done in Kenya and Africa to understand the complexities of farming systems and to make recommendations to improve productivity

Murithi (1990), Echessah (1994), Mose (1995) and Kilungo (1999) did similar economic analyses of dairy production in various areas of Kenya namely Meru Central, Kilifi, Nyamira and Kiambu Districts respectively. They did descriptive and production function analyses focusing mainly on the efficiency of resource use especially feeds, concentrates, capital, hired and family labour and byproducts. They recommended that, in the short run, it is cheaper to raise the agricultural production in high and medium potential areas rather than in the arid and semi-arid lands (ASAL) and that due to land scarcity, the highest scope for increasing milk yield exists in the zero grazing system. This should be done by intensification and efficient use of resources accompanied by availability of credit; cattle genetic improvement; improvement of veterinary and extension services; and improvement of the marketing systems to link supply and demand.

Omiti (1995) did an economic analysis of crop – livestock integration in the Ethiopian Highlands. He collected data using direct measurements, structured questionnaires, field observations, secondary sources and group interviews. In analyzing his information, he also did descriptive analysis, principal component analysis and cluster analysis together with modeling. He described their crop and livestock production systems and captured the crop-livestock interactions, some of which were manure, food production, crop residues for animal feed, increased income, farm labour and animal traction.

Wella et al. (1996) did an informal livestock survey in Kwimba District, Northwestern Tanzania, with the purpose of understanding the livestock keeping, identifying constraints and opportunities and prioritizing research and development activities. They used participatory rural appraisal with various techniques such as group discussions, mapping, ranking, transect walks, kraal visits and individual discussions. They were able to understand the farming system and the livestock component; to identify constraints and research priorities; and to understand resource availability and use, the role of livestock and production levels among other issues.

Staal et al. (1997) did a characterization study in Kiambu, Kenya, focused on identifying constraints and opportunities within smallholder dairy systems, whose alleviation or exploitation respectively could be enabled by targeted research. They conducted a survey using a structured questionnaire and analyzed the data gathered to yield descriptive information on farm/household resources and characteristics, cropping and feeding practices, reliance of input and output markets, herd structures, animal disease control practices and prevalence and changes in farm practices. The data was then used in principal component and cluster analyses to identify homogenous groups of dairy producers representing specific recommendation domains.

Mubiru et al. (2002) categorized dairy production systems in Uganda on the criteria of milk production, total land and annual expenditure on artificial insemination and other veterinary services. These categories, together with their supporting conditions, can provide a valuable decision support tool for targeting research and development interventions. They recommended that such interventions should include those devised to address issues related with breeding, feeding and grazing, crop-livestock interactions, health management and product marketing strategies.

Waithaka et al. (2002) designed their study, "Characterization of dairy systems in the western Kenya region", to gather information on broad agricultural activities. They used PRAs and questionnaire surveys to capture information on household composition and labour availability; land size and allocation; farm activities (including crop husbandry) and facilities; livestock inventory; dairying history and production practices; dairy marketing; livestock management and health services; cooperative membership; and household income levels and sources. In analyzing their information, they did descriptive analysis, principal component analysis and cluster analysis. Their survey highlighted the growing importance of dairying in the region and the potential for improving animal productivity through more intensification and utilization of crop-livestock interactions.

Staal et al. (2003) did a longitudinal study in three Districts in Kenya to obtain data on the cost of milk production and determinants of milk prices. They concluded that smallholder dairy producers in Kenya are able to capture useful profits and are likely to continue to be competitive if given the necessary public policy support.

In their diagnostic study of the socio-economic status of smallholder livestock production in Zimbabwe, Chawatama et al. (2005) used a structured questionnaire survey and participatory rapid appraisal to identify the livestock production systems and constraints to livestock production. They gathered information on household characteristics; land use and tenure; and livestock production including drought mitigation strategies and constraints. They found that the main livestock species kept in the study areas were cattle, chicken and goats. The main motivational factors for livestock and crop production were subsistence, followed by income and livestock feed while the constraints included diseases, inadequate grazing, poor access to capital and markets, gender imbalances and shortage of draught power.

Lanyasunya et al. (2006) conducted a study in Nakuru, Kenya, to quantify performance of dairy cows on smallholder farms over three years. They considered mainly farm forages, milk yields and cow body weight gains. They concluded that lack of sufficient land is the most critical factor limiting fodder production and recommended capacity building of farmers on methods of efficient production, conservation and appropriate utilization of feeds.

Mburu et al. (2007), in their 'Characterization of Smallholder Dairy Production Systems for Livestock Improvement in Kenya highlands', studied three different agro-ecological zones and compared among them. Their aim was to characterize the smallholder dairy production based on the level of intensification, risk management strategies, level of access to output markets and input services and farm / household resources available. They identified four clusters, each of which had unique constraints and opportunities, which can help define research priorities based on opportunities and constraints. They recommended that appropriate interventions should consider variations in all factors of production and the relationships and patterns among the clusters.

Liyama et al. (2007) did a study on the mixed crop-livestock system in Kerio District, Kenya. They focused mainly on income and manure use to identify the dominant crop-livestock diversification patterns and to understand the divergent patterns of intensification and their relation to the economic needs of households. They identified five dominant diversification patterns which had different income levels and intensification of manure use.

Tittonell et al. (2009) and Zingore et al. (2009) did similar studies in Kenya and Zimbabwe respectively using simulation models to investigate smallholder crop-livestock interactions, resource use efficiencies, productivity and farm incomes. They concluded that it is important to consider farm resource endowments and the nature and degree of system component integration before making technical recommendations for improving efficiency of resource use and sustainable intensification of systems.

2.8 The need for further mixed crop-livestock systems research

Pomareda (1994) recommended that ongoing diagnosis is the basic way to acquire knowledge regarding the evolution of production systems, the livestock sector, and in particular the different social groups engaged in production and that such diagnoses should not be limited to specific, isolated regions.

ILRI (2006) also observed that it is easier to make broad generalizations and recommendations for the extreme ends of livestock systems i.e. marginal and highly intensive than for the middle ground of mixed crop-livestock systems and therefore advocated for more characterization and examination of the impacts of different strategies and interventions in a wide range of these systems and locations.

Most of the livestock production studies done in Kenya have concentrated on a few regions and they focus mainly on dairy production. Staal et al. (1997), Waithaka et al. (2002), Mburu et al. (2005), Liyama et al. (2007) and Tittonell et al. (2009) studied the crop-livestock farming system as a whole. Various methods have been used including questionnaire survey, descriptive analysis, principal component analysis, cluster analysis and modeling. Little emphasis has been put on farmer participation (PRA), analysis of farmers' objectives and dynamics of farm component interactions and this is a deficiency which should be addressed.

References

Chawatama S., Mutisi C. and Mupawaenda A. C., 2005. The socio-economic status of smallholder livestock production in Zimbabwe: a diagnostic study. Livestock Research for Rural Development 17 (12) 2005.

Dalibard C. 1995. Livestock's contribution to the protection of the environment. FAO Agriculture and Consumer Protection. FAO Corporate Document Repository.

de Leeuw P N., Omore A., Staal S. and Thorpe W., 1999. Dairy Production Systems in the Tropics. In Falvey L. and Chantalakhana C. (Editors), 1999. 'Smallholder Dairying in the Tropics', ILRI, Nairobi. pp 35.

Delgado C., Rosegrant M., Steinfeld H., Ehui S and Courbois C., 1999. Livestock to 2020: The next Food Revolution. Food, Agriculture and the Environment Discussion Paper 28. IFPRI/FAO/ILRI. pp 1.

Devendra C., 1999. Dairying in Integrated Farming Systems. In Falvey L. and Chantalakhana C. (Editors), 1999. 'Smallholder Dairying in the Tropics', ILRI, Nairobi. pp 279, 285.

Devendra C., 2007. Constraint analysis to improve integrated dairy production systems in developing countries: The importance of participatory rural appraisal. Tropical Animal health and Production (2007) 39: 549–556. pp 549.

Echessah P. N., 1994. An economic analysis of the constraints in the production and marketing of milk in Kilifi District of the Coast Province of Kenya. MSc Thesis, University of Nairobi.

Fujita T. In Sere C. and Steinfeld H., 1995. World Livestock Production Systems, Current Status, Issues and Trends. FAO Animal Production and Health Paper No. 127. pp 1.

International Livestock Research Institute (ILRI), 2006. Lessons from a changing world: Implications for livestock research and development. In Birthal P. S., Taneja V. K. and Thorpe W. (Editors), 2006. Smallholder Livestock production in India: Opportunities and Challenges. Proceedings (14) of an ICAR-ILRI international workshop. pp 100, 104, 105.

Karanja A. M., 2003. The Dairy Industry in Kenya: The Post Liberalization Agenda. Working Paper No.1, 2003. Tegemeo Agricultural Monitoring and Policy Analysis (TAMPA II) Project, United States Agency for International Development (USAID) , Nairobi. Paper presented at a dairy industry stakeholders workshop held in Nairobi, Kenya (27th August 2002). pp 1.

Kilungo J. K., 1999. An economic analysis of smallholder dairy production in Kiambu District, Kenya. Phd Thesis, University of Nairobi.

Lanyasunya T. P., Rong W. H., Mukisira E. A. and Abdulrazak S. A., 2006. Performance of Dairy Cows in Different Livestock Production Systems on Smallholder Farms in Bahati Division, Nakuru District, Kenya. Pakistan Journal of Nutrition 5 (2): 130-134, 2006 ISSN 1680-5194.

Lelo F., Ayieko J., Makenzi P., Muhia N., Njeremani D., Muiruri H., Omollo J. and Ochola W., 1995. PRA Field Handbook for Participatory Rural Appraisal Practitioners. The PRA Program, Egerton University, Njoro, Kenya.

León-Velarde C., Quiroz R. A., Valdivia R. E., Reinoso J. and Holle M., 2008. Evolving from farming systems research into a more holistic rural development approach: Experiences in the Andean region. Working paper no. 2008-1, International Potato Center, Lima, Peru. pp 10.

Liyama M., Maitima J. and Kariuki P., 2007. Crop-livestock diversification patterns in relation to income and manure use: A case study from a Rift Valley Community, Kenya. African Journal of Agricultural Research Vol. 2(3), pp. 058-066, March 2007.

Mburu L. M., Wakhungu J. W. and Kang'ethe W, G., 2007. Characterization of smallholder dairy production systems for livestock improvement in Kenya highlands. Livestock Research for Rural Development 19 (8) 2007.

Moll H. A. J., Staal S. J. and Ibrahim M. N. M., 2007. Smallholder dairy production and markets: A comparison of production systems in Zambia, Kenya and Sri Lanka. Agricultural Systems 94 (2007) 593–603. pp 599, 600.

Morton J., Adolph B., Ashley S. and Romney D., 2002. Conceptual, methodological and institutional issues in participatory livestock production research. Livestock Research for Rural Development 14 (4) 2002.

Mose J. I., 1995. An economic analysis of dairy production systems in Nyamira District, Kenya. MSc Thesis, University of Nairobi.

Mubiru S. L., Tenywa J. S., Halberg N., Romney D., Nanyeenya W., Baltenweck I. and Staal S.,2002. Categorisation of dairy production systems: A strategy for targeting meaningful development of the systems in Uganda.

Murithi F. M., 1990. Efficiency of resource use in smallholder milk production: the case of Meru Central dairy farmers, Kenya. MSc Thesis, University of Nairobi.

Muriuki H. G., Mwangi D. M. and Thorpe W., 2001. How Smallholder Dairy Systems in Kenya Contribute to Food Security and Poverty Alleviation: results of recent collaborative studies. Paper presented at the 28th Tanzania Society of Animal Production Conference. Morogoro 7th- 9th August 2001. pp 1, 3.

Ndambi O. A., Hemme T. and Latacz-Lohmann U., 2007. Dairying in Africa - Status and recent developments. Livestock Research for Rural Development 19 (8) 2007. pp 9.

Omiti J., 1995. Economic analysis of crop-livestock integrating: the case of the Ethiopian Highlands. PhD thesis, University of New England.

Omiti J. and Muma M., 2000. Policy and Institutional Strategies to Commercialize the Dairy Sector in Kenya. Occasional Paper No. 006/2000. Institute of Policy Analysis and Research, Nairobi. pp 7, 11.

Pomareda C., 1994. Contributions of Research on Livestock Systems to a Livestock Development Policy. In Ruiz M. E. (Comp.), 1994. Animal Production Systems

Research, Methodological and Analytical Guidelines, Inter-American Institute for Cooperation on Agriculture, Costa Rica. pp 284.

Rey B., Thorpe W., Smith J., Shapiro B., Osuji P., Mullins G. and Agyemang K., 1993. Improvement of dairy production to satisfy the growing consumer demand in sub-Saharan Africa – A conceptual framework for research. International Livestock Centre for Africa, Addis Ababa, Ethiopia. pp 9-12.

Roeleveld A. C. W., 1996. Issues in livestock systems diagnosis. In Roeleveld A. C. W. and van den Broek A. (Editors), 1996. Focusing livestock systems research. Royal Tropical Institute, Amsterdam, The Netherlands. pp 137.

Ruiz M. E., 1994. Standardization of the General Methodology for Designing Improved Systems. In Ruiz M. E. (Comp.), 1994. Animal Production Systems Research, Methodological and Analytical Guidelines. Inter-American Institute for Cooperation on Agriculture, Costa Rica. pp 7-18.

Ruthenberg H., 1980: Farming Systems in the Tropics. 3rd Ed. Clarendon Press, Oxford. pp 2.

Sansoucy R., 1994. Livestock, a driving force for food security and sustainable development. FAO Agriculture and Consumer Protection. FAO Corporate Document Repository.

Staal S. J., Chege L., Kenyanjui M., Kimari A., Lukuyu B., Njubi D., Owango M., Tanner J., Thorpe W. and Wambugu M., 1997. Characterization of Dairy Systems Supplying the Nairobi Milk Market. A Pilot Survey in Kiambu District for the Identification of Target Groups of Producers. Kenya Agricultural Research Institute, Nairobi; International Livestock Research Institute, Nairobi; Livestock Production Department, P.O. Box 728 Kiambu.

Staal S. J., Waithaka M., Njoroge L., Mwangi D. M., Njubi D. and Wokabi A., 2003. Costs of milk production in Kenya: Estimates from Kiambu, Nakuru and Nyandarua districts. SDP

Research and Development Report No. 1. Smallholder Dairy Project, MoLFD, KARI, ILRI, DFID. pp 25.

The World Bank, 2008. World Development Report 2008; Agriculture for Development, An Overview. pp 1.

Thornton P. K. and Herrero M., 2001. Integrated Crop-livestock Simulation Models for Scenario Analysis and Impact Assessment. Agricultural Systems 70 (2001) 581-602. pp 582, 583, 587-596.

Thorpe W., Muriuki H. G., Omore A., Owango M. O. and Staal S., 2000. Dairy Development in Kenya: the past, the present and the future. Annual Symposium of the Animal Production Society of Kenya, March 22nd – 23rd 2000, KARI Headquarters, Nairobi. pp 1, 4.

Tittonell P., van Wijk M. T., Herrero M., Rufino M.C., de Ridder N. and Giller K.E., 2009. Beyond resource constraints – Exploring the biophysical feasibility of options for the intensification of smallholder crop-livestock systems in Vihiga district, Kenya. Agricultural Systems 101 (2009) 1–19. pp 18.

Upton M., 2000. The 'Livestock Revolution' – Implications for Smallholder Agriculture: A Case Study of Milk and Poultry Production in Kenya. Livestock Policy Discussion Paper No. 1. FAO. pp 4, 6, 13, 21.

Waithaka M. M., Nyangaga J. N., Staal S. J., Wokabi A. W., Njubi D., Muriuki K. G., Njoroge L. N. and Wanjohi P. N., 2002. Characterization of dairy systems in the western Kenya region, Report of Dairy and Crop Characterization Activities in Western Kenya. Smallholder Dairy Project, Nairobi, Kenya. Ministry of Agriculture and Rural Development, Kenya Agricultural Research Institute, International Livestock Research Institute, Department for International Development-UK (DFID)

Wella E. B., Roeleveld A. C. W., Ngendello A. M. and Bunyecha K. F. N., 1996. Setting livestock research priorities through a participatory rapid appraisal: North-western Tanzania. In: Roeleveld A C W and van den Broek A. (Editors), 1996. Focusing livestock systems research. Royal Tropical Institute, Amsterdam, The Netherlands. pp 91.

Zingore S., González-Estrada E., Delve R. J., Herrero M., Dimes J. P. and Giller K.E., 2007. An integrated evaluation of strategies for enhancing productivity and profitability of resource-constrained smallholder farms in Zimbabwe. Agricultural Systems 101 (2009) 57–68. pp 67.

Chapter 3 Participatory analysis of the farming system and resources: A livestock perspective

Abstract

This study was carried out, in Wundanyi division of Taita District, using two of the methods of farming systems analysis namely Participatory Rural Appraisal (PRA) and Static Survey. The objective was to analyze the mixed farming system in this area in view of the changes in demands, constraints and opportunities that have affected the agricultural sector in Kenya since the Structural Adjustment Programs. The results show that, indeed, the area was negatively affected by the liberalization, land pressures and concomitant economic stresses, but the decline in technology adoption and production is not so drastic as to be declared irreversible. This decline is manifested in low sales of livestock and products and it appears to have been caused mostly by factors external to the farm, especially resulting from liberalization and privatization of animal health and production services. It is thus recommended that, to stop further decline, extension and service provision should be intensified, accompanied by a commercialization approach by the farmers themselves.

