AN ECONOMIC ANALYSIS OF EFFECTS OF RISK MANAGEMENT STRATEGIES ON DAIRYING IN SMALLHOLDER FARMS IN KIAMBU DISTRICT, KENYA

BY

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DECLARATION

This thesis is my original work and has not been already submitted for any degree and is not currently being submitted for any other degree or qualification in this or any other University.

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DEDICATION

This thesis is dedicated to my parents, Mr Kaguongo Wagura Kabari and Mrs. Cecilia Nyaguthii Kabari, who tirelessly looked after me with commitment throughout my entire school life. It is also dedicated to my wife, Mrs Gladys Wanjiru Wachira, daughter Vera Nyaguthii and son Collins Taiti for their patience and understanding throughout the study.

ABSTRACT

This study investigated the risks facing the smallholder dairy farmers and examined how income sources and risk management strategies used by the farmers affect the dairy enterprise. The study was carried out in Limuru Division, Kiambu District using both primary and secondary data obtained from 35 farmers and the Division's offices of Ministry of Agriculture, Livestock and Development and Marketing The data collected were analyzed using both descriptive analysis and simulations using TIES (Technology Impact Evaluation System) The results of the study indicated that.

(i) risk management strategies used by farmers interfere with intensification of dairying These strategies included.

- matching, where a farm produced much of the food it consumes reducing household exposure to market risk,
- input parsimony, where a household reduced fluctuations in net income by restricting the use of inputs,
- diversification, where a household expected income is stabilized by diversifying income sources and ensuring the incomes do not all vary in the same direction and at the same time,

(ii) sources of incomes, such as off-farm incomes, that increase and stabilize household income tend to facilitate intensification of dairying, households with higher and more stable incomes intensify dairying, with high concentrate feeding and health services;

(iii) intensification of dairying which involves increased concentrate feeding and health services leads to higher but less stable and more risky incomes which are less preferred by farmers, and

(v) cash flow problems and risk posed by available credit is a major constraint in most farm economies and adoption of dairy technologies

The following recommendations arise from the results of this study

(i) The implicit risk associated with dairy intensification (increased concentrate feeding and animal health services) should be reduced to enhance the adoption of the dairy technology This may be achieved through development of a competitive dairy sector which ensures a potentially high and relatively more stable milk prices by encouraging more processors, distributors and retailers in the sector.

(ii) Infrastructure such as roads should be improved to enable easy transportation of milk throughout the year This would also enhance farmers' accessibility to agricultural inputs (such as concentrates and fertilizer) throughout the year reducing their seasonal price fluctuations caused by poor or lack of roads.

(iii) Farms should be encouraged to undertake additional activities which stabilize household incomes to enable them adopt dairy technologies without exposing their households to additional risk Activities which help stabilize household incomes such as off-farm activities facilitate adoption of dairy technologies by the risk averse farmers.

(iv) Credit availability and lending terms should be improved in order to boost dairy productivity Credit is instrumental in adoption of technologies that involve additional cost if the adoption is to take place without adversely affecting the smallholder's income security.

(v) Cooperatives should be encouraged to broaden their services and undertake most of the services previously provided by the government. For example, beside providing A.I and animal health services a dairy cooperative should be able to provide technical advices on crop husbandry and credit according to the needs of the members

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ABBREVIATIONS

AD	Agriculturally Dependent
ECF	East Coast Fever
GDP	Gross Domestic Product
KARI	Kenya Agricultural Research Station
KCC	Kenya Co-operative Creameries
LDCS	Limuru Dairy Co-operative Society
MoALDM	Ministry of Agriculture Livestock Development and Marketing
NDDP	National Dairy Development Programme
NAD	Non-Agriculturally Dependent
NDP	National Development Plan
SSA	Sub-Saharan Africa
TBD	Tick Borne Diseases
TIES	Technology Impact Evaluation System

CHAPTER ONE

INTRODUCTION

1.1 Importance of Dairying in Kenya's Economy

Dairying in Sub-Saharan Africa (SSA) plays an important role, both as a means of generating income for livestock producers and in providing much needed food for consumers (Mbogoh, 1984). The livestock sub-sector accounts for about 18% of agricultural GDP in SSA, with milk contributing 20% to 25% of this, an estimated $1 75 billion in 1987, (Walshe *et al.*, 1991).