Key words: Extension and service provision; farming systems analysis; low sales; participatory rural appraisal; static survey; technology adoption.

3.1 Introduction

Thornton and Herrero (2001) observed that the mixed crop-livestock system is the most common form of keeping livestock in developing countries, supplying over 90% and 50% of the world's milk and meat respectively and providing livelihoods to more than 70% of the world's resource poor livestock keepers. This proportion is likely to increase with rising populations in sub-Saharan Africa.

In Kenya, the system is characterized by a variety of food and cash crops combined with livestock. Dairy cows invariably have a central place, but farmers also keep other livestock mostly sheep, goats and chicken. The system is largely self-sustaining, but unable to provide adequate employment or household livelihood. It is therefore supported by off-farm income and remittances from the extended family (Thorpe et al., 2000).

Various constraints to small-holder dairy productivity in the Kenyan highlands have been identified. These include erratic payments, low prices and low sales, unreliable market outlets and limited access to animal health and breeding services (Karanja, 2003). It is thus uncertain whether the mixed system has been appropriately optimized and if the productivity level could be raised.

Increased productivity will enhance farm incomes and nutrition, reduce poverty and supply dairy products to the growing urban populations (Karanja, 2003). There is, therefore, need for greater understanding of the production system, its objectives, constraints and resource distribution to the various components in order to suggest appropriate options for improvement. This study collected data to enable evaluation of resource availability and allocation and to identify constraints and coping strategies and opportunities for increased productivity available to farmers in Wundanyi Division.

3.2 Materials and Methods

3.2.1 Description of the study area

Wundanyi is one of the Divisions of Taita District in Coast Province. The Division consists of some of the high potential parts of the District in Agro-ecological Zone Upper Midland 3 i.e.

Semi-humid and some of the drier lower areas in Agro-ecological Zone Lower Midland 5 i.e. Semi-arid (Jaetzold & Schmidt, 1983).

The Division has an area of 682.1 sq. km. and an estimated human population (projections for 2008) of 64,056 (District Statistics Office, 2007). The average temperature in the District is 23.9° C, with the lowest at 16.4° C (District Statistics Office, 2007).

The study area was specifically Wesu Sub-location of Wundanyi Location (same name as the Division) and the sampling frame was the nine villages of the Sub-location. The Sub-location was chosen to represent the high potential parts of the Division because of its homogenous ecology. The average rainfall per annum in the study area is 1,400 mm (Jaetzold & Schmidt, 1983; Ministry of Finance and Planning, 2001).

3.2.2 Data collection

Data was collected using participatory rural appraisal (PRA) and a structured questionnaire survey in the nine villages of Wesu sub-location. The PRA was done in three days and the survey took one week.

A total of 70 farmers participated in the PRA. These farmers attended in response to a general publicity (not specific personal invitations) of the meeting by the Location Administration, Agriculture and Livestock officers and each individual's presence and the total number was therefore random and not pre-determined. The discussions were conducted with all the participants mixed except during the gender activity calendar analysis when men and women were separated and then mixed again for corroboration. The languages used were mainly Kiswahili with a bit of local language (Kitaita) and the leading team recorded the information in English. Most of the participants also understood English and the discussions were lively and participatory. The PRA tools as described by Lelo et al. (1995) were used and the issues discussed were availability of resources; constraints and opportunities among others.

The survey was done on foot by enumerators, using simple random sampling without any list of the individuals in the sub-location. The enumerators used personal interviews with structured questionnaires that captured the following parameters: farm activities and labour, land size, cattle pests and disease management practices, cattle management systems including feeding and grazing strategies, cattle herd structure, level of milk production, access to extension services, and farm and non-farm employment among others. Sixty-nine household heads were interviewed.

3.2.3 Data analysis

The PRA information was recorded on flip charts. Mapping, time and trend lines, seasonal and gender calendars, diagramming and ranking were used to elicit, record, analyze and agree on community spatial, time related, social and technical data.

The survey data was entered into Microsoft Office Excel 2007 data sheets and analyzed using Statistical Package for Social Sciences (SPSS 16.0 for Windows) program. Analysis was done for descriptive statistics (means, standard deviations, minimum and maximum values), frequencies and percentages. Test for differences among categorical variables was done using the Chi-squared test at 5% significance level. The results are summarized in tables.

3.3. Results and discussions

3.3.1 Description of Household Heads

Information on the heads of the households is summarized in Table 3.1 below. Most of the sampled farmers, 76.8%, were male and 23.2% were female. The youngest respondent was 22 years old and the oldest 77, with a mean age of 51 years. A proportion of 13% of the farmers had no formal education, 59.4% were of primary school level, 26.1% had completed secondary school and very few had gone past secondary school level. Most of the respondents (88.4%) had no off-farm employment.

Household surveys usually describe such characteristics because in the social context there must be hierarchy of decision making, responsibilities and in some cases even consumption and all these can be determined by gender, age and education/experience. However, according to Kitalyi et al. (2005) it is not always easy, in traditional small scale livestock production systems, to decide who is the owner of an animal, as 'ownership' is not a simple or indivisible concept, but a 'bundle of rights' and furthermore the people who look after an animal are not necessarily those who own it or control access to its benefits.

Most of the farmers were quite old, with low to middle level education and employed fulltime in their farms. These figures point at a subsistence livelihood and since education adds skills and knowledge to the human capital and age brings wisdom and conservatism, they have a bearing on the level of technology adoption and general farm management such as fodder and breeding management. Garforth et al. (2005) discussed how lack of knowledge can contribute to poverty and new knowledge can open new livelihood opportunities and the relationship between poverty, power and knowledge and that depending on the way it is generated and disseminated, knowledge can either improve or worsen the situation of resource poor farmers.

The fulltime employment in farms could be due to old age and inability to partake of other opportunities, but as discussed later in section 3.3.6, in rural areas, dairying is a major source of employment for both family and hired labour (Staal et al., undated) and furthermore Staal et al. (2003) also pointed out that off-farm employment is not always readily available to farm family members.

Table 3.1: Characteristics of the household heads interviewed during the survey.

	Frequency	Percent	Chi-square (χ^2) ($P < 0.05$)
Male	53	76.8	19.8
Female	16	23.2	
Not formally educated	9	13	52.0
Educated up to primary school level	41	59.4	
Educated up to secondary school level	18	26.1	
Educated up to post-secondary level	1	1.5	
Have off-farm employment	8	11.6	40.7
Have no off-farm employment	61	88.4	

3.3.2 Farm resources

The farm characteristics and resource availability are summarized in Table 3.2. Farm sizes ranged from 0.2 acres to eight acres with a mean of 2.3 acres. The farm area devoted to food crops was 52.7% and that to forage crops 24.1%. The total livestock area (31.6%) including the sheds is less than that of food crops. This land pressure is similar to that found in other smallholder mixed farming systems in Kenya as seen in the characterizations done in Central and Western Provinces (Staal et al., 1997; Waithaka et al., 2002; Mburu et al., 2005). In Kiambu, in Central Province, the mean household land ownership was 2.68 acres and the proportions allocated to crops and livestock are similar to this study area. In fact, this apparent inequality in land allocation is neither bad nor unfair since, unlike crops which utilize only the land they stand on, livestock are more efficient land users because they utilize not only the grown fodder, but also purchased fodder and feed, weed mixtures, crop residues and fodder from or on public and other land. Thus, Upton (2000) recommends that, because of increasing land and population pressure, the intensity of agricultural production must be increased and livestock production offers one of the prospects of increasing intensity of land use.

Most (44 %) of the farm workers were men, 16-60 years, closely followed by women (41.6%) of the same age. Some old men and women over 60 years also assisted in the farms equally. More boys (6.4%) assisted in the farms than girls (3.2%). Thus, there is near gender equality in farm duty allocations, but women are further burdened by household chores, which continue after the men have gone for recreation and well after the evening meal. There was a significant difference among the age categories ($\chi^2_{(5)} = 154.696$, $P < 0.001$). Gender roles are the socially constructed expectations for men, women and children and they vary greatly among societies (Kitalyi et al., 2005).

Streams were the main sources of water for home consumption, livestock, forages and crops followed by piped water and then rain water for those with storage facilities. More forages and crops were irrigated with stream water than with piped or rain water. These water sources were not far from the homesteads and there is adequate water for domestic and livestock use. However, the topography of the land and the amounts of water do not allow for large-scale irrigation and the few people who do forage and horticulture irrigation, use hosepipes or hand-fetching from streams passing near their farms. The water availability and utilization could be improved by more rain water harvesting and storage, adequate terracing of the farms and avoidance of cultivation too near the streams which causes them to dry. Livestock especially dairy have an important role in integrated land management when they cause the adoption of agro-forestry with nutrient cycling fodder plants and nutrient flow onto farms through feed collected elsewhere and brought onto the farm (Kitalyi et al., 2006). Livestock also provide manure for soil fertility and Napier grass has a dual function of fodder and control of soil erosion.

The fodder plants grown include Napier grass (*Pennisetum purpureum)*, Calliandra (*Calliandra calothyrsus*), Desmodium (*Desmodium* spp), and Kikuyu grass (*Pennisetum clandestinum*). As in other smallholder areas in the country especially central Kenya (Mwendia, 2007), Napier grass is the dominant fodder plant; it is grown in small plots and along contours and serves both as fodder and for prevention of soil erosion. The majority of farmers (69.9%) produce their own fodder, 22.6% buy and 7.6% get it at no cost from neighbours. Forage inadequacy is a problem especially during the dry season. Lanyasunya et al. (2006) found that lack of adequate planting space was a critical limiting factor to increased fodder production on smallholder farms in Kenya. They recommended that, since little can be done on land scarcity, farmers should be trained on increasing productivity, conservation, appropriate utilization, introduction of other suitable fodder crops, other methods of fodder production and ration formulation.

Crop residues and weed mixtures are used as supplementary or replacement feed. Maize residues are the most commonly used, though banana stems, beanstalks, cabbages, kales/collards and sweet potato vines are also used. All the respondents indicated that the source of crop residues was 100% own farms. Few people use grazing and tethering on the roadsides as this space has little biomass and grazing would also take them away from other farm work. Traditional grazing is not possible as all the land is demarcated into individual farms or public institutions and there is no free trust land (Personal observation).

Animal Health technicians were available within less than one km to only 12% of farmers, while 24% indicated that technicians were more than five km away. Extension officers are within 1-5 km for 21% of farmers, while for 77% the officers are more than five km away. Inseminators were 1-5 km away for 27% of the farmers and more than five km away for 71%. Thus service providers are few and far from reach and this is a real constraint to technology extension and implementation. This has become a big problem in the whole country after the privatization of some Government Services (Oruko et al., 2000). Wambugu (2001), in a study in Kiambu District to establish the extent to which extension services affected farming practice, found that only 32% of the farmers were in contact with the Government extension service and the most important sources of technical information were dairy cooperatives and neighbours. In another study on the delivery of veterinary services in Kenya, where three key parameters were evaluated (access, acceptability and affordability), access rather than affordability appeared to be the primary constraint (Heffernan and Misturelli, undated).

Table 3.2: Farm characteristics and resource availability and utilization

a) Land sizes and utilization

Utilization / Area (acres)	Mean	Proportion (%)
Homesteads and other farm structures	0.387	17.2
Livestock sheds	0.169	7.5
Food crops	1.19	52.7
Area for forage crops	0.545	24.1
Total farm size	**2.259**	**100%**

b) Labour division

Gender & ages assisting in the farms	Total	Proportion (%)
Men 16-60 yrs	55	44
Women 16-60 yrs	52	41.6
Women >60 yrs	3	2.4
Men >60 yrs	3	2.4
Boys 0-15 yrs	8	6.4
Girls 0-15 yrs	4	3.2

c) Distribution and utilization of water resources

Sources / Use (%)	Home	Livestock	Forages	Crops
Streams	58	61.6	62.5	88.9
Piped	26	25.6	25	7.4
Stored rain water	16	12.8	12.5	3.7

d) Distribution and utilization of feed resources

Feed / Availability (%)	Own	Out free	Out bought
Forage feed	69.9	7.6	22.6
Water	29.8	53.2	7.1
Supplements	0	0	100
Crop residues	100	0	0

e) Proportion of respondents having livestock services at various distances

Services / Availability (%)	< 1 km	1-5 km	> 5 km
Animal health technician	12	64	24
Extension officer	2	21	77
Inseminator	2	27	71
Agro-veterinary shops	44	51	5

3.3.3 Livestock feeding systems

The proportions of livestock in the different feeding systems are shown in Table 3.3. The systems have been classified based on the feeding and housing of the animals. 'Intensive' means fed within a house/stall such as a zero-grazing unit for cattle with cut-and-carry for fodder and confinement for chicken. 'Semi-intensive' means both intensive and sometimes free range or tethered outside in the case of ruminants; and 'extensive' means completely free range or grazed outside the farm for ruminants. This is a classification according to intensity of production, but the three criteria which have been used by Sere and Steinfeld (1995) to classify World livestock production systems (into eleven classes) are integration with crops, relation to land and agro-ecological zones.

The 69 sampled farmers had a total of 84 cattle, 49 chicken, 20 sheep, three dairy goats and two pigs among them. Intensively reared cattle were 76%, 17% were semi-intensive and 7% were grazed outside the farm. Extensively kept sheep were 50%, while 45% were semi-intensive and only 5% were intensive. About half of the chicken (49%) were left to fend for themselves, 35% were supplemented with purchased feed and household leftovers and 16% were intensive, completely fed on purchased feed. Most of the dairy goats (67%) were tethered and also fed with cut forage and 33% were stall fed. The two pigs were all kept intensively. The figures are a reflection of the farmers' objectives and allocation of resources and importance to the various farm enterprises. Farmers spent a greater proportion of their time looking after cattle than other farm activities including crops. The high proportion of stall-fed cattle is similar to that seen in the Kenyan central highlands by Omore et al. (1999) who also found out that this proportion increases with decreasing land sizes.

Table 3.3: Proportions of livestock in the different production systems classified based on the feeding and housing of the animals

	Proportions of livestock in different production systems (%)		
Species	**Intensive**	**Semi-intensive**	**Extensive**
Cattle	76	17	7
Chicken	16	35	49
Sheep	5	45	50
Dairy goats	33	67	0
Pigs	100	0	0

3.3.4 Breeding and reproduction

Most farmers use bulls for cattle breeding with 65% using out-sourced males and only 2% mating within their own herds. Artificial insemination (A.I.) is used by only 33% of the farmers. This observation differs from that reported by the National Veterinary Research Centre (1996) that nearly all farmers in smallholder dairy cooperatives breed their cattle by A.I. and bulls are therefore not important in this production system. This means that the figures have declined over the years. The A.I. charges by the private inseminators range from KSh900 – 1500 (US$11.25 – 18.75) per insemination for local and imported semen respectively while owners of breeding bulls charge KSh400 (US$ 5) per visit.

Farmers are reluctant to meet the cost of A.I. despite having knowledge that use of unimproved bulls results in poorer quality cattle and less milk production as indicated in the table of constraint analysis (Table 3.6). Possibly, this reluctance could be due to unfavourable comparison of the fees with the average daily earnings and other expenses; the long time before the investment realizes returns and the perceived poor performance of A.I. in terms of conception rates and actual progeny performance. The use of A.I. has dropped in the whole country since the privatization of the services in 1992 (Omiti and Muma, 2000; Karanja, 2003; Department of Veterinary Services, 2007) and there is need to explore the causes and how to boost the uptake of the private A.I. services.

Most farmers (75%) get breeding rams and bucks from outside the farm for their sheep and the few dairy goats. As in other areas of the country, most of the chicken are indigenous, kept in the traditional way (Mugambi, 2007) with no clear breeding objectives or plans.

3.3.5 Livestock Produce

The numbers of livestock sold during the 11 months of the study period are summarized in Table 3.4. More farmers sold bulls and cows than other species although the mean number sold per person was just 1.2 and the maximum four. Larger numbers of chicken and chicken products were sold than other animals probably because of the small size and ease of selling chicken and their products. Overall, the figures show that sales were made to meet small frequent cash requirements and larger needs once in a while rather than for commerce.

Milk production per day was minimum two lts and maximum 25 lts with a mean of seven lts. Sales ranged from zero to 19 lts with a mean of five lts and consumption from 0.5 to six with a mean of two lts. The price of milk was reported at KSh20 (US$0.25) per liter. Sales figures are lower than those reported in Kiambu District at 7.6 lts per day (Staal et al, 1997) although the price is much higher. The potential of getting more income from sales of milk exists if yields and prices could be improved. Yields could be improved through better breeding and management practices while prices may be improved through better marketing organization and strategies.

Upton (2000), observed that in traditional areas of extensive, rangeland-grazing and mixed farming, a market usually exists for live animals, prior to their movement to urban slaughter slabs, and for small quantities of fresh milk. A review by Staal et al. (undated) suggested that polices in Kenya have historically targeted achievement of national development goals in food security, employment and income generation and that these policies have influenced dairy production and marketing and have resulted in phenomenal increase in the contribution of smallholder farmers to total national marketed milk production.

Table 3.4: Proportions of respondents (N=53) that sold livestock of different species in the study period. Milk is not included as it is sold daily.

	Proportion of respondents (%)	Minimum number sold/respondent	Maximum number sold/respondent	Mean
Bulls	24.5	1	4	1.2
Mature cows	17.0	1	4	1.9
Heifers	11.3	1	3	1.7
Extra calves	11.3	1	3	1.3
Local chicken	9.4	3	13	7.8
Broilers	7.5	1	35	9.8
Rams/bucks	5.7	1	1	1.0
Female sheep/goats	5.7	1	4	2.0
Eggs	7.6	4	10	7.0
Total	**100**			

3.3.6 Livestock ranking

The farmers' opinion was sought on the importance of each livestock species as sources of food and income and the ranking is shown in Table 3.5. The dairy cow is the most important livestock, being ranked top as a source of cash and second as a food source. Milk is the only product that reaches the external market. The chicken is the second for cash and first for food. Fish was ranked last for both food and cash and this is not surprising since there is little fish farming and no water body in the area.

Staal et al. (1997) similarly found that dairying was an important income generating activity for a majority of households in Kiambu and probably the single most important farming activity in the District. In other mixed smallholder areas in the country, dairying is also cited as the most important source of income and cash flow, but is done together with other livestock, mostly chickens, sheep and goats (Omore et al., 1999). Dairying provides higher returns than crops and rural wage labour and is a source of employment for both family and hired labour (Staal et al., undated).

Cattle are the main livestock species in the smallholder agricultural sector and are even given higher priority in feeding because of their multiple uses (Chawatama et al., 2005). However, the integration with smaller animals addresses the problem of unpredictability of food and income supply; it provides stability, surety and variety; and furthermore smaller animals are more prolific, have lower requirements, are less risky and are easier to sell and use as food than larger species (Kitalyi et al., 2005).

Table 3.5: Livestock ranking for all species in order of their importance as sources of food and income. The ranking was done by the community themselves during the PRA as part of their livelihood mapping.

Species, products, purpose and markets								Ranking	
Livestock	Meat	Milk	Eggs	Cash stock	Food stock	Local market	External market	Cash	Food
Cow	√	√		√	√	√	√	1	2
Chicken	√		√	√	√	√		2	1
Sheep	√			√	√	√		3	4
Goat	√	√		√	√	√		4	3
Pigs	√			√	√	√		5	5
Rabbits	√			√	√	√		6	7
Ducks	√		√	√	√	√		7	6
Guinea pigs	√				√	√		8	9
Fish	√			√	√	√		9	6

3.3.7 Evaluation of livestock constraints

The problems in livestock production were listed and ranked using pair-wise matrix ranking method and these are reported in Table 3.6. High cost of A.I. services was ranked the most important problem in livestock production. This is borne by the data that shows 67% of farmers using bulls compared to 33% using A.I. The use of unimproved bulls due to the high cost of A.I. services was considered to result in cattle of poor potential and thus lower milk production and this was exacerbated by pests and diseases and dry season fodder unavailability. Fodder unavailability did not rank high in the list as might have been expected and this is probably because the inadequacy occurs only during the dry season. Low milk production is listed and is considered as a constraint although it is in fact a result and the causes are indicated. This is probably as a result of the nature of the local languages which have little difference between causal constraints and resultant problems – if it is not adequate, it is a problem. This could be a problem in itself as it seems to absolve the causes of the result. Lack of cooling facilities was not considered to be a major problem showing either that there is a high turn-over of milk to the market or that the quantities do not demand these facilities.

3.3.8 Constraint analysis, coping strategies and opportunities

The constraints to dairy production analyzed for causes, coping strategies and opportunities are summarized in Table 3.6. The primary goal of any PRA exercise is to initiate an interactive process between the community and the PRA team so that a community action plan can be prepared (Lelo et al., 1995). Such outputs and conclusions are the culmination of careful planning and conduct of the PRA (Devendra, 2007). The listing of the constraints and causes demonstrates that the community knows their problems. Coping strategies is what they do currently to attempt to solve the problems and opportunities are possible solutions to the problems. These constraints and aspirations are found in different order in other similar parts of the country and the Policy challenges have been discussed by Omiti and Muma (2000) and Muriuki et al. (2003).

The farmers' identification of the opportunities shows that these are services, institutions and technologies they know of or have experienced, and indeed they have. Upton (2000) summarized policy instruments for promoting the development of the dairy industry as falling under three main headings: prices, institutions and technology change. All of the instruments that the Government of Kenya has undertaken over the years have had a positive impact on the farming system of this community. For example, the Kenya National Dairy Development Project (1980 – 1995); Taita-Taveta Dairy Cooperative Society (collapsed in 2005); Taita Horticultural Produce Cooperative Society (operating at a very low level); Agricultural Finance Corporation (moved out of the District in the late 1990s); the pre-liberalization Government run animal health, breeding and extension services; all put dairy and horticulture farming in the District on a strong and sound footing. The problem seems to be sustainability and continued implementation of technologies after completion of projects and institutional changes. This could be a result of the farmers' slow acceptance of change and pining for the good old days or due to the strain on the research-extension-farmer linkage occasioned by liberalization and privatization of services.

Intensified extension and service provision accompanied by a commercialization and 'go-get' approach by the farmers are therefore urgently required to stop further decline. It may not be far-fetched to relook at the public good versus private good classification of services as recommended by Pica-Ciamarra (2008) that Governments retain the freedom to step into free markets and directly supply private goods when alternative instruments prove ineffective.

Table 3.6: Dairy Production constraint analysis, coping strategies and opportunities

CONSTRAINT	CAUSES	COPING STRATEGIES	OPPORTUNITIES
High cost of Artificial Insemination Services	Don't know	The local bull	Appeal for low price; improved bull camps; training on the importance of AI; improved production for high returns
Low milk production	Poor breeds; inadequate feed & minerals; pests & diseases; poor shelter.	Local-bulls; purchase fodder; purchase-mineral supplements.	Training; loans; increase fodder production; improved breeding.
Pests and diseases	Lack of sprays; poor management; poverty; lack of equipment; bringing animals from outside; roaming dogs.	Zero grazing; local equipment; merry go rounds; preventive medication for incoming stock.	Revive cattle dips and improve management. Work harder; go for loans; avail animals for vaccination.
Low milk prices	Use of middle men; piece meal payment; collapsed cooperative movement; adulteration of milk; unclean milk production.	Clean milk production; no strategy for the others.	Training; improved collection/transport; form milk associations; cooling facilities to minimize spoilage; quality assurance.
Fodder unavailability during the dry spell	Low rainfall; low fodder; no alternatives; poverty.	No strategies; grazing by the road-sides	Fodder preservation; education on fodder preservation; planting fodder crops
Lack of Storage facilities	No provider; low production level.	Boiling; selling locally; selling on credit to middlemen.	Establishment of cooling facilities; cooperatives & external markets; value addition e.g. yoghurt, ghee.

3.4. Conclusions

This study has made the following conclusions:

- The area has most of the necessary components of a good dairy production system, but household livelihoods are still subsistence and there is low level of technology adoption and general farm management.
- The major constraints are scarcity of land, high cost of A.I. services, dry season forage inadequacy and shortage of livestock service providers.
- Thus dairy production is still low and inadequate to meet demands for food and income and there is room for improvement through more intensification, forage conservation and use of available services and technologies.

It is therefore recommended that farmers should be provided with capacity building and access to micro-credit facilities to enable the community move beyond the coping strategies towards exploitation of the opportunities and commercialization. At the same time the Government, donors and private investors should move in to provide/intensify the enabling services and facilities.

References

Chawatama S., Mutisi C. and Mupawaenda A. C., 2005. The socio-economic status of smallholder livestock production in Zimbabwe: a diagnostic study. Livestock Research for Rural Development 17 (12) 2005. pp 5, 6.

Department of Veterinary Services, 2007. Draft Strategic Plan 2007-2012. pp 19.

Devendra C., 2007. Constraint analysis to improve integrated dairy production systems in developing countries: The importance of participatory rural appraisal. Tropical Animal Health & Production (2007) 39:549–556. pp 555.

District Statistics Office 2007: Taita District Fact Sheet.

Garforth C., Sukumaran R. and Kisauzi D., 2005. Knowledge – key to empowerment. In Owen E., Kitalyi A., Jayasuriya N. and Smith T. (Editors), 2005. Livestock and Wealth Creation. Improving the husbandry of animals kept by resource-poor people in developing countries. DFID.

Heffernan C. and Misturelli F., undated. The Delivery of Veterinary Services to the Poor: Preliminary findings from Kenya. University of Reading/DFID. pp 2.

Jaetzold R. and Schmidt H., 1983. Farm Management Handbook of Kenya, Vol. 11- Natural Conditions and Farm Management Information, Part C, East Kenya (Eastern and Coast Provinces), Ministry of Agriculture, Kenya. Pp 247, 252, 267

Karanja A. M., 2003. The Dairy Industry in Kenya: The Post Liberalization Agenda. Working Paper No.1, 2003.Tegemeo Agricultural Monitoring and Policy Analysis (TAMPA II) Project, United States Agency for International Development (USAID), Nairobi. Paper presented at a dairy industry stakeholders workshop held in Nairobi, Kenya (27th August 2002). pp vi, 1.

Kitalyi A., Mtenga L., Morton J., Mcleod A., Thornton P., Dorward A. and Saadullah M., 2005. Why keep livestock if you are poor? In Owen E., Kitalyi A., Jayasuriya N. and Smith T. (Editors), 2005. Livestock and Wealth Creation. Improving the husbandry of animals kept by resource-poor people in developing countries. DFID. pp 17,18, 20, 21.

Kitalyi A., Mwebaze S., Muriuki H., Mutagwaba C., Mgema M. and Lungu O., 2006. The role of livestock in integrated land management: RELMA's experiences in eastern and southern Africa. Working Paper No. 25. World Agroforestry Centre. pp 3,4.

Lanyasunya T. P., Rong W. H., Mukisira E. A. and Abdulrazak S. A., 2006. Performance of Dairy Cows in Different Livestock Production Systems on Smallholder Farms in Bahati Division, Nakuru District, Kenya. Pakistan Journal of Nutrition 5 (2): 130-134, 2006 ISSN 1680-5194. pp 133,134.

Lelo F., Ayieko J., Makenzi P., Muhia N., Njeremani D., Muiruri H., Omollo J. and Ochola W., 1995. PRA Field Handbook for Participatory Rural Appraisal Practitioners. The PRA Program, Egerton University, Njoro, Kenya. pp 11 and chapters 5&6.

Mburu L. M., Wakhungu J. W. and Kang'ethe W. G., 2005. Characterization of smallholder dairy production systems for livestock improvement in Kenya highlands. Livestock Research for Rural Development 19 (8) 2007. pp 4.

Ministry of Finance and Planning 2001: Taita Taveta District Poverty Reduction Strategy Paper, Consultation Report for the Period 2001 – 2004; pp 6.

Mugambi J. N., 2007. Brief report on poultry industry in Kenya: Early detection, prevention and control of avian influenza in Kenya. Avian Influenza Project. FAO, Department of Veterinary Services. Nairobi. pp 2.

Muriuki H., Omore A., Hooton N., Waithaka M., Ouma R., Staal S.J. and Odhiambo P., 2003. The Policy environment in the Kenya dairy sub-sector: A review. SDP Research and Development Report 2. MoLFD, KARI, ILRI.

Mwendia S. W., 2007. Impact of Head Smut Disease (*Ustilago kameruniensis*) on Napier Grass Yields in Smallholder Dairy Production Systems. MSc Thesis, University of Nairobi. pp 30.

National Veterinary Research Centre, Kenya, 1996. Manual of Livestock Production Systems in Kenya. KARI/ODA Livestock Socio-economics and Epidemiology Project. pp 19.

Omiti J. and Muma M., 2000. Policy and Institutional Strategies to Commercialize the Dairy Sector in Kenya. Occasional Paper No. 006/2000. Institute of Policy Analysis and Research, Nairobi.

Omore A. O., McDermott J. J., Muriuki H. M. and Thorpe W., 1999. Smallholder Dairy Herd Management in Kenya. International Livestock Research Institute, Kenya Agricultural Research Institute, Nairobi; Department of Population Medicine, University of Guelph, Canada; Ministry of Agriculture, Nairobi. pp 1, 3.

Oruko L. O., Upton M. and McLeod A., 2000. Restructuring of Animal Health Services in Kenya: Constraints, Prospects and Options. Development Policy Review Vol.18 (2000), 123–138. Overseas Development Institute, Oxford, UK. pp 1.

Pica-Ciamarra U., 2008. A Menu of Livestock Sector Policies Rationale and Structure. Background document for the FAO Informal Expert Meeting on 'Designing Effective Country Specific Strategies for Dairy Development'. Bangkok, Thailand, 17-20 November, 2008. FAO Pro-Poor Livestock Policy Initiative. pp 3.

Sere C. and Steinfeld H., 1995. World Livestock Production Systems, Current Status, Issues and Trends. FAO Animal Production and Health Paper No. 127. pp 4.

Staal S. J., Chege L., Kenyanjui M., Kimari A., Lukuyu B., Njubi D., Owango M., Tanner J., Thorpe W. and Wambugu M., 1997. Characterization of Dairy Systems Supplying the Nairobi Milk Market, A Pilot Survey in Kiambu District for the Identification of Target Groups of Producers; KARI/ILRI/MoA, Nairobi Kenya. pp vii, 13, 29.

Staal S. J., Nin Pratt A. and Jabbar M., undated. A Comparison of Dairy Policies and Development in South Asia and East Africa. Part 2: Country Case Studies from South

Asia and East Africa – Kenya, Ethiopia, Pakistan and India, and Final Synthesis. ILRI. pp 2, 15, 16.

Staal S. J., Waithaka M., Njoroge L., Mwangi D. M., Njubi D. and Wokabi A., 2003. Costs of milk production in Kenya: Estimates from Kiambu, Nakuru and Nyandarua districts. SDP Research and Development Report No. 1. Smallholder Dairy Project, MoLFD, KARI, ILRI, DFID. pp 17.

Thornton P. K. and Herrero M., 2001. Integrated Crop-livestock Simulation Models for Scenario Analysis and Impact Assessment. Agricultural Systems 70 (2001) 581-602. pp 2.

Thorpe W., Muriuki H. G., Omore A., Owango M. O. and Staal S., 2000. Dairy Development in Kenya: the past, the present and the future. Annual Symposium of the Animal Production Society of Kenya, March 22nd – 23rd 2000, KARI Headquarters, Nairobi. pp 4.

Upton M., 2000. The "Livestock revolution" – Implications for Smallholder Agriculture: A Case Study of Milk and Poultry Production in Kenya. FAO Livestock Policy Discussion Paper No. 1. pp 4, 18, 47.

Waithaka M. M., Nyangaga J. N., Staal S. J., Wokabi A. W., Njubi D., Muriuki K. G., Njoroge L. N. and Wanjohi P. N., 2002. Characterization of dairy systems in the western Kenya region, Report of Dairy and Crop Characterization Activities in Western Kenya. Smallholder Dairy Project, Nairobi, Kenya. Ministry of Agriculture and Rural Development, Kenya Agricultural Research Institute, International Livestock Research Institute, Department for International Development-UK (DFID). pp 14.

Wambugu M. N., 2001. Extension and its effect on dairy cattle nutrition and productivity in smallholder dairy enterprises in Kiambu District. MSc Thesis, University of Nairobi. pp XIV, 36.

Chapter 4 A dynamic study of the smallholder mixed farms: Activities, performance and interactions

Abstract

This study undertook a dynamic survey of a sample of thirty mixed dairy-crop farms for 11 months over the two rainy seasons. The study identified the farmer's objectives and observed the system over the period to get a quantitative and qualitative measure and trends of their activities, performance and interactions. The farming system was identified to be a low input, low output system although there were little exogenous shocks on both crops and livestock. There is, therefore, room for improvement in optimization of resources and productivity. This can be done by diversification and stabilization of production with other crops and livestock species coupled with Government social protection measures.

Key words: Diversification and stabilization; dynamic survey; low input, low output; optimization of resources; social protection.

4.1 Introduction

Smallholder crop-dairy cattle systems contribute, through milk consumption and income generation, to both food security and alleviation of poverty for the majority of smallholders in many areas of Kenya (Muriuki et al., 2001). Although Jaetzold and Schmidt (1983) recognized the potential of Wundanyi division particularly for dairy and horticulture, the predominantly rain-fed smallholder farming practiced in this area is at risk of the prevailing climate change and Taita District is not self-sufficient in food. One of the coping strategies has been movement to the lowlands which have less agricultural potential, but are more expansive and more virgin and therefore perceived to require less inputs especially fertilizer. However, the lowlands are drier and therefore more likely to be degraded and cannot sustain increasing population pressure (Jahnke, 1982). Intensification was one of the principles that underpinned the Asian green revolution and that can be applied to Sub-Saharan Africa (Jones, 2008). The livestock revolution requires intensification and optimized nutrition, disease control, breeding, credit and other inputs and marketing services (Upton, 2000). It is also necessary to ensure that intensification is in line with production objectives. However, there is inadequate understanding of the objectives of production in this farming system, the levels of production and the role and development potential of livestock. It was necessary, therefore, to identify the farmer's objectives and study the system in order to get a quantitative and qualitative measure and trends of farm activities, performance and interactions.

4.2 Materials and Methods

4.2.1 Description of the study area

Wundanyi is one of the Divisions of Taita District in Coast Province. The study was undertaken in Wesu Sub-location which is in the high agriculture potential zone, 'Semi-humid, 3' (Jaetzold & Schmidt, 1983). The average rainfall in the study area is 1,400 mm per annum (Jaetzold & Schmidt, 1983; Ministry of Finance and Planning, 2001) in two rainy seasons – the short rains in October to December, and the long rains in March to July. Farms are generally small and the farming system is mixed rain-fed with the dairy cow being ranked the most important livestock as a source of cash and food. The main crops grown are maize, beans, bananas, cabbages, kales, tomatoes, sweet potatoes and some indigenous vegetables (black nightshade and amaranthus).