In Kenya, dairy plays a significant role in the economy It forms an integral part of farming systems and acts as a major source of animal protein in diets of smallholder farm families In addition to provision of food, dairying provides direct cash income Animals are a living bank for many farmers and are critical to agricultural intensification via provision of power, manure and fuel (FAO/ILRI, 1995). In 1993, milk and milk products ranked fifth after tea, coffee, cattle and sugar in terms of their estimated cash earnings as farm activities in Kenya (Kenya, 1995) Table 1 1 shows gross marketed value for various farm commodities in Kenya

Except in the years of extreme drought when imports of dry milk powder have been necessary, production has generally been sufficient to meet demand Recorded milk production increased from 260 million litres in 1982 to 316 million litres in 1986 and to 392 million litres in 1990. Total production was estimated to be 2.4 billion litres in 1990 of which about 60% entered the formal marketing systems According to government estimates, a large proportion of the remaining 40% would have entered the formal market had roads been in place and factory intake capacity adequate (Kenya, 1994b)

Milk production is mainly concentrated in the high and medium potential areas of Kenya, occupying about 2.8 million hectares According to Oluoch-Kosura and Ackello-Ogutu (1995), 70% of total milk production comes from exotic dairy cattle breeds estimated at 0.9 million lactating cows (each giving about 1400 litres of milk per year) while the balance is produced by Zebu cows numbering about 2.9 million (each producing 200 litres of milk per year)

Table 1.1
Gross Marketed Value for Various Farm Commodities at Constant (1982) Prices, 1986 - 1990.

	Year and Gross marketed value (K£ million)				
Commodity	1989	1990	1991	1992	1993
Tea	175.25	191.17	196 68	182.50	208 61
Coffee	157.21	155.49	121.06	122.91	108 21
Cattle	62.53	68.85	80.57	76 54	81.49
Sugar	36.22	36.05	35.03	31.08	32.64
Dairy Produce	37.97	42.17	38.55	23.63	26.78
Maize	33.72	28.43	16.35	17.46	13.03
Pyrethrum	6.90	8.05	10.57	12.17	12.68
Sisal	9.40	9.89	9.76	8.59	8.61
Wheat	21 87	7.36	18.73	11 81	6.85

Source Kenya, 1995

1.2 Importance of Smallholder Dairying

Dairying provides the majority of Kenya's smallholder families with milk, a food with most of the essential nutrients (energy, protein, vitamins and minerals), and also presents a viable income-generating option for land constrained smallholder farmers (Kilungo *et al*, 1994). The industry has grown remarkably since pre-independence days when market-oriented dairying was dominated by large scale farmers only According to Buteyo (1987) the facilities to serve the industry were organised and developed to serve the large scale dairy farming community only because, by law, small scale rural milk producers were excluded from the organised milk market. In post-independence Kenya, the dairy industry has changed its structure, as smallholder participation in the industry has increased significantly. In 1974, the share of smallholder milk production accounted for 40% of all commercially marketed milk (Rurgu, 1976) In 1988, 61% of this milk production came from the smallholder sector (Kenya, 1991). Currently, dairying within mixed farming small holding is an essential farming system in Kenya, producing 75% - 90% of the total milk supply (Kilungo *et al*, 1994)

The Kenya Government recognizes the contribution to the economy and the potential of smallholder dairying in the country and since 1970's the government has actively promoted the sector through policy and technical assistance programmes (Buteyo. 1987, ILCA, 1981, Launonen *et al.*,1985, Walshe *et al.*, 1991) such as the National Dairy Development Project

A further increased milk production is expected to take place through expansion of intensive dairy farming in the small farm sector, and intensification of existing small-scale dairy husbandry (Launonen *et al.*, 1985).

1.3 Characteristics of Smallholder Dairy Farms

The majority of Kenyans, about 81%, live in rural areas, and the large majority of them are small holders (Bhushan, 1995). Though smallholder agriculture started as subsistence farming, by the 1980's smallholders contributed about 50% of marketed agricultural production (Kenya, 1983) and their share is still growing Dairying being an integral part of most rural smallholder mixed-farming systems, has grown simultaneously with the smallholder farming.