4.2.2 Data collection

The sampling frame was nine villages that were involved in a participatory rapid appraisal (PRA) and baseline survey in a previous study (Chapter 3). Due to logistical and cost considerations, the sample size selected was 30 farmers, the minimum recommended by Petrie and Watson (1999). Purposive sampling was done to get farmers with a high degree of conscientiousness able to participate in the long study.

Data was collected using direct measurements and observations by six research assistants recording five farmers each, once every two weeks. The study was dynamic (that is, it evaluated the farming system components over time as discussed by Quijandria, 1994) and longitudinal (it gathered information from the same set of respondents through repeated visits over a defined period as discussed by Staal et al, 2003). It was undertaken for 11 months over the two rainy seasons. Quijandria (1994) divides the compilation of system characterization information into six stages, namely: - defining the boundaries of the system, determining the components, determining the social component, determining interactions, determining system inflows and determining system outflows. In this study, the following information was recorded:

- Land and crop activities, inputs, costs, outputs and values
- Herd recording, namely cattle management characteristics, cattle herd characteristics and number of other animals
- Dairy cattle recording, namely condition, inputs and outputs

- House – hold recording, namely demographic information, farming objectives, crop and livestock products utilization, farm income, off-farm employment income and income from outside remittances

4.2.3 Data analysis

Data was entered into Microsoft Office Excel 2007 data sheets and analyzed using Statistical Package for Social Sciences (SPSS 16.0 for Windows) program. Analysis was done for descriptive statistics (means, standard deviations, minimum and maximum values), frequencies and percentages. Analysis of variance (ANOVA) at 5% significance level was used to test for differences in the continuous variables measured. The results are summarized in tables and charts.

4.3 Results and discussions

4.3.1 The farm components

The land, household and livestock characteristics at the beginning and end of the study period are summarized in Table 4.1. The human population in the sample was 218 at the beginning and 172 at the end. On average, the mean household composition was 7.8 people comprising of 3.4 adults, 2.3 schoolchildren and 2.1 non-school going children. The livestock population in Tropical Livestock Units, at conversion factors given by Jahnke (1982) (cattle 0.7, sheep and goats 0.1, chickens 0.01) was 73.8 TLU and 61.3 TLU at the beginning and end respectively. Among the monthly human and livestock population changes, only the changes in total cattle and chicken were significant ($P<0.05$) and these can be explained by sales or purchases and other herd dynamics including births and deaths.

Jahnke (1982) lists the resources for livestock production as livestock and land, but clearly, if people, land (including forage and food crops) and livestock are interacting components of one system, then people also are livestock production resources as much as livestock are human development resources. The projected 2008 population density for Wundanyi division was 91.3 persons per sq. km. (District statistics Office, 2008). The calculated land resource availability therefore, was 0.47 acres per person and 1.40 acres per livestock unit. The human: livestock ratio was 0.34 livestock units per person and 2.95 people per livestock unit. Livestock appeared to be more adequately catered for than people, but these were only bare-resource availability indicators. The minimum and maximum farm sizes were one and 18 acres respectively with a mean of 3.43 acres and the average total livestock units per farm/household was 2.47.

These parameters are compared in Table 4.2 with figures for similar systems in Sub-Saharan Africa (SSA) and the World calculated from Sere and Steinfeld (1995). These authors observed that when comparing livestock resource availability indices among systems, within systems and across countries, a very wide range of resource endowment per inhabitant can be observed and developed countries tend to be substantially better endowed per inhabitant with land and livestock than developing countries. This study area was better endowed with arable land per person than the average of SSA, but not the world. It has much less land per head of livestock, but more livestock per person. As observed by The World Bank (2008) for developing countries in general, continuing demographic and land pressures can compromise survival if off-farm income opportunities are not available and farm production is not optimized.

The various ways that livestock drive food security and development and contribute to the environment have been discussed by Sansoucy (1994) and Dalibard (1995) and are shown in Chapter 2. In this farming system, the interactions between the farm components were seen in the objectives, land space, food and fodder, crop residues, labour, income, soil conservation by Napier grass (*Pennisetum purpureum*) and manure for soil fertility. There is no animal traction or use of manure for building or fuel (neither dry nor biogas).

Table 4.1: Mean land, household and livestock herd sizes at beginning and end of the study period (N = 30)

	Farm acreage	Adults	School children	Non-school children	Total cattle	Sheep	Goats	Chicken
April 2008	3.43	3.6	2.3	2.6	1.4	2.6	1.8	16.9
February 2009	3.43	3.0	1.8	1.8	2.9	1.5	0.9	15.5
Grand mean of all months	3.43	3.4	2.3	2.1	2.7	2.5	1.6	12.9

Table 4.2: Comparison of resource parameters with other parts of Africa and the World in mixed rain fed humid and sub-humid tropics and sub-tropics systems

	Study area	Sub-Saharan Africa	World
Arable land per person (acres)	0.47	0.058	0.52
Arable land per head of cattle (acres)	1.40	5.07	19.6
Human : Livestock ratio	2.95	8.8	3.8
Livestock : Human ratio	0.34	0.11	0.26

Parameters for Sub-Saharan Africa and the World were calculated from figures for the human population and resource base in mixed rain fed humid and sub-humid tropics and sub-tropics systems (Sere and Steinfeld, 1995).

4.3.2 Farmers' objectives for mixed farming

The farmers were each asked an open question to give three reasons for this mixed farming. They gave a total of ten different reasons which group into two broad objectives and four specific objectives. Food security was given by 56% of the farmers as the broad objective and the rest 44 % cited business. Food security was further specified into family food (21.4%), livestock feed (6%) and soil conservation (28.6%).

The reasons for food security which actually come out as the methods of attaining that objective are getting manure easily (44.7%), meeting own needs (21.3%), getting milk (17%), getting fodder for animals (10.6%) and improving soil fertility (6.4%). The reasons for the business objective were increasing income (51.4%), maximizing resources (16.2%), spreading risk (13.5%), self-employment (10.8%) and reduction of expenditure (8.1%). The objectives and reasons indicate that the farmers lean more towards subsistence than commercial farming. In comparison, Muriuki et al. (2001) identified a commercial orientation in central Kenya. Unlike market-oriented commercial farmers, subsistence livestock producers follow broad production objectives that are driven more by their immediate subsistence needs rather than demands of a market and subsistence agriculture follows low-input and risk-averse strategies (Ayalew et al., 2001). These classifications however, merely indicate "orientation" and not rigid conformation. Jaleta et al. (2009) observed that there is no common standard for measuring the degree of household commercialization and that it depends on the sum of consumption and income effects of market shocks (risks) and the scale can easily be tilted by favorable policies and institutional arrangements.

4.3.3 Allocation of labour in farm activities

In the participatory analysis of the farming system and resources study, the farm area devoted to food crops was found to be 52.7% and that to forage crops 24.1%. The changes in the farm area that actually occupied the farmers attention and labour at a time during the study period is illustrated in Figure 4.1. This area ranged from 0.36 to 0.53 acres that is, 10.5% to 15.5%, of the mean 3.43 total acreage. The trend line shows that the area tended to increase steadily from April to February. However, the month to month variation was significant ($P < 0.05$) peaking in April, September and December. This was due to differences in short term activities probably dictated by the rainfall patterns. The figures show that farmers were active and working on at least 10.5% of their farms all the time and there was no time when they were idle. This continuous working, literally living off the land, appears to be a characteristic of smallholder subsistence farming. The other proportion of the farms not being worked on contained crops like bananas, maize or others already weeded or otherwise managed and left to grow.

As in other smallholder areas in Kenya (Omore et al., 1999), farm labour resources consist of available family members and hired casual and /or permanent labour. The number of family members assisting in the farm ranged from a mean of 2.8 to 3.7 and varied ($P > 0.05$) with time probably depending on the type of farm activities and the family dynamics. The allocation of labour in the various farm activities is shown in Figure 4.2. Hired labour was markedly higher than family labour for crops in April while family members availed more work hours on livestock than hired labour consistently throughout the study period except in November when they were equal. April and November are the peak months of the long and short rains respectively. Labour intensive activities such as weeding, crop spraying and harvesting take place during these periods necessitating additional labour.

More hours are put into cattle management than crops. Jahnke (1982) also indicates that livestock production tends to be more complex and more demanding than crop production mainly because livestock has two 'crops', fodder and livestock, and they both require such routine daily activities as feeding, milking, egg collection, cleaning and fodder harvesting. These facts point out that technological interventions on livestock production are likely to assist the farming household more than those on crops.

More hired labour is allocated to crops than to livestock activities. This could be evidence of higher value attached to livestock and less trust in hired hands. This explanation is supported by the high ranking of dairy animals as indicated in the earlier PRA study (Chapter 3). On the other hand, since livestock activities are more time demanding, they are likely to be more expensive to pay for and families would rather do them themselves either to save, because they cannot afford the wages or just for the employment. It is conceivable therefore, that labour allocation can be used to gauge disposable household wealth.

Figure 4.1: Seasonal variation and linear trend of mean active farm area (area that actually occupied the farmers' attention and labour at a time) on crop and forage production

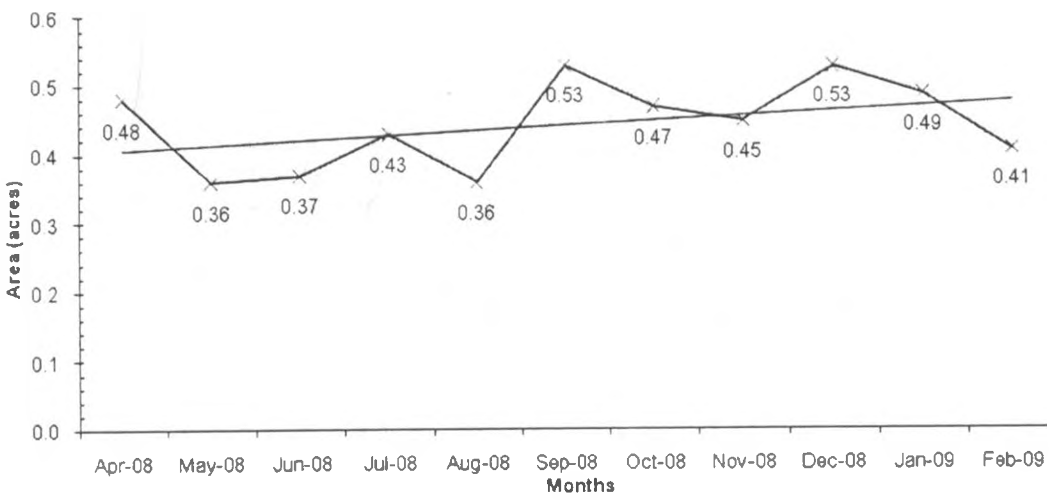
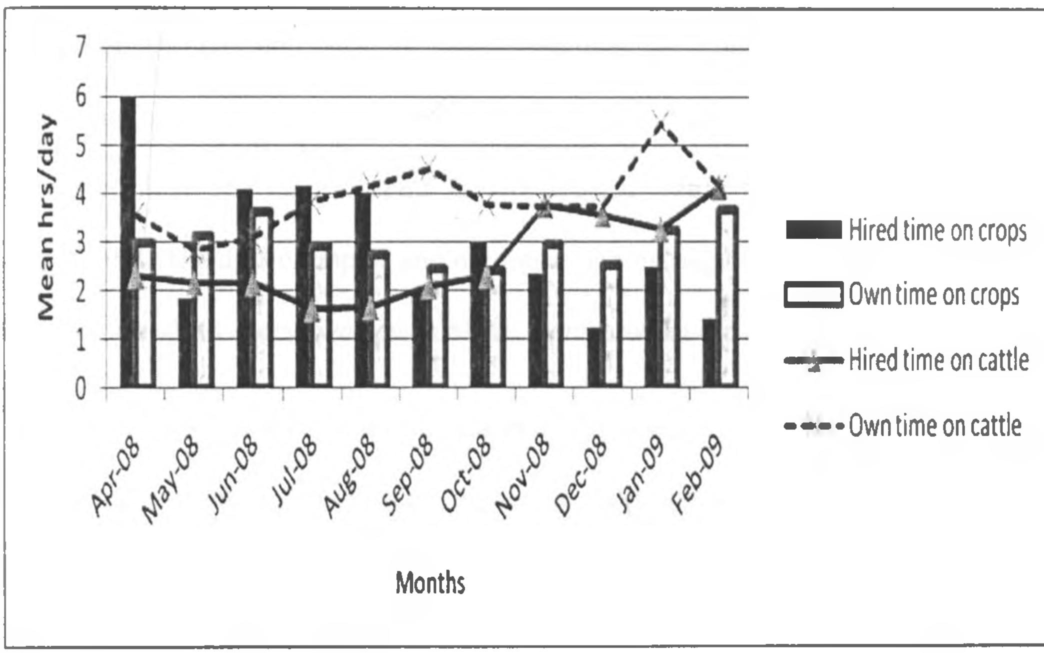


Figure 4.2: Differences in labour allocation to crop and cattle production activities during the study period (time in hours)



4.3.4 Inputs and outputs from the land

The main inputs into the system are human labour, plant seeds, manure, fertilizer, pesticides/acaricides, cattle forages and rainfall. It is difficult to irrigate crops and fodder because the streams are small and lack adequate water. Farm activities therefore, follow the rainfall patterns. Land preparation takes place in January and February and from June to September. Planting and fertilizer/ manure application follows in February to May. Weeding is the main activity in the wet months while establishment of Napier grass is done just before the short rains. The main outputs are food crops, cattle forages, milk, manure and some animal sales. The data on inputs and outputs is summarized in Table 4.3 and Figure 4.3 shows the profit trends in every two weeks of the months when the data was collected.

April – July are the main input months and the costs are high. November – January are the harvest months and the outputs are high. The outputs are higher than the inputs throughout except in April. Therefore, there was profit made in the enterprises in all the months except April. February shows a marked decline indicating that there may be a drop to begin the cycle at a lower level. This could be because output is not continuous and stocks get depleted after some months of sales and consumption. Both the costs of inputs and value of outputs are low which means that the returns were not great. The variation in input costs between months was significant ($P<0.001$), while the variation in output values was not ($P>0.05$). This implies that the farmers worked most of the time, but made money only some of the time and this agrees with the subsistence orientation. This orientation is defined by the combination of food security as the overriding objective and the low level of purchased inputs and outputs so that any sales are made for meeting immediate needs rather than commerce (Jaleta et al., 2009).

Table 4.3: Input costs, output values and profits during a duration of two weeks within each month of the study period

Month	Mean input costs, Ksh	Mean output values, Ksh	Profits in 2 weeks (Ksh 80=1USD)
April 2008	768	627	-141
May	279	587	309
June	413	535	122
July	327	532	204
August	230	569	339
September	237	425	188
October	206	414	209
November	240	702	462
December	234	811	577
January 2009	191	1215	1024
February	237	1026	790

Figure 4.3: Seasonal variation of output values less input costs (profits) of food crops and livestock products in every two weeks of the months

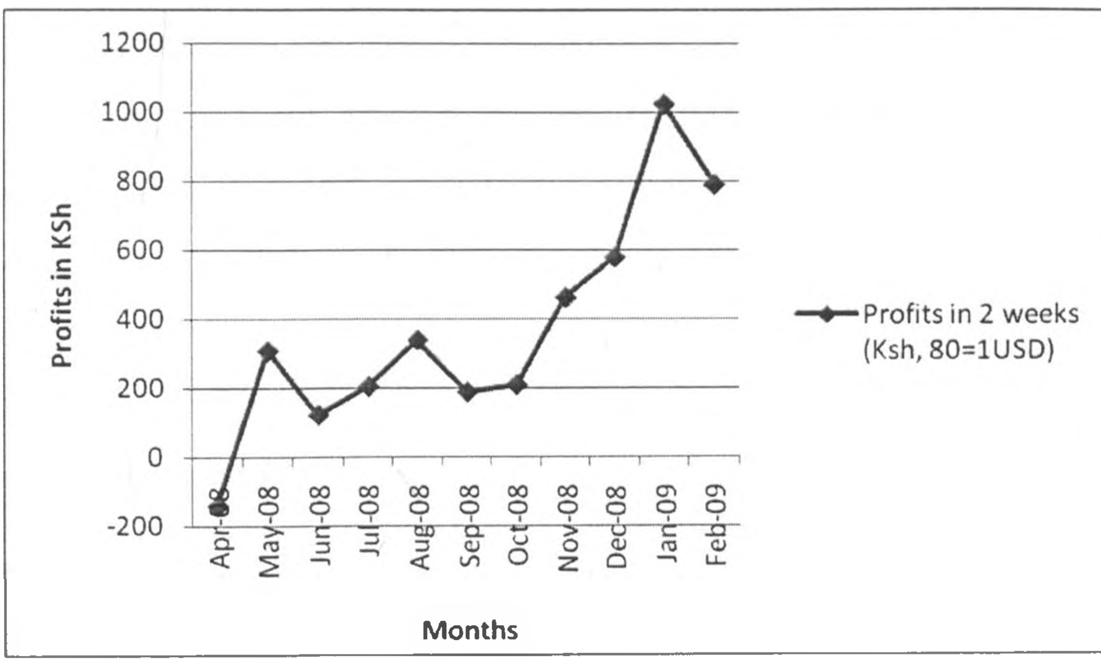


Table 4.4: Livestock structure and composition at the beginning and end of the study period showing the sums, means, proportions and the change in the sum

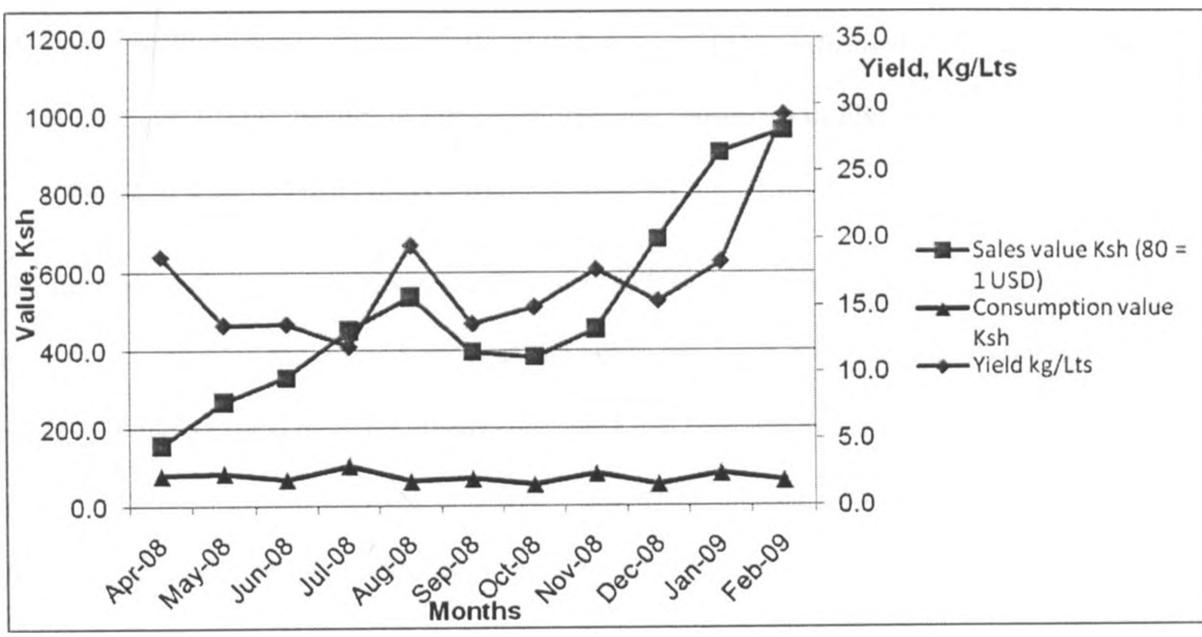
	April 2008				February 2009				% Sum change
	Sum (TLU)	% Cattle	% TLU	HH Mean	Sum (TLU)	% Cattle	% TLU	HH Mean	
Bulls	2	2.13		.07	6	7.5		.20	+200
Milk cows	39	41.49		1.30	32	40		1.07	-17.9
Dry cows	13	13.83		.43	11	13.75		.37	-15.4
Heifers	15	15.96		.52	11	13.75		.37	-26.7
Calves	25	26.59		.83	20	25		.67	-20
Total cattle	94 (65.8)	100	89.14	3.03	80 (56)	100	91.42	2.70	-14.9
Pregnant cows	16	17.02		.53	26	32.5		.87	+62.5
Sheep	27 (2.7)		3.66	.90	25 (2.5)		4.08	.83	-7.4
Goats	7 (0.7)		0.95	.23	4 (0.4)		0.65	.13	- 42.8
Chicken	462 (4.62)		6.25	15.40	236 (2.36)		3.85	7.87	- 48.9
TLU	73.82		100		61.26		100		-17

The figures in brackets indicate the Total Livestock Units (TLU) derived from the Sum figures alongside. The Sums are for all the farms while the household (HH) means are also shown.

4.3.6 Total farm production and utilization of produce

The relationship and trends in the farm production, consumption and sales are shown in Figure 4.4. There was variation ($P<0.05$) in sales value among months, but not in yield and consumption ($P>0.05$). The relationship between farm production, consumption and sales shows that production and sales increased steadily while consumption decreased slightly from the beginning of the long rains to the end of the short rains. The increase in sales matches the trend in profits seen in Figure 4.3 above. It appears that sales were done at the expense of consumption, which could indicate a conflict of objectives. On the other hand, it could mean creation of capital by individuals foregoing current consumption (Beardshaw et al., 2001). This apparent contradiction confounded Mutsotso and Chirchir (2005) who concluded that Taita farmers lead lower standards of living compared to the Embu despite earning more from horticulture than the Embu do from tea and coffee. The low level of farm production exemplifies that of all the Sub-Saharan Africa, which is the only region of the world where per capita food production has been declining for the past three decades, a situation which is not acceptable if the region is to meet the Millennium Development Goals (Jones, 2008). Upton (2000), observed that although in smallholder subsistence systems some poultry, small ruminants and even cattle may be slaughtered for home consumption and small quantities of milk and eggs are used within the households, production of a marketable surplus necessitates the existence of an effective marketing system and policies for the development and diffusion of new technologies. In addition, as discussed by Sabates-Wheeler et al. (2008), the Government can also assist with well-timed food- or cash-for-work e.g. public works projects as a safety net to address the seasonal under-employment and hunger that is typical of rain-fed agriculture systems.

Figure 4.4: Comparison of farm produce yields, consumption and sales in every two weeks of the months from the beginning of the study period to the end



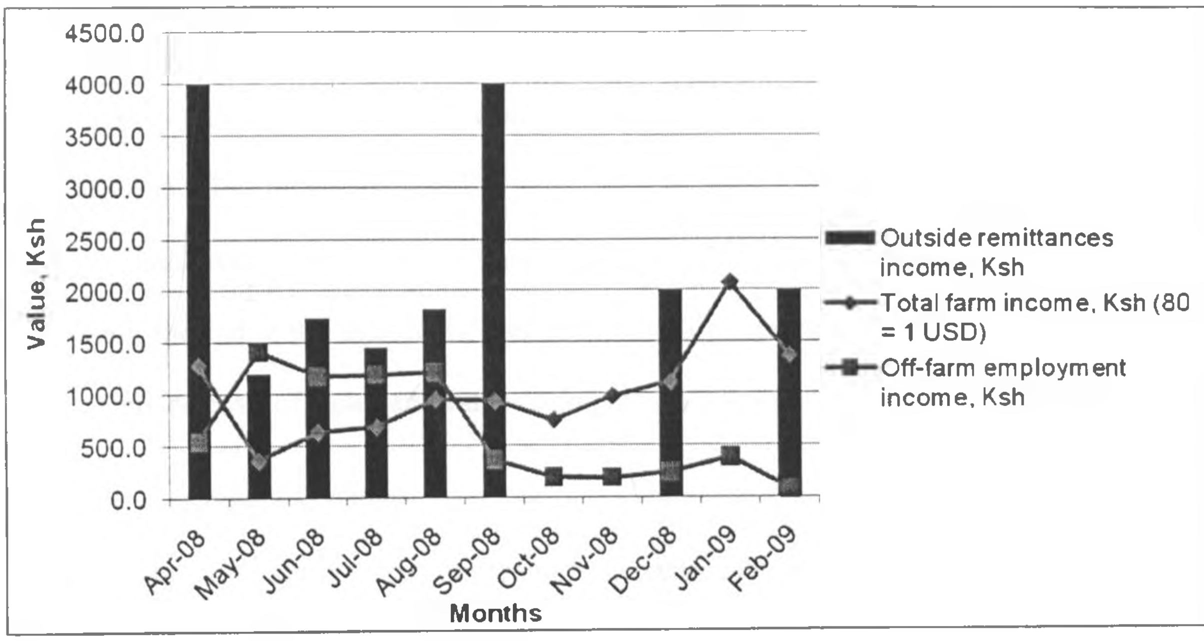
4.3.7 Comparison and trends of household incomes

Income from outside is higher than the others for most part of the year. Farm income was initially lower, but surpassed employment income in August. All income from farm, off-farm and outside remittances was not steady meaning that they are all outside the farmers' control. However, the trends show an increase in farm income from May to January and a decrease in off-farm employment income from August to February. This confirms that most employment is not permanent. The changes in family incomes are illustrated in Figure 4.5 and they reflect the increase in sales of farm produce seen in Figure 4.4.

Off-farm employment is not always readily available to farm family members and this in fact renders the opportunity cost of family labour below the wage rate (Staal et al., 2003). In a study in Malawi (Takane, 2007), it was concluded that off-farm income can help to reduce the risk of own-farm production, but it is also a source of income disparity and provides little opportunity for upward economic mobility to escape poverty. In this study, the income from outside remittances was taken to be that from family members employed outside the immediate circle of the farming system and not resident in the area. This income is probably out of the farmers' control and depends on remitter factors.

As discussed by Sansoucy (1994), Dalibard (1995) and Moll et al. (2007), it is recognized that these measurements are for visible, recordable incomes, but there are other incomes in kind and intangible benefits that may make the farming system more productive and competitive than observed. These benefits include weed control, use of manure, insurance value, household nutrition and cultural values.

Figure 4.5: Family incomes – farm, off-farm and outside remittances



4.4 Conclusions

This study makes the following conclusions:

- The farmers' objectives are subsistence oriented, reflecting a need for self-sustenance, but also sustainability of resource use and an aspiration for commercialization.
- The study area is better endowed with arable land per person than the average of similar systems in SSA, but not the world.
- The overall system performance increased steadily from the beginning of the long rains towards the end of the short rains, then dropped sharply probably to start the cycle again, but both the costs of inputs and value of outputs were low and the returns were not great.

It is therefore recommended that:

- There should be optimization of resource use especially inputs such as fertilizer, feeds and good dairy breeds to increase production from the limited land sizes.
- The farmers should stabilize their production by diversifying into other crops and livestock species such as indigenous vegetables, dairy goats, indigenous and exotic poultry and fish farming.

References

Ayalew W., King J.M., Bruns E. and Rischkowsky B., 2001. Economic Evaluation of Smallholder Subsistence Livestock Production: Lessons from an Ethiopian Goat Development Program. NOTA DI LAVORO 107.2001. pp 1.

Beardshaw J., Brewster D., Cormack P. and Ross A., 2001. Economics, A Student's Guide. Pearson Education Limited, Essex, England. pp 31.

Chawatama S., Mutisi C. and Mupawaenda A. C., 2005. The socio-economic status of smallholder livestock production in Zimbabwe: a diagnostic study. Livestock Research for Rural Development 17 (12) 2005. pp 5, 6.

Dalibard C., 1995. Livestock's contribution to the protection of the environment. FAO Agriculture and Consumer Protection. FAO Corporate Document Repository.

District Statistics Office, 2008. Taita Taveta District Fact Sheet.

Jaetzold R. and Schmidt H., 1983. Farm Management Handbook of Kenya, Vol. 11- Natural Conditions and Farm Management Information, Part C, East Kenya (Eastern and Coast Provinces), Ministry of Agriculture, Kenya. pp 247, 252, 267.

Jahnke H. E., 1982. Livestock Production Systems and Livestock Development in Tropical Africa, Kieler Wissenschaftsverlag Vauk, Germany. pp 10, 59, 157.

Jaleta M., Gebremedhin B. and Hoekstra D., 2009. Smallholder commercialization: Processes, determinants and impact. ILRI Discussion paper No. 18. pp 1, 2.

Jones M. P., 2008. Achieving food security and economic growth in sub-Saharan Africa: Key institutional levers. Forum for Agricultural Research in Africa. pp 1, 7.

Kitalyi A., Mtenga L., Morton J., Mcleod A., Thornton P., Dorward A. and Saadullah M., 2005. Why keep livestock if you are poor? In Owen E., Kitalyi A., Jayasuriya N. and Smith T. (Editors), 2005. Livestock and Wealth Creation. Improving the husbandry of animals kept by resource-poor people in developing countries. DFID. pp 20, 21.

Ministry of Finance and Planning, 2001. Taita Taveta District Poverty Reduction Strategy Paper, Consultation Report for the Period 2001 – 2004. pp 6.

Moll H. A. J., Staal S. J. and Ibrahim M. N. M., 2007. Smallholder dairy production and markets: A comparison of production systems in Zambia, Kenya and Sri Lanka. Agricultural Systems 94 (2007) 593–603. pp 602.

Muriuki H. G., Mwangi D. M. and Thorpe W., 2001. How Smallholder Dairy Systems in Kenya Contribute to Food Security and Poverty Alleviation: results of recent collaborative studies. Paper Presented at the 28th Tanzania Society of Animal Production Conference, Morogoro, 7th - 9th August, 2001. pp 3, 6.

Mutsotso B. M. and Chirchir J. K., 2005. The Socio-economic aspects of Sustainable Agriculture and Conservation of Agro-biodiversity in Embu and Taita Districts, Kenya. Paper presented at the Global Conference on Conservation and Management of Below Ground Biodiversity in Manaus, Brazil, 11th -17th April, 2005. pp 7.

Omore A. O., McDermott J. J., Muriuki H. M. and Thorpe W., 1999. Smallholder Dairy Herd Management in Kenya. International Livestock Research Institute, Kenya Agricultural Research Institute, Nairobi; Department of Population Medicine, University of Guelph, Canada; Ministry of Agriculture, Nairobi. pp 1.

Petrie A. and Watson P., 1999. Statistics for Veterinary and Animal Science, Blackwell Science Ltd, UK. pp 215 – 217.

Quijandria B., 1994. Minimum Data Required for Characterizing Systems. In Ruiz M. E. (Comp.), 1994. Animal Production Systems Research, Methodological and Analytical Guidelines, Inter-American Institute for Cooperation on Agriculture, Costa Rica. pp 55 - 61.

Sabates-Wheeler R., Devereux S. and Guenther B., 2008. Social Protection for the Poorest in Africa: Learning from Experience, Building synergies between social protection and smallholder policies. Institute of Development Studies, Sussex, UK.). pp 9

Sansoucy R., 1994. Livestock, a driving force for food security and sustainable development. FAO Agriculture and Consumer Protection. FAO Corporate Document Repository.

Sere C. and Steinfeld H., 1995. World Livestock Production Systems, Current Status, Issues and Trends. FAO Animal Production and Health Paper No. 127. pp 45, 58.

Smith W. A., Cruywagen C. W. and Maree C., 1993. Dairy production systems. In Maree C. and Casey N. H. (Editors), 1993. Livestock Production Systems, Principles and Practice. Agri-Development Foundation, Brooklyn, USA. pp 223.

Staal S. J., Waithaka M., Njoroge L., Mwangi D. M., Njubi D. and Wokabi A., 2003. Costs of milk production in Kenya: Estimates from Kiambu, Nakuru and Nyandarua districts. SDP Research and Development Report No. 1. Smallholder Dairy Project, MoLFD, KARI, ILRI, DFID. pp 9, 17.

Takane T., 2007. Gambling with liberalization: Smallholder livelihoods in contemporary rural Malawi. Institute of Developing Economies, Japan. pp 1, 13.

The World Bank, 2008. World Development Report 2008; Agriculture for Development, An Overview. pp 21

Upton M., 2000. The 'Livestock Revolution' – Implications for Smallholder Agriculture: A Case Study of Milk and Poultry Production in Kenya, Food and Agriculture Organization. pp 4, 18, 19.

Chapter 5 An analysis of factors affecting the smallholder mixed farming activities, performance and interactions

Abstract

Principal component analysis was used to analyze data collected from a dynamic study of thirty mixed dairy-crop farms. The study was undertaken for 11 months over two rainy seasons to analyze the major production factors affecting the smallholder mixed farming in this area. The major factors were identified as own and hired labour, cost of inputs, price of milk, milk marketing distance and herd number dynamics. Farm output, sales and income and cattle characteristics and management were the most important factors influencing the activities, performance and interactions of the system.

Key words: Activities, performance and interactions; dynamic study; principal component analysis; production factors.

5.1 Introduction

Smallholder farming is recognized by the Commission for Africa, NEPAD and others as central to rural livelihoods and therefore indispensable to food security and poverty reduction and the achievement of the Millennium Development Goals in Africa (Sabates-Wheeler et al., 2008). The Kenya Vision 2030 has earmarked increased productivity of crops and livestock as one of the strategies to increase value in the Agricultural sector (The National Economic and Social Council of Kenya, 2007). International Livestock Research Institute (ILRI) (2006) and Moll et al. (2007) observed that the availability and values of production factors interact with the smallholders' choices for production technologies and market forces to characterize the farming system. Steinfeld and Mack (1995) have discussed the livestock production factors: - livestock, capital, feed, land and labour as well as the production process and the consumption end including marketing and processing. Sansoucy (1994), however, noted that in developing countries, most of the increase in animal products has come from an increase in animal numbers rather than in individual animal productivity. This is because the farm production factors are not utilized towards commercialization but subsistence orientation, with the farmers' objective being mainly food self-sufficiency. Jaleta et al. (2009) argued that in the long run, subsistence agriculture could not be a viable activity and was unlikely to ensure sustainable household food security and welfare. An understanding of the production factors and processes that affect animal production is, thus, a prerequisite for livestock development (Staal et al., 1997). There was need, therefore, to analyze the major factors affecting the smallholder mixed farming in this area to determine their level of influence on the activities, performance and interactions of the system.