Smallholder dairying is characterized by small scale activity in other agricultural enterprises (mainly crops) besides dairy, leading to a mixed crop-livestock system of farming. In the Kenyan highlands, population pressure on land has lead to expansion of the cultivated area, replacing pasture and thereby reducing the grazing area for animals. This has lead to intensified agriculture where more labour is used on less land, and typically more purchased inputs are used per unit of output The resulting mixed crop-livestock farming system is more efficient in utilization of farm resources than either specialized crop or animal production (Mcintire *et al.*, 1992). The interaction between crops and animals leads to a lower cost of production because crop residues are fed to animals, manure is available to partially replace costly commercial fertilizers and animals can be used for traction.

Smallholder farm families reside on the farms and the majority of them derive their livelihood from the farms. Besides providing food and cash income, the mixed crop-livestock farming system helps increase food security for the smallholder dairy farmers. Risks posed by such factors as unreliable rain and market instability make household income and food security uncertain. As a coping strategy smallholder farmers invest in both livestock and crops as an insurance strategy against failure of either livestock or crops.

1.4 Problem Statement

Developing countries have nearly two thirds of the world's livestock but produce less than a third of the worlds meat and a fifth of its milk. Low output is due to low off take rates and low yields per animal. Milk yields in Africa and in both South America and Asia are only one tenth and one quarter respectively, of that of North America and Europe (FAO/ILRI,

1995) These data suggest that there is a great potential for major improvements in livestock productivity particularly in Africa.

In Kenya, although there has been increased milk production, especially in the smallholder sector, it has resulted mainly from an increased number of animals and use of land rather than from increases in individual-cow productivity (ILCA, 1979, Walshe *et al*.,1991). The rate of growth of milk production in Kenya remains far below the requirement level. The projected milk requirement for self-sufficiency in the year 2000 is 2.795 billion litres (Kenya, 1994) To meet this requirement an annual growth rate of 4.4% in milk production is required as projected from 1990 total milk output of 1.826 billion litres Therefore, concerted efforts are required to achieve the correct rate of growth of milk production

According to the sixth National Development Plan (Kenya, 1995a) the production of maize, beans and milk utilizes approximately two thirds of the land area devoted to agricultural production, leaving limited possibilities for further expansion of land devoted to the three commodities without reducing the output of higher valued commodities[1] Therefore, the required output growth rates can only come from productivity growth

However, due to the nature of smallholder farms where dairying fits in the complex farming systems as just one of the many enterprises, intensive dairying means adjustment of the balance in resources and input use among enterprise mixes This is because, despite the complementarity that exists between livestock and crops, there is still competition for resources and inputs between the two. The timeliness of their returns affect the cash flow pattern which is also an important factor in a smallholder economy. A farmer is required to make decisions as to what enterprise mix to have and level of farm resources to use in each

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[1] Include coffee and tea which earn the country foreign currency

enterprise The decision is influenced by the available resources, the productivity of various activities at different scales of production and various risks that face the farmer as he strives to raise household income and food security

The majority of smallholder dairy farms are faced with risks arising from fluctuating milk prices[2], unavailability of inputs, threat of livestock diseases, poor marketing infrastructure and unpredictable weather However, the smallholder is well aware of these constraints and is constantly trying to adjust to a very complex and dynamic situation caused by them (Ikombo. Esilaba and Kilewe) After incurring losses through animal deaths, low prices and low yields, farmers associate different levels of risk to different enterprises, and this affects the amount they are willing to invest in each enterprise, and also the enterprise mix and management practices they undertake to mitigate risk.

The risk attitudes held by the farmer may reduce the rate of uptake of any technology if it is perceived to contradict risk management strategies employed by the farmer, regardless of its potential returns Therefore, to increase adoption rate of intensive dairying such as increased concentrate feeding and health services by smallholder farms, it is important to determine the sources of risks in these farms and assess coping strategies employed by the farmers The effect of these strategies on the performance of dairying must also be evaluated The results of the study will help identify appropriate interventions and easily-adopted risk-reducing livestock technologies

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[2] In addition to posing risk to household economy, fluctuating prices make it difficult for farms to plan with reasonable accuracy However, fluctuation of prices within a range whose minimum level allows farms to make high profits does not constitute any risk to household economies nor a major problem in planning

1.5 Study Justification

As already noted, dairy sector has a vital role to play in the growth and development of the Kenyan economy. Since research acts as the cutting edge for development in any sector of the economy, there is a need for continued research and evaluation studies to increase productivity Increased productivity alone will go a long way in achieving the most important national objective in Kenya's development policy, which is food security (Kenya, 1994a) However, attainment of food self-sufficiency and security at smallholder farm level is elusive due to numerous risks that face such farmers making them adopt minimum risk farming practices. Often the security of the household economy rests on a complicated balance of off- and on-farm income sources, cash and food crop activities and livestock, in particular dairying A move such as adoption of intensive dairying, which requires initial additional cost may mean off-setting this balance and in time of dairy-induced household income insecurity the damage to the farm family may be severe and irreversible[1]. The additional cash used to improve animal health and purchase (more) concentrate may have no marginal return in case of a sudden drop in milk price leading to a farmer being worse off. Such concern affects the adoption of technologies aimed at increasing dairy productivity.