5.2 Materials and Methods

5.2.1 Description of the study area

Wundanyi is one of the Divisions of Taita District in Coast Province. The Division consists of some of the high potential parts of the District in Agro-ecological Zone 3 i.e. Semi-humid (Jaetzold and Schmidt, 1983). The average rainfall in the study area is 1,400 mm per annum (Jaetzold & Schmidt, 1983; Ministry of Finance and Planning, 2001).

The study was undertaken in Wesu Sub-location, in the high agriculture potential zone, where dairy management is the main farm activity in terms of both inputs and outputs. Farming here is low input/low output, with a higher subsistence than commercial orientation, and continuing demographic and land pressures can compromise survival if production is not increased and off-farm income opportunities are not available.

5.2.2 Data collection

Data was collected in 30 farms sampled purposefully from nine villages in the study area using direct measurements and observations by the researchers and six assistants. The survey was dynamic (evaluation of the farming system components over time as discussed by Quijandria, 1994) and longitudinal (gathering of information from the same set of respondents through repeated visits over a defined period as discussed by Staal et al, 2003). It was undertaken for 11 months over the two rainy seasons. The following information was recorded:

- Land and crop activities, inputs, costs, outputs and values
- Herd recording, namely housing, equipment and labour; cattle herd structure and changes and number of other animals
- Dairy cattle recording, namely condition, inputs (feed, care and services) and outputs (mainly milk)
- House – hold recording, namely demographic information, farming objectives, crop and livestock products utilization, farm income, off-farm employment income and income from outside remittances

These four categories of information were considered in the planning stage to best capture the activities, performance and interactions in the farming system.

5.2.3 Data analysis

Data was entered into Microsoft Office Excel 2007 data sheets and analyzed using Statistical Package for Social Sciences (SPSS 16.0 for Windows) program. As described by Quiroz et al (1994), Principal component analysis was used to examine the relationships among several quantitative variables, in this case the following:

a. Land area in acres; hired and own labour hours per day on crops; cost of inputs and value of outputs
b. Hired and own labour hours per day on herd management; number of animals bought and number of animals died; price of milk, distance milk sold and total tropical livestock units.
c. Age of individual cattle, number of other animals fed together, live weight estimate; amounts of forage, crop residues and water offered; amounts of concentrates fed and milk fed to calves; number of own labour hours on cattle management; costs of labour, spray chemical and worm medicine; amount of milk production; amounts of feed wasted and manure output.
d. Age of house – hold head, number of adults in the farm, number of school-going children, number of non-school going children, number of people assisting in the farm; yield of outputs, output sales, value of sales, output consumption, value of consumption; total farm income and off-farm employment income.

The means for the different variables in the thirty farms were consolidated together in each month for the 11 months duration of the study (N). The analysis was done for descriptive statistics, correlation, and explanation of variance and rotated component matrix. Principal component analysis is a multivariate technique for describing, simplifying and analyzing data sets where many different variables are measured on a set of samples or objects (Mead et al., 2003). The analysis uses the statistical/mathematical concepts of mean, standard deviation, variance and covariance which are distribution measurements and Eigen vectors and values which are important properties of matrices in algebra, to convert a set of original inter-correlated variables into a new set of independent variables i.e. the principal components. The Eigen values are the variances of each principal component. The first component contains as much of the variation of the variables as possible, the second contains as much of the remaining variation as possible and so on. In other words, the component with the largest Eigen values is the first principal component.

The principal components are linear functions of all the original variables i.e.

$$Y_1 = a_{11} X_{i1} + a_{12} X_{i2} + a_{13} X_{i3} + \text{-----} + a_{1p} X_{ip}$$

$$Y_2 = a_{21} X_{i1} + a_{22} X_{i2} + a_{23} X_{i3} + \text{-----} + a_{2p} X_{ip}$$

Where:

- Y_1 and Y_2 are the first and second principal components.
- a_{11}, a_{12}------ a_{1p}, a_{21}, a_{22}--------- a_{2p} are correlation coefficients between the principal components with the original variables. The coefficients give the weightings or loadings of the original variables on each of the derived components and thus indicate the relative importance of the original variables to the principal components. A high positive coefficient means high correlation i.e. strong relationship.
- X_{i1}, X_{i2}, ------ X_{ip} are the original inter-correlated variables and p is their number.

5.3 Results and discussions

5.3.1 Principal component analysis by land and crop activities

Land is the main farm component; it occupies the farmer's thoughts and labour; it is the sink of inputs and source of outputs and it is the medium through which nutrients are recycled. The variables for land and crop activities and their means and standard deviations are shown in Table 5.1 together with the resulting principal components. The first principal component accounts for almost 41% of total variation and together with the second explains 74% of the total variation. This means that, for the farmers, these are the most important factors in describing their land and crop activities and if it came to choosing what to concentrate scarce resources on, then they should choose the variables in these two components.

The two components are also shown in the table (5.1) in rotated Component Matrix for better interpretation. The most important variables in the first principal component are hired labour followed by cost of inputs and then value of outputs with the last having a negative correlation coefficient. This means that land area cannot be used to explain variation in land and crop activities and that labour and inputs matter more i.e. bigger land will not necessarily translate into higher productivity in terms of input: output ratio. Therefore, increased intensity of labour use should translate into higher productivity, but this needs a corresponding increase in other inputs such as capital, fertilizer, water, good cattle and crop genetics and knowledge. In the first principal component own labour is the most important variable followed by land area which has a negative correlation coefficient. This negative correlation between labour and land means that as land decreases, intensity of labour use should increase to realize the same returns.

Table 5.1: Descriptive statistics and principal component values for land and crop activities

Descriptive statistics			Rotated component matrix	
Variable	**Mean (N=11)**	**S.D.**	**Component 1**	**Component 2**
Av. Time hrs/day Hired	3.08	1.59	0.921	0.198
Input items cost in 2 weeks (Ksh, 80 =1USD)	305.59	165.74	0.832	0.149
Output Items value in 2 weeks (Ksh)	676.74	250.14	-0.623	0.515
Av. Time hrs/day Own	2.97	0.42	0.013	0.968
Area(acres)	0.44	0.06	-0.22	*-0.684*
Explanation of total variance for the first two principal components				
Initial Eigen values			2.045	1.662
Rate of Variance, %			40.9	33.2
Cumulative variance, %			40.9	74.1

Note: The variables are shown in the same lines together with their statistics and correlation coefficients with the components while the explanation of variance is shown below the respective components.

5.3.2 Principal component analysis by herd characteristics and management

Livestock are the most important factor in livestock development. Their characteristics and management determine the productivity. The management variables chosen for herd characteristics and management and their means and standard deviations are shown in Table 5.2.

The first two principal components explain 68% of the variation with the first alone accounting for over half of the total. The two components are shown in rotated Component Matrix. The first component which accounts for such a large percentage (51.7%) of the variation also has a high correlation coefficient (0.926) with the distance milk is sold which means that this was a very important variable in herd management compared to the others. The other important variables are hired labour (0.907), price of milk (0.705) and own labour (0.507). In the second component the important variables are animals bought (0.905), total animals in the herd (0.645) and animals which died (0.461). There were big differences in the milk marketing distance between farmers as seen from the large standard deviation. On the other hand, the price of milk was almost equal at an average of Ksh 20 in the whole area. This means that there is need for intervention in milk collection and marketing. As seen in the earlier participatory analysis study, mean milk production per day was seven liters and sales five liters, usually of morning milk. Milk that is not delivered by the farmers is collected by individual consumers or traders. The latter rely on collecting from many farmers to get sufficient economies of scale and they sell in the District Headquarters, about five km away, and up to Mombasa City, 200 km away, using public means. Thus, any prospective large scale commercial milk processor would need to construct a collection point at a central place and work with a large milk shed combining this location and others.

Table 5.2: Descriptive statistics and principal component values for herd characteristics and management

Descriptive statistics			Rotated component matrix	
Variable	Mean (N=11)	S.D.	Component 1	Component 2
Distance milk sold (Km)	6.53	4.68	0.926	0.101
Hired labour, hrs/day	2.65	0.87	0.907	-0.169
Price of milk (Ksh)	20.09	0.43	0.705	-0.329
Own labour, hrs/day on herd management	3.90	0.69	0.507	-0.215
Number of animals bought	1.36	0.39	-0.027	0.905
Total Tropical Livestock Units	10.55	0.76	-0.296	0.645
Number of animals died	1.52	0.46	-0.785	0.461
Explanation of total variance for the first two principal components				
Initial Eigen values			3.622	1.159
Rate of Variance, %			51.7	16.6
Cumulative variance, %			51.7	68.3

Note: The variables are shown in the same lines together with their statistics and correlation coefficients with the components while the explanation of variance is shown below the respective components.

5.3.3 Principal component analysis by individual cattle characteristics and management

Options for increasing livestock productivity include improvements in nutrition, disease control, management and breeding (Upton, 2000). The descriptive statistics and principal component values of the individual cattle characteristics and management variables are shown in Table 5.3. The components had high Eigen values, but contributed relatively low variance with both accounting for only 56.8% of total variance.

Both components are heavily weighted for several variables and this, together with the relatively low variance they contributed, shows that several variables should be looked at together to influence the good management of a herd. In order to have good milk production, farmers should combine good nutrition with disease control, breeding and management such as housing, cleaning, clean milk production and record keeping. In addition, instead of working hard merely cutting and carrying (fodder, crop residues and weeds), farmers should work smarter and try to increase feed productivity by conservation during the wet season when there is plenty; appropriate utilization such as chopping to minimize wastage; cost effective methods of feed production; introduction of other suitable feed crops such as fodder shrubs; and ration formulation to utilize various available ingredients. These methods have been recommended by Lanyasunya et al. (2006) for smallholder areas which suffer the constraint of inadequate land for forage production. The dominance of Napier grass (*Pennisetum purpureum)* in this study area as in other smallholder areas in the country especially central Kenya (Mwendia, 2007), has led farmers to neglect fodder shrubs such as Calliandra (*Calliandra calothyrsus*) and others with multiple benefits. Wambugu et al. (2006) have adequately discussed the advantages, types, properties, growing and utilization of the important fodder shrubs in East Africa.

Table 5.3: Descriptive statistics and principal component values for individual cattle characteristics and management

Descriptive statistics			Rotated component matrix	
Variable	Mean (N=11)	S. D.	Component 1	Component 2
Spray chemical Ksh	115.69	33.51	0.88	-0.101
Feed wasted Kg	6.36	1.59	0.852	0.006
No. of other animals fed together	1.92	0.34	0.798	0.184
Concentrates fed kg Total	3.02	2.80	0.795	0.025
Manure output Kg	11.47	1.15	0.762	0.354
Age of animal (years)	4.04	0.32	0.755	-0.471
Worm medicine Ksh	136.51	28.79	0.654	0.233
Total water offered Lts	23.62	4.08	0.549	0.132
Weight Estimate	249.30	25.13	-0.639	-0.188
Forage offered kg Total	117.95	14.61	0.125	0.908
Milk fed Lts	3.70	1.12	-0.346	0.406
Hrs own	2.82	0.67	-0.159	-0.94
Labour Ksh	138.84	95.58	0.259	0.39
Crop residues offered Total	21.62	5.67	0.039	0.385
Explanation of total variance for the first two principal components				
Initial Eigen values			5.41	2.548
Rate of Variance, %			38.6	18.2
Cumulative variance, %			38.6	56.8

Note: The variables are shown in the same lines together with their statistics and correlation coefficients with the components while the explanation of variance is shown below the respective components.

5.3.4 Principal component analysis by house – hold characteristics and income

The chosen household characteristics and livelihood variables and the explanation of total variance for the first two principal components are shown in Table 5.4. The first component has a high Eigen value (5.742) and alone explains for almost half of the variation. Together with the second, they account for 64% of the variation. The components are shown in rotated component matrix. Both components have several important variables and this again shows that household livelihoods are characterized by many factors, but the most important appear to be sales and total farm income with correlation coefficients of 0.97 and 0.906 respectively.

As seen in the participatory analysis and dynamic studies, in smallholder subsistence systems most product sales are made to meet small and frequent needs rather than for commerce. The primary driving force is food security and thereafter cash to meet other household expenses. This cash is not necessarily surplus as earlier shown in Chapter 4 (4.3.6). It is sometimes accumulated at the expense of consumption from various sources such as sale of live animals, milk, eggs, horticulture and other crop harvests that can be spared. This is supported by off-farm income and outside remittances, again not by choice or surplus, but of necessity because that support is really needed. Off-farm income can be classified into four categories, namely agricultural wage income, non-agricultural wage income, self-employment income, and other income; and agricultural wage income can be earned by working on other farms (Takane, 2007). Thus, for resource-poor mixed farmers, the balance sheet can be quite complicated and would need consideration of the roles of all incomes.

Table 5.4: Descriptive statistics and principal component values for house – hold characteristics and income

Descriptive statistics			Rotated component matrix	
Variable	**Mean (N=11)**	**S.D.**	**Component 1**	**Component 2**
Sales amount, kg or lts	13.68	4.46	0.97	-0.098
Total farm income	1012.32	458.33	0.906	-0.044
House-hold non-school children	2.24	0.64	0.861	-0.344
Sales value, Ksh	502.98	253.76	0.79	-0.26
Yield, kg or lts	16.95	4.77	0.648	-0.367
Age of house-hold head	48.48	2.29	0.585	-0.565
Consumption amount, kg or lts	5.48	6.27	0.352	0.208
Consumption value, Ksh	73.80	14.57	0.131	0.844
House-hold adults	3.36	0.21	0.011	0.812
House-hold school children	2.29	0.16	-0.366	0.685
Off-farm employment income	635.89	504.93	-0.523	0.657
House-hold members assisting in the farm	3.22	0.29	-0.3	0.492
Explanation of total variance for the first two principal components				
Initial Eigen values			5.742	1.995
Rate of Variance, %			47.9	16.6
Cumulative variance, %			47.9	64.5

Note: The variables are shown in the same lines together with their statistics and correlation coefficients with the components while the explanation of variance is shown below the respective components.

5.3.5 Principal component analysis by all the variables combined.

The analysis of all the variables from land and crop activities; herd characteristics and management; individual cattle characteristics and management and house – hold characteristics and income is shown in Table 5.5. From the many variables, a total of five principal components are derived accounting for 100% of the variation and carrying a different order of variables, positioned differently from the separate analyses.

The correlation coefficients of the variables with the principal components are much stronger than with the principal components in the separate analyses and the variances of these principal components are also much larger. The heavy weightings (strong correlation coefficients) are not in the first principal component alone, but are distributed in the first three. Out of all the variables, 50% originated from house – hold characteristics and income (Table 5.4) with most of them being about sales and income; 40% originated from individual cattle characteristics and management (Table 5.3); 10% from land and crop activities (Table 5.1); and none from herd characteristics and management (Table 5.2). All the variables were originally in a first principal component in their separate analyses.

These observations indicate that the variables retained their importance in a different order and strength of relationship among them. Household characteristics and income and cattle characteristics and management appear to be the most important variables to household livelihoods.

Table 5.5: Principal component values for all variables. All the five resulting principal components (PC) are shown with the first ten variables in order of importance, all of which have coefficient values greater than 0.8

No.	Rotated Component Matrix						Origin table	Origin PC	Origin value
		Component							
	Variable	1	2	3	4	5			
1	Output sales value, Ksh	0.951	0.079	-0.283	-0.079	-0.055	5.4	1	0.79
2	Output sales amount, kg or lts	0.948	-0.042	-0.177	-0.176	-0.19	5.4	1	0.97
3	Total farm income	0.935	-0.14	-0.304	-0.112	0.034	5.4	1	0.906
4	Number of other animals fed together	0.925	-0.03	0.259	-0.249	-0.119	5.3	1	0.798
5	Household non-school children	0.885	-0.137	-0.411	0.155	-0.073	5.4	1	0.861
6	Consumption amount, kg or lts	-0.123	0.987	0.102	0.01	0.014	5.4	1	0.352
7	Cattle weight estimate, kg	0.162	0.938	0.277	-0.049	-0.122	5.3	1	-0.639
8	Output items value	-0.165	0.05	0.977	0.029	-0.122	5.1	1	-0.623
9	Water offered, lts Total	0.083	0.036	0.963	-0.243	-0.079	5.3	1	0.549
10	Concentrates fed, kg Total	-0.215	0.158	0.957	0.018	-0.11	5.3	1	0.795
Explanation of total variance for all the five resulting principal components									
Initial Eigen values		18.411	14.526	7.275	6.575	5.212			
Rate of Variance %		35.406	27.936	13.991	12.645	10.023			
Cumulative variance %		10.023	63.341	63.341	89.977	100			

Note: The variables are shown in the same lines with their correlation coefficients with the new components and their original position and values. The explanation of variance is shown below the respective components. The descriptive statistics are not shown as they have been considered in earlier tables.

5.4 Conclusion

This analysis shows that the major factors influencing the farming activities, performance and interactions of the farming system in this area are labour; cost of inputs; price of milk and marketing distance; and entries and exists from the herd. Overall, farm output, sales and income are the most important factors followed by cattle characteristics and management (feeding and numbers). All these factors indicate the points of intervention to be given priority by the farmers and any assisting development agencies.

References

International Livestock Research Institute (ILRI), 2006. Lessons from a changing world: Implications for livestock research and development. In Birthal P. S., Taneja V. K., and Thorpe W. (Editors), 2006. Smallholder Livestock production in India: Opportunities and Challenges. Proceedings (14) of an ICAR-ILRI international workshop. pp 66.