The information generated by this study will improve our understanding of smallholder farmer behaviour with regard to risk and resource management, thereby elucidating what constitutes "appropriate" livestock technologies and means for their delivery to smallholder farms The present study is therefore justified on the basis of identifying ways to help increase productivity in dairying.

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[1] Due to the additional cost caused by adoption of a dairy technology (such as increased concentrate feeding and animal health services), during the risky periods (as times of low milk yield, prices or both), it is assumed that a household is worse off with than without the technology

1.6 Objectives of the Study

The broad objective is to identify the sources of risk associated with smallholder dairy production, and to assess how risk management strategies affect the dairy enterprise Specific objectives are to

- document sources of incomes, patterns of farm household resource utilization and investment in dairying on the selected farms in Kiambu District,
- describe the risk management strategies used by these farmers and to determine how these strategies relate to and affect the dairy enterprise,
- evaluate how the adoption of national extension recommendations on intensive dairying would affect household's income,
- explore alternative avenues of reducing whole-farm risk with a view to increasing resource investment in the dairy enterprise

1.7 Hypothesis of the Study

The study was based on the general hypothesis that the decision-making process of the farmers was heavily influenced by their need and desire to minimize risk To study the stated objectives, the following hypotheses were tested

- matching as a risk mitigation strategy is not a major determinant of the pattern of resource utilization and investment in dairying
- farmer's input parsimony behaviour is not a major determinant of the pattern of resource utilization and investment in dairying
- the pattern of resource utilization and investment in dairying is not affected by the farmer's need to diversify.

- off-farm incomes do not affect household economy (level and stability of income).

- intensive dairying decreases both the level and variability of household income (Net Present Value), and does not lower houschold income security

1.8 Background to the Study Area

1.8.1 Physiography

Kiambu District being one of the most densely populated and most agriculturally productive Districts in Kenya was selected for this study. The District is in Central Province of Kenya and lies between 0-25° South of equator and between longitudes 36°30' and 37° (map 1). Its altitude ranges between 1350 and 2400 metres above sea level The District borders Nairobi Province and Kajiando District in the South, Murang'a and Nyandarua Districts in the North, Nakuru District in the West and Thika District in the East The central landscape consists of undulating to rolling volcanic foothill ridges.

Administratively, Kiambu District has 5 divisions Githunguri, Kiambaa, Kikuyu, Lari and Limuru Divisions (map 2)[4] The Limuru Division where the study area is located is surrounded by the other four Divisions of the District, with Kikuyu in South, Kiambaa in East, Lari and Githunguri in North In the west the Division is bordered mainly by Kajiando District and partly by Nakuru District The Division has 4 Locations, namely, Ngecha, Limuru, Tigoni and Ndaiya. The area of study covered Kabuku sub-Location in Ngecha Location and Kaminthu Sub-Location in Limuru Locations

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[4] Kenya is divided administratively into Provinces, which are further divided into Districts, Divisions, Locations and sub-Locations, in that order