Jaetzold R. and Schmidt H., 1983. Farm Management Handbook of Kenya, Vol. 11- Natural Conditions and Farm Management Information, Part C, East Kenya (Eastern and Coast Provinces), Ministry of Agriculture, Kenya. Pp 247, 252, 267

Jaleta M., Gebremedhin B. and Hoekstra D., 2009. Smallholder commercialization: Processes, determinants and impact. ILRI Discussion paper No. 18. pp 1.

Lanyasunya T. P., Rong W. H., Mukisira E. A. and Abdulrazak S. A., 2006. Performance of Dairy Cows in Different Livestock Production Systems on Smallholder Farms in Bahati Division, Nakuru District, Kenya. pp 133,134.

Mead R., Curnow R. N. and Hasted A. M. 2003. Statistical Methods in Agriculture and Experimental Biology 3rd Edition. Chapman & Hall/CRC, Washington, USA. pp 403.

Ministry of Finance and Planning 2001: Taita Taveta District Poverty Reduction Strategy Paper, Consultation Report for the Period 2001 – 2004. pp 6.

Moll H. A. J., Staal S. J. and Ibrahim M. N. M., 2007. Smallholder dairy production and markets: A comparison of production systems in Zambia, Kenya and Sri Lanka. Agricultural Systems 94 (2007) 593–603. pp 601.

Mwendia S. W., 2007. Impact of Head Smut Disease (*Ustilago kameruniensis*) on Napier Grass Yields in Smallholder Dairy Production Systems. MSc Thesis, University of Nairobi.

The National Economic and Social Council of Kenya, 2007. Kenya vision 2030; New long Term National Planning Strategy. pp 6.

Quijandria B., 1994. Minimum data required for characterizing systems. In Ruiz M. E. (Comp.), 1994.Animal Production Systems Research, Methodological and Analytical Guidelines, Inter-American Institute for Cooperation on Agriculture, Costa Rica. pp 55 - 61.

Quiroz R. A., Ame´zquita M. C., Guerra P. and Quiel J., 1994. Using Information Generated in Animal Production Systems Research. In Ruiz M. E. (Comp.), 1994. Animal Production Systems Research, Methodological and Analytical Guidelines, Inter-American Institute for Cooperation on Agriculture, Costa Rica. pp154.

Sabates-Wheeler R., Devereux S. and Guenther B., 2008. Social Protection for the Poorest in Africa: Learning from Experience, Building synergies between social protection and smallholder policies. Institute of Development Studies, Sussex, UK. pp 1.

Sansoucy R., 1994. Livestock, a driving force for food security and sustainable development. FAO Agriculture and Consumer Protection. FAO Corporate Document Repository. pp 4.

Staal S J., Chege L., Kenyanjui M., Kimari A., Lukuyu B., Njubi D., Owango M., Tanner J., Thorpe W. and Wambugu M., 1997. Characterization of Dairy Systems Supplying the Nairobi Milk Market. A Pilot Survey in Kiambu District for the Identification of Target Groups of Producers. Kenya Agricultural Research Institute, Nairobi; International Livestock Research Institute, Nairobi; Livestock Production Department, P.O. Box 728 Kiambu. pp 32.

Staal S. J., Waithaka M., Njoroge L., Mwangi D. M., Njubi D. and Wokabi A., 2003. Costs of milk production in Kenya: Estimates from Kiambu, Nakuru and Nyandarua districts. SDP Research and Development Report No. 1. Smallholder Dairy Project, MoLFD, KARI, ILRI, DFID. pp 9.

Steinfeld H. and Mack S., 1995. Livestock Development Strategies. FAO Agriculture and Consumer Protection. FAO Corporate Document Repository. pp 2.

Takane T., 2007. Gambling with liberalization: Smallholder livelihoods in contemporary rural Malawi. Institute of Developing Economies, Japan.

The National Economic and Social Council of Kenya, 2007. Kenya vision 2030; New long Term National Planning Strategy. pp 6.

Wambugu C., Franzel S., Cordero J. and Stewart J., (2006). Fodder shrubs for dairy farmers in East Africa: making extension decisions and putting them into practice. World Agro-forestry Center, Nairobi, Kenya; Oxford Forestry Institute, Oxford, U.K.

Upton M., 2000. The 'Livestock Revolution' – Implications for Smallholder Agriculture: A Case Study of Milk and Poultry Production in Kenya, Food and Agriculture Organization. pp 4.

Chapter 6 General discussion, conclusions and recommendations

6.1 General discussion

The characteristics of the study area and the resources show that the area has most of the necessary bio-physical components of high potential dairy and horticulture production and this was also earlier recognized by Jaetzold and Schmidt (1983). As in other smallholder areas especially central Kenya (Omore et al., 1999), dairy is the most important livestock enterprise. The mean livestock numbers per family are small, but the cattle herd structure has adequate stock for potential production and replacement. Farm sizes are also small, but apart from seasonality of rainfall and moderate disease and pest occurrence, there are no major exogenous shocks to crops or livestock. There is adequate labour consisting of family members and hired labour as seen in other smallholder areas in Kenya (Omore et al., 1999). The farmers' objectives are subsistence oriented, but with a strong aspiration for commercialization. However, in terms of wealth assessment, the community would be categorized as between poor and transient.

Since in livestock production, the overriding considerations are the availability and efficient use of local natural resources (Sansoucy, 1994), this community can be said to have the potential to be self sustaining as they own land capable of producing a variety of feed resources such as Napier grass, fodder shrubs, crop residues and weed mixtures. There is a high proportion of stall-fed cattle which allows the spatial integration of livestock and crops even where space is limited (Bayer and Waters-Bayer, 1998) and family labour resources are mostly allocated on dairy activities. Thus, interventions on livestock production are likely to be of great assistance to the households and more effort and technology are needed in this subsector.

The study observed the use of livestock in the community for food, income, employment generation, risk stabilization, insurance and capital accumulation, soil nutrient recycling, weed control, utilization of crop residues and waste, and soil conditioning with manure. Napier grass is also planted along farm contours to prevent soil erosion which is reported to result in crop productivity losses as high as 2 – 3 % per year in the East African highlands as well as downstream effects e.g. siltation of reservoirs (The World Bank, 2008). The community does not use animals for draft power because of the hilly terrain. Farm activities are dictated by rainfall patterns, water is sourced from small streams and there is little irrigation of crops and fodder. Thus, there is inadequacy of forage in the dry season, crop outputs are not continuous and stocks get depleted before the next harvest and there is seasonal under-employment and hunger (Ministry of Finance and Planning, 2001, a, b; Kenya Food Security Steering Group (KFSSG), 2008).

With the land limited and the population growing at a rate of 1.74% (Ministry of Finance and Planning, 2001, a) survival can be compromised if farm production is not optimized and off-farm income opportunities are not available as observed by The World Bank (2008) for developing countries in general. There is, therefore, need for intensification and optimization of resource use especially land, water, labour, livestock and crops. Availability and utilization of water can be improved by rainwater harvesting and storage, more farm terracing and avoidance of encroachment on water catchment areas. Land, labour, livestock and crop resources can be optimized by better use of inputs such as fertilizer, manure, breeding and feeding. Some of the issues and proposed solutions to the poverty problem have been identified and documented in the District Poverty Reduction Strategy Paper (PRSP) Consultation Report (Ministry of Finance and Planning, 2001, b) and they only require implementation and empowerment by provision of adequate extension and follow-up. However, shortage of extension service providers has been shown to have an influence on farmers' knowledge and practice of dairy technologies (Wambugu, 2001). This too needs intervention by the farmers, the Government and Development partners.

Active farm area, labour allocation, yields and sales, farm income and profits, showed similar trends in their variation over time meaning they were positively correlated. However, both the value of inputs and value of outputs were low which means that the returns were not great. Farm produce sales were made to meet small frequent cash requirements and larger needs once in a while rather than for commerce. Thus, the farmers worked most of the time, but made money only some of the time and income from outside remittances was larger than income from farm and off-farm employment for most of the year. As a result, farmers have adopted low risk activities because risk preference is determined by asset and income levels – risk rationing (The World Bank, 2008). The farmers create capital by foregoing consumption (Beardshaw et al. 2001) only, rather than by also saving from surplus. Consequently, apart from the low value inputs there is no other investment because farmers live off their land, literally land to mouth, and there is inability or unwillingness to pay for expensive services such as cattle Artificial Insemination.

Farm output, sales and income and cattle characteristics and management were the most important factors influencing the activities, performance and interactions of the system. These, together with the major constraints identified, need both internal and external interventions. The opportunities identified include working harder; taking farm development loans; planting fodder crops and forage preservation; better animal health with vaccination and tick control; improved breeding with training on the importance of cattle Artificial

Insemination (A.I.) or improved bull camps; forming milk associations and cooperatives; and having milk cooling facilities to enable value addition and tapping of external markets. Internally, farmers need to adopt a commercialization approach and relevant production technologies and optimize their resources, including better manure management; introduction of high-value horticulture and cash crops such as indigenous vegetables and tissue culture bananas; feed conservation and introduction of multi-purpose fodder shrubs; better management of the indigenous chicken; and introduction of dairy goats, improved sheep and fish farming. This integration and diversification will result in optimum utilization of land and labour and stabilize farm income and furthermore the additional animals use different feed resources and offer little or no competition to cattle. The Government and other external assistance should include interventions to address the constraints such as shortage of extension staff, inadequate and expensive animal health and breeding services and marketing.

As seen in a study in Nakuru by Moll et al. (2007), the potential for dairy intensification with high levels of inputs and outputs in this area is high as there is the combination of low opportunity cost for labour, scarcity of land and good markets together with population increase and urbanization. International Livestock Research Institute (ILRI) (2006) and Moll et al. (2007) observed that the availability and values of production factors interact with the smallholders' choices for production technologies and market forces to characterize the farming system. Staal et al. (2003) concluded from their studies in Kiambu, Nakuru and Nyandarua districts, that smallholder dairy farmers can become and continue being competitive if given the necessary public policy support. This includes favorable policies, research, adequate extension, training and information technology and marketing.

The World Bank recognizes that agriculture is a vital development tool for achieving the Millennium Development Goal of halving the number of people suffering from extreme poverty and hunger by 2015 and recommends that accelerated agricultural productivity growth requires a sharp productivity increase in smallholder farming combined with more effective support to subsistence farmers (The World Bank, 2008). The Government of Kenya Vision 2030 has earmarked increased productivity of crops and livestock as one of the strategies to increase value in the Agricultural sector which is one of six key sectors given priority to act as growth drivers (The National Economic and Social Council of Kenya (NESC), 2007).

The social need of seasonal under-employment and hunger also needs to be addressed and since this community cannot be categorized as poor, it needs different social protection interventions such as micro-credit, food for work and cash for work. Productive assets can produce future income, so asset transfers could reduce poverty more sustainably than food or cash transfers (Sabates-Wheeler et al., 2008). Heifer Project International is one project which gave dairy cows to some farmers in this area in 2002 (Heifer Project International, 2009). Such projects should be encouraged, but they should give diverse assets e.g. tools, seeds, fertilizer, dairy goats, improved sheep and fish ponds so as not to flood the local economy with the same produce and affect prices (Sabates-Wheeler et al., 2008). They should also include capacity building such as 'farmer field schools' (The World Bank, 2008) which have been done by Coast Development Authority in some areas of the Coast Province (Coast Development Authority, 2009).

Collective action through farmer organizations can be used to empower smallholder livestock producers with limited resources and improve their bargaining power for information, credit and markets (ILRI, 2006). The Taita-Taveta Dairy Cooperative Society, which collapsed in 2005 due to mismanagement, and the Taita Horticultural Produce Cooperative Society, which is operating at a very low level for similar reasons (District Cooperative officer, 2009), if revived and fully operative would play a very important role in marketing and boosting farm incomes. Otherwise, less formal forms of farmer groups, such as self-help groups, which are smaller and control fewer resources, could play an important role as they are less likely to be targeted by politically powerful interests, and are also better adapted to linking directly to the traditional market (Staal et al., undated). As discussed by Ruthenberg (1980) the farm is also an independent unit of economic activity. Savings and investment would, therefore, also play a big role in acquiring assets and more inputs and have an impact on increased production.

6.2 Conclusions

- The farmers' objectives and area resources have the potential to support their food security and have a surplus for commerce, but they are unable to do so because of the constraints mainly in technology, capital and markets.
- Relevant institutional and technological support was available before the Structural Adjustment Programs, but these have mostly collapsed or are inadequate.
- With the right approach and necessary assistance the constraints can be surmounted and the identified opportunities exploited.

6.3 Recommendations

- The farmers need to adopt a commercialization approach and relevant production technologies to optimize their resources and stabilize their incomes.

- The Government and Development partners should undertake interventions to address the constraints and at the same time provide social protection measures when needed.

6.4 Scope for further work

- A study should be carried out to explore the causes of the decline in use of Artificial Insemination services in the country and how to boost the uptake of the private services.
- Farming system studies in such communities should be combined with a socio-economic component in order to comprehensively look at all the stages in the economic cycle of production, income, expenditure, savings and investment.

References

Bayer W. and Waters-Bayer A., 1998. Forage Husbandry. The Tropical Agriculturist. CTA, Macmillan, GTZ. pp 14.

Beardshaw J., Brewster D., Cormack P.and Ross A., 2001. Economics, A Student's Guide. Pearson Education Limited, Essex, England. pp 31.

Coast Development Authority, 2009. Personal Communication with Mr Mcharo, September 2009.

District Cooperative officer, 2009. Personal Communication with Mr Alwale, August 2009.

Heifer Project International, 2009. Personal Communication with Mr Mwatate, September 2009.

International Livestock Research Institute, 2006. Lessons from a changing world: Implications for livestock research and development. In Birthal P. S., Taneja V. K. and Thorpe W. (Editors), 2006. Smallholder Livestock production in India: Opportunities and Challenges. Proceedings (14) of an ICAR-ILRI international workshop. pp 66, 96.

Jaetzold R. and Schmidt H., 1983. Farm Management Handbook of Kenya, Vol. 11- Natural Conditions and Farm Management Information, Part C, East Kenya (Eastern and Coast Provinces), Ministry of Agriculture, Kenya.

Kenya Food Security Steering Group, 2008. Taita Taveta District Report, Long Rains Food Security Assessment, July 2008. Ministry of Water and Irrigation, Ministry of Agriculture, World Food Program.

Ministry of Finance and Planning, 2001, a. Taita Taveta District Development Plan 2002 – 2008. pp 8, 21.

Ministry of Finance and Planning, 2001, b. Taita Taveta District Poverty Reduction Strategy Paper, Consultation Report for the Period 2001 – 2004. pp 14, 23.

Moll H. A. J., Staal S. J. and Ibrahim M. N. M., 2007. Smallholder dairy production and markets: A comparison of production systems in Zambia, Kenya and Sri Lanka. Agricultural Systems 94 (2007) 593-603, pp 600, 601.

Omore A. O., McDermott J. J., Muriuki H. M. and Thorpe W., 1999. Smallholder Dairy Herd Management in Kenya. pp 1.

Ruthenberg H., 1980. Farming Systems in the Tropics. 3rd Ed. Clarendon Press, Oxford. pp 2.

Sabates-Wheeler R., Devereux S. and Guenther B., 2008. Social Protection for the Poorest in Africa: Learning from Experience, Building synergies between social protection and smallholder policies. Institute of Development Studies, Sussex, UK.

Sansoucy R., 1994. Livestock, a driving force for food security and sustainable development. FAO Agriculture and Consumer Protection. pp 5.

Staal S. J., Nin Pratt A. and Jabbar M., (undated). A Comparison of Dairy Policies and Development in South Asia and East Africa. Part 2: Country Case Studies from South

Asia and East Africa – Kenya, Ethiopia, Pakistan and India, and Final Synthesis. ILRI. pp 90.

Staal S. J., Waithaka M., Njoroge L., Mwangi D. M., Njubi D. and Wokabi A., 2003. Costs of milk production in Kenya: Estimates from Kiambu, Nakuru and Nyandarua districts. SDP Research and Development Report No. 1. Smallholder Dairy Project, MoLFD, KARI, ILRI, DFID. pp 25.

The National Economic and Social Council of Kenya, 2007. Kenya vision 2030; New long Term National Planning Strategy. pp 6.

The World Bank, 2008. World Development Report 2008; Agriculture for Development, an Overview. pp v, 13, 16.

Wambugu M. N., 2001. Extension and its effect on dairy cattle nutrition and productivity in smallholder dairy enterprises in Kiambu District. MSc Thesis, University of Nairobi. pp 73.

Appendices

A1. Baseline survey questionnaire

DATE....................

NAME OF ENUMERATOR---

1. Farmer identification

Date of interview	
Farmer number	
Farmer name(Who makes decisions on farming activities)	
District	
Division	
Location	
Sub-location	
Division	

2. Characteristics of the farmer

Gender (a)	
Age (In years)	
Education level (b)	
Off-farm employment (c)	

Codes:

(a) Gender (1=Female; 2=Male)

(b) Educational level (1=Not Ed; 2=Primary; 3=Secondary; 4=Post secondary; 5=Adult education)

(c) Off-farm employment (1=yes, 2=no)

3. Family members staying in the farm

Variable	Number	Number in school	Number assisting in the farm	Number with off-farm activities
Girls 0-10 yrs				
Boys 0-10 yrs				
Girls 11-15 yrs				
Boys 11-15 yrs				
Women 16-60 yrs				
Men 16-60 yrs				
Women >60 yrs				
Men >60 yrs				

4. **Farmer Livestock awareness**

Kind of Training	**Main information received**
Formal training	
Seminars and workshops	
Government extension visits	
NGO visits	
Visits by researchers	
Tours and visits by farmer	
Radio/Television program	
Membership and activities in any group	
Neighbours	
Experience	

5. Characteristics of the area

Ecological zone--

Terrain/Topography---

Periods of rainfall, months by name,

Short rains -- Long rains-------

Amounts of rainfall,

Short rains, Adequate ( ) Inadequate ( ) Not Predictable ( )

Long rains, Adequate ( ) Inadequate ( ) Not Predictable ( )

6. Characteristics of the farm

	Area, acres	Percentage	Reasons if any
Total farm size		100%	
Area devoted to homestead			
Area devoted to livestock shed			
Area for other farm structures			
Area for food crops			
Area for forage crops			

7. Details of food crops and utilization

Crop	Acres short rains	Acres long rains	Production in normal year total (bags)	% home consumption	% surplus for sale	% surplus or residue for livestock feed

8. Details of forage crops and utilization

Forage crops on own farm, acreage per crop and utilization

Forage crop name	Acreage	%Own use	%Surplus for sale

Source of planting material: Own ( ) Neighbours ( )

Both ( ) Others, specify ( )……………..

9. Water sources and utilization

Source	Home consumption	Livestock consumption	Forage irrigation	Crop irrigation
Rainfall				
Rivers				
Borehole				
Shallow well				
Pipe				
Streams				

10. Feeds and other inputs sources and utilization

Cattle

	Own	Local free	Local bought	Far free	Far bought	Specify if stall fed	Specify if grazed	Amount fed per day
Forage feed								
Water								
Supplements								
Other inputs								

Small stock

	Own	Local free	Local bought	Far free	Far bought	Specify if stall fed	Specify if grazed	Amount fed per day
Forage feed								
Water								
Supplements								
Other inputs								

Names of natural grasses and fodder trees in grazing land

Natural grass species	Natural fodder trees

Use of crop residues to feed livestock: Insert crop, tick answer yes or no and insert source and reason whether deliberate planned or surplus

Crop/answer	Yes	No	Own	Out free	Out bought	Reason

Use of manure on farm:

Use/For what	Crops	Forage	Bio-gas In place	Bio-gas aware	Surplus manure for sale
Yes					
No					
Own manure					
Out free					
Out bought					

11. Number of service providers in available distance

Service/distance	0 (own)	< 1km	1-5 km	>5 km	Not easily available
Animal health technician					
Extension officer					
Inseminator					
Agro-Vet shops					
Structures e.g. dip, crush					
Watering trough					
Sale yard					
Spray pumps					

12. Livestock count and production systems. Specify species and breeds and insert information ***(All livestock including poultry).***

SPECIES	BREEDS	NUMBERS	PRODUCTION SYSTEM

Key to types of production systems

1. Intensive
2. Semi- intensive
3. Extensive planned e.g. paddocking
4. Extensive random

Is the herd/ flock structured into ages, production or reproduction groups e.g. cows in milk, heifers, steers, kids, chicks?

Specify structure

Herd/ Flock				
Dairy cattle				
Beef/Zebu				
Sheep/goats				
Poultry				

13. Production of livestock kept

Live livestock sold per year:

- Bulls.........
- Heifers......
- Mature cows.........
- Extra calves.........
- Steers.........
- Rams/bucks.................
- Female sheep/goats.................
- Local Chicken-------
- Broilers-------
- Ex-layer chicken-------
- Local chicken eggs---------
- Layer chicken eggs—

- Milk per day in liters and Ghee per month in kilograms, production and sales

	Milk production per day	Milk sales	Milk home consumption	Ghee production per month	Ghee sales	Ghee home consumption
Dairy cattle						
Beef/Zebu cattle						
Dairy goats						

14. Land use and production trends and reasons

Variable/Trend	Increasing	Decreasing	Stable	Main reason
Livestock production				
Livestock numbers				
Use of manure				
Use of crop residues				
Amount of natural pasture				
use of grown forage				
Acreage of forage				
Acreage of food crops				
Production of food crops				

Reasons, codes

1. Land size
2. Rainfall
3. Inputs
4. Type/breeds
5. Expenses
6. Market
7. Other, specify

15. **Breeding and reproduction**

Methods of livestock breeding used in different species, specify species and tick method

Method/species					
Mating within herd					
Out-sourced males					
Artificial Insemination					
Any form of selection used? Specify					

Calving/Kidding interval and reasons. Tick one and give reason

Species/ months	12-14	15-18	19 and above	Season, specify	Other, specify	Main reason
Dairy cattle						
Beef/Zebu cattle						
Small stock						

16. Housing and management

Housing for all livestock:

Species/housing	Breed	Housed	Not Housed	Reason

15. **Breeding and reproduction**

Methods of livestock breeding used in different species, specify species and tick method

Method/species					
Mating within herd					
Out-sourced males					
Artificial Insemination					
Any form of selection used? Specify					

Calving/Kidding interval and reasons. Tick one and give reason

Species/ months	12-14	15-18	19 and above	Season, specify	Other, specify	Main reason
Dairy cattle						
Beef/Zebu cattle						
Small stock						

16. Housing and management

Housing for all livestock:

Species/housing	Breed	Housed	Not Housed	Reason

Calf management:

Feeding colostrum, Yes ( ) No ( )

If yes specify amount per day, Lts------------

Feeding milk, Yes ( ) No ( )

If yes specify amount per day, Lts------------

Weaning age:

Species/age, months	Breed	4-5	6-7	8-9	Other
Cattle	Dairy				
	Beef/Zebu				
Dairy goats					

Milking management:

Hygiene, know ( ) specify, what ---------------------------------- don't know ( ) specify, what-----------------------------------

Mastitis control, know ( ) specify, what----------------------------------

don't know ( ) specify, what ---------------------------------

Drying period, know ( ) specify, how long------------------------------ don't know ( ) specify, what-----------------------------------**Milk withholding period after antibiotic treatment:**

Know ( ), don't know ( )

If yes, Specify: 0 days ( ) 1 day ( ) 2days ( ) 3days ( )

4 days ( )

Record keeping: Know ( ) don't know ( )

If yes, specify type of records kept:

....

....---

Animal welfare awareness

Awareness of specific animal welfare issues:

Freedom from thirst, hunger and malnutrition; Yes ( ) No ( )

Freedom from discomfort; Yes ( ) No ( )

Freedom from pain, injury and disease; Yes ( ) No ( )

Freedom to express normal behaviour; Yes ( ) No ( )

Freedom from fear and distress; Yes ( ) No ( )

17. Negative factors affecting livestock production and health

Drought, Yes ( ) No ( ) Feeds, Yes ( ) No ( )

Inputs, Yes ( ) No ( ) Diseases, Yes ( ) No ( )

Extension staff numbers, Yes ( ) No ( ) Labour, Yes ( ) No ( ) Land, Yes ( ) No ( )

Capital, Yes ( ) No ( )

Theft, Yes ( ) No ( ) Predators, Yes ( ) No ( ) Market, Yes ( ) No ( )

Infrastructure, Yes ( ) No ( ) Others, specify Yes ( ) No ( ) ---------------------------
----

Ranking of the factors ticked *'yes'* with most affecting as number one

1. -------------------------------------- 11. ------------------------------------

2. -------------------------------------- 12. ------------------------------------

3. -------------------------------------- 13. ------------------------------------

4. -------------------------------------- 14. ------------------------------------

5. --------------------------------------

6. --------------------------------------

7. --------------------------------------
8. --------------------------------------

9. --------------------------------------

10. ------------------------------------

18. Disease and pest control

Most common livestock diseases, ***ranked by prevalence***

- ---
- ---
- ---
- ---
- ---

Livestock diseases experienced in the last 12 months, ***ranked by economic importance***

- ....
- ....
- ....
- ....

Young stock mortalities/dead in the last 3 years: 0 ( ) 1( )

2 ( ) 3 ( ) other, ( ) specify...............................

Mature stock mortalities/dead in the last 3 years: 0 ( ) 1( )

2 ( ) 3 ( ) other, ( ) specify...............................

Animal health measures: Preventive, Yes ( ) No ( )

Prophylactic treatment, Yes ( ) No ( )

Case treatment, Yes ( ) No ( )

Specify the main measures undertaken e.g. de-worming etc--

END

A2. Dynamic study data collection sheets Number of period of study (1 – 22) -------

A) Land and Crops activities recording Name of recorder-------------------------------------

Date of recording: ------------- Name of Farmer: ---

Period of study: -------to------ Village: --

Total farm acreage (acres): ---------- [Approximations: 0.25 acres =100x100ft, 1 acre =200x200ft, 1 acre = 70x70 yards]

Measurements recording for the 2 weeks period total

Plot identity by activity	**and area (acres)**	**Av. Time hrs/day** Hired	Own	**Input item**	**Item cost**	**Output item**	**Item value**
----------------------------	----------	--------	--------	-------------	----------	--------------	-------------
----------------------------	----------	--------	--------	-------------	----------	--------------	-------------
----------------------------	----------	--------	--------	-------------	----------	--------------	-------------
----------------------------	----------	--------	--------	-------------	----------	--------------	-------------
----------------------------	----------	--------	--------	-------------	----------	--------------	-------------
----------------------------	----------	--------	--------	-------------	----------	--------------	-------------
Maize, beans, napier, tomatoes, etc				Preparation, planting, manure, compost, seeds, weeding, fertilizer, pesticides, harvesting, labour, major investment e.g. loan, farmer training, farmer tour etc		Harvest Kg, etc	

Remarks--

B) Herd recording

Name of recorder--

Date of recording: -------------
Period of study: -------to------

Name of Farmer: --
Village: ---

Measurements recording for the 2 weeks period total

Cattle management characteristics	Cattle herd characteristics	Number of other animals
Housing, Yes/No -------	Total number of cattle -------	Sheep -------
Stall feeding, Yes/No -------	Number of bulls -------	Goats -------
Water trough, Yes/No -------	Number of cows in milk -------	Chicken -------
Water bucket, Yes/No -------	Number of dry cows -------	Ducks -------
Chaff cutter, Yes/No -------	No. of heifers (weaning-bulling) -------	Rabbits -------
Hand cutting, Yes/No -------	Number of calves -------	No. other animals sold------Ksh------Specify-----
Own spray, Yes/No -------	Number of cows pregnant -------	No. all animals slaughtered -------Specify-------
Own labour, Yes/No -------	Number of calves born -------	Number of calves weaned -------
Employed labour, Yes/No -------	Number of animals sold -------	Price of Milk -------
Daily hired labour, Yes/No -------	Number of animals bought -------	Distance milk sold -------
Own labour, hours-------	Number of animals died -------	Milk delivery: Self/collected -------
Hired labour, hours-------	Number of calves aborted -------	

Remarks---

C) Individual dairy cattle recording

Name of recorder---

Date of recording: -------------
Period of study: -------to------

Name of Farmer: ---
Village: --

Animal Identity: -------------------- Breed type: ------- Sex: ------- Age: ------- Number of other animals fed together: -------

Condition		Inputs		Outputs	
Weight Estimate	-------	Forage offered, Kg/day, ---- specify type ------		Milk production, Lts	-------
Body score	-------	Concentrates fed, Kg/day, ---- specify type ------		Calves born	-------
Fertility status	-------	Crop residues offered, Kg/day ---- specify type ------		Animals sold, Ksh	-------
Healthy	-------	Water offered, Lts	----, ----, ----, ----, total----	Bull service, Ksh	-------
Sick	-------	Milk fed, Lts	----, ----, ----, ----, total----	Growth, Kg	-------
		Bull bred, Ksh	-------	Feed wasted, Kg	-------
Injured	-------	A.I. bred, Ksh	-------	Manure, Kg	-------
		Labour, Ksh	------- Hrs own------Hrs hired-------	Calves aborted	-------
		Own treatment, Ksh	-------	Calves weaned	-------
Slaughtered	-------	LHA treatment, Ksh	-------		
Dead	-------	Extension visit, Yes/No-------			
Sold	-------	Inseminator visit, Y/N-------			
		Farmer visit to livestock office Y/N-------			
		Spray chemical, Ksh	-------		
		Worm medicine, Ksh	-------		
		Other procedures, Ksh-------, specify-------			
		Other input, Ksh	-------, specify ------- e.g. loan, farmer training		

Remarks--

Fertility status = Pregnant, Empty, on heat, Problematic. **Body score** = Good, Fair, Poor Other **procedures** = dehorning, castration etc.

D) House – Hold recording Name of recorder-------------------------------------

Date of recording: -------------Name of respondent: --------------------------------------Name of H/H head if not the same..........................
Period of study: -------to------ Village: --

Gender, M/F: ------- Age: ------- Education level, (None, Pri, Sec, Post Sec.): ------- Off farm employment, Yes/No: -------

Family members in the farm: Adults ------- School children ------- Non- school children ------- No. of all assisting in the farm -------

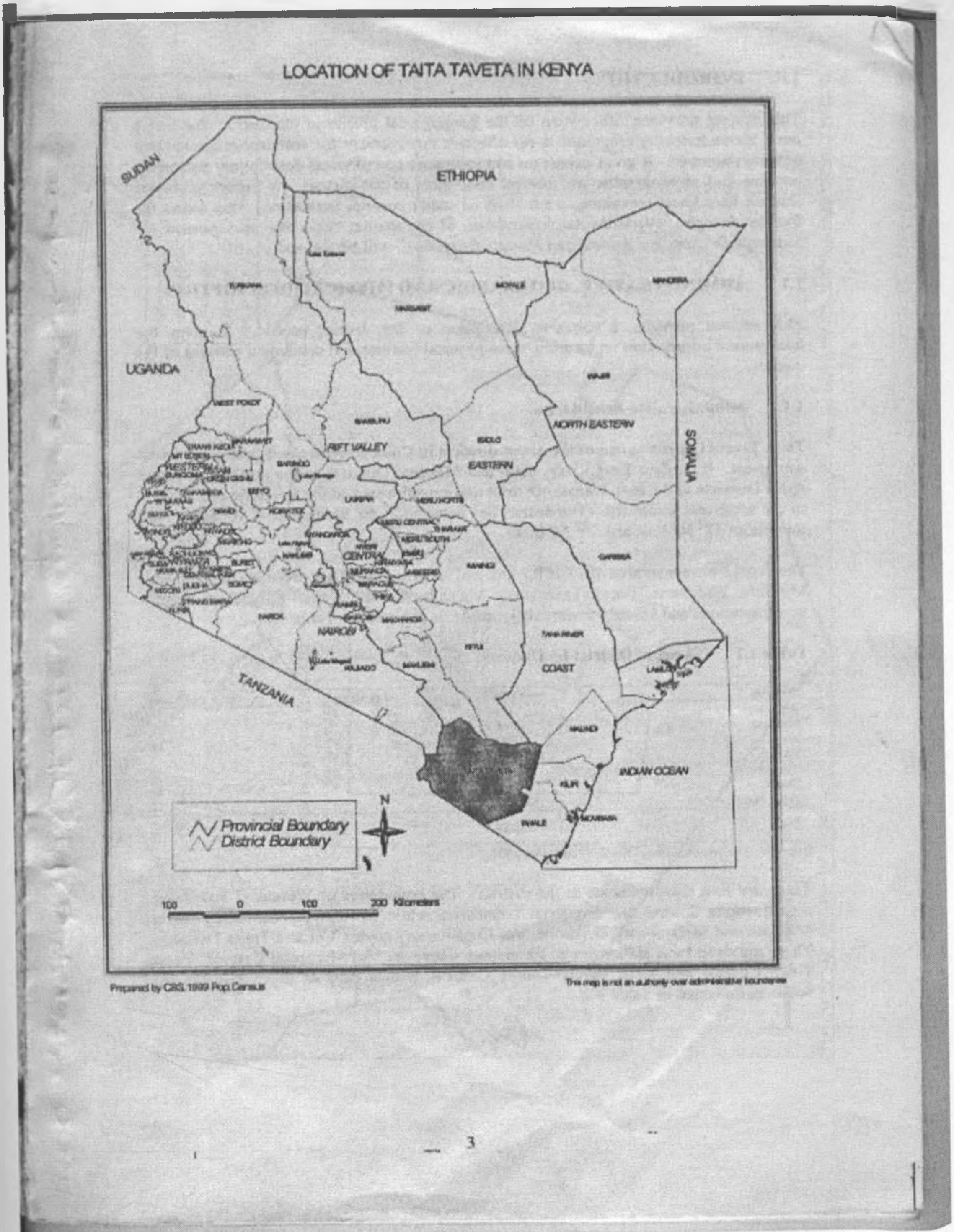
Main reasons (objectives) for this mixed farming: 1) -----------------------------2) ------------------------------3) --------------------------

Measurements recording for the 2 weeks period total

Crop and livestock products utilization [<u>Important:</u> If purchased from off-farm begin recording from consumption]

Item	Yield, Kg/Lts.	Sales amount, Kg/Lts.	Sales value, Ksh.	Consumption amount, Kg/Lts.	Consumption value, Ksh
E.g. Milk	-------	-------	-------	Tea------- Children-------	-------
-------	-------	-------	-------	-------	-------
-------	-------	-------	-------	-------	-------
-------	-------	-------	-------	-------	-------
-------	-------	-------	-------	-------	-------
-------	-------	-------	-------	-------	-------
		Total farm income	-------	Total	-------
		Off-farm employment income	-------		
		Outside remittances income	-------		

A3. Map of Kenya showing location of Taita Taveta District



A4. Map of Taita Taveta showing administrative boundaries