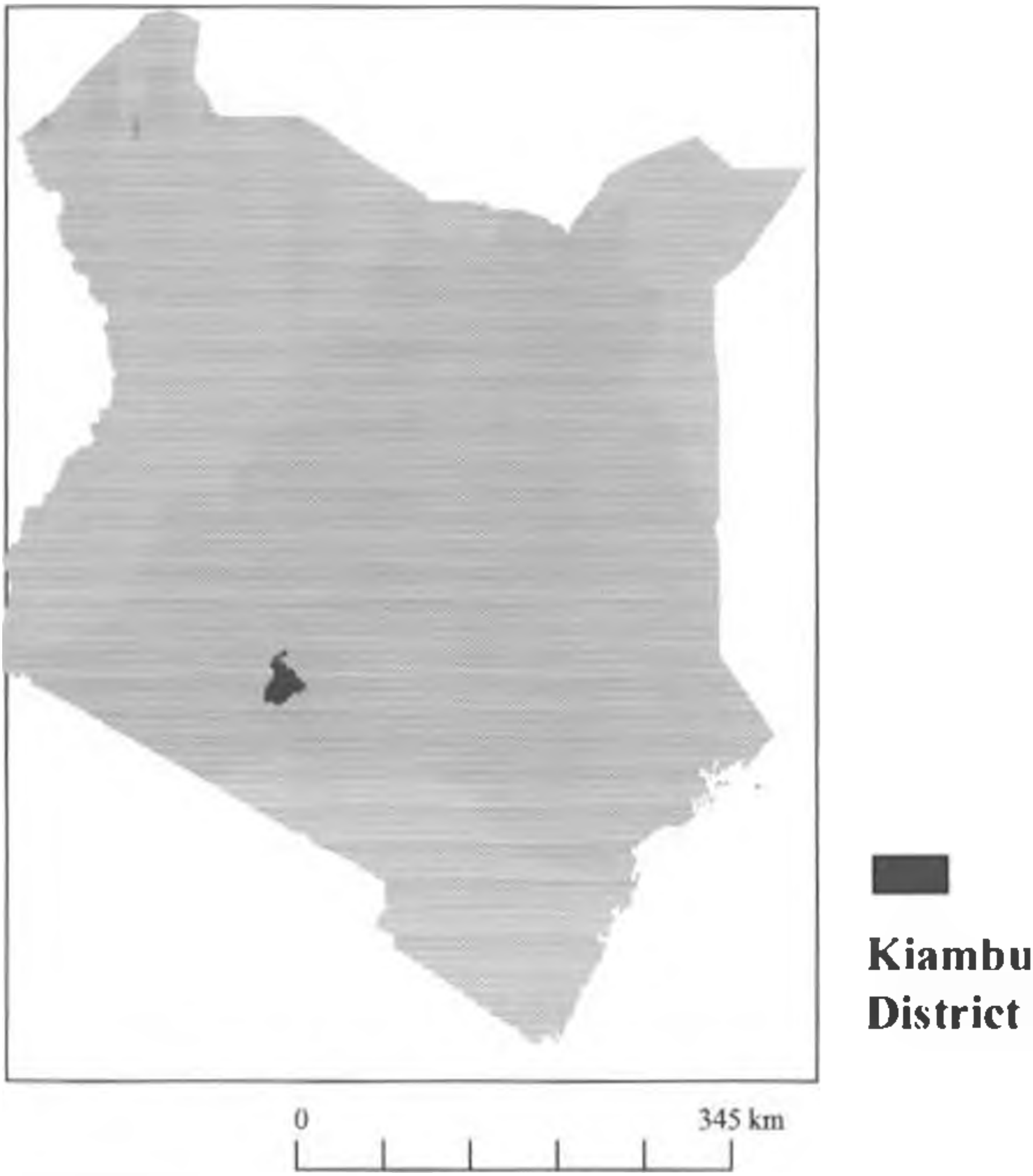
1.8.2 Climate and Agro-Ecological Zones

The District has a bimodal type of rainfall with long rains usually beginning in late March and decreasing in intensity towards the end of May and early June The short rains occur from October to December and are generally less reliable than the long rains The average annual rainfall is 1100 mm but ranges from the 600 mm in south and increases to 2500 mm in the North West Temperatures range between 10°C and 25°C depending on the location and altitude Soils are predominantly Nitosal (FAO/UNESCO Class) or Alfisols (USDA Class) well known as "Kikuyu red Loam" (Ikombo, Esilaba and Kilewe)

The District falls under four Agro-Ecological Zones, Upper Highland zone (UH0-2), Lower Highland zone (LH1-5), Upper Midland zone (UM1-5) and Lower Midland zone (LM4-5) (Jaetzold and Schmidt, 1983) The UH0-2 neighbours the Nyandarua range and consists of Forest, Sheep/dairy and Pyrethrum/wheat zones. LH1-5 consist of Tea/Dairy, Wheat/maize-Pyrethrum and Lower Highland ranching zones. The UM1-5 consists of Coffee/Tea, Main Coffee, Marginal coffee, Sunflower/Maize, and Livestock/sorghum zones while LM4-5 consists of only Livestock/millet zone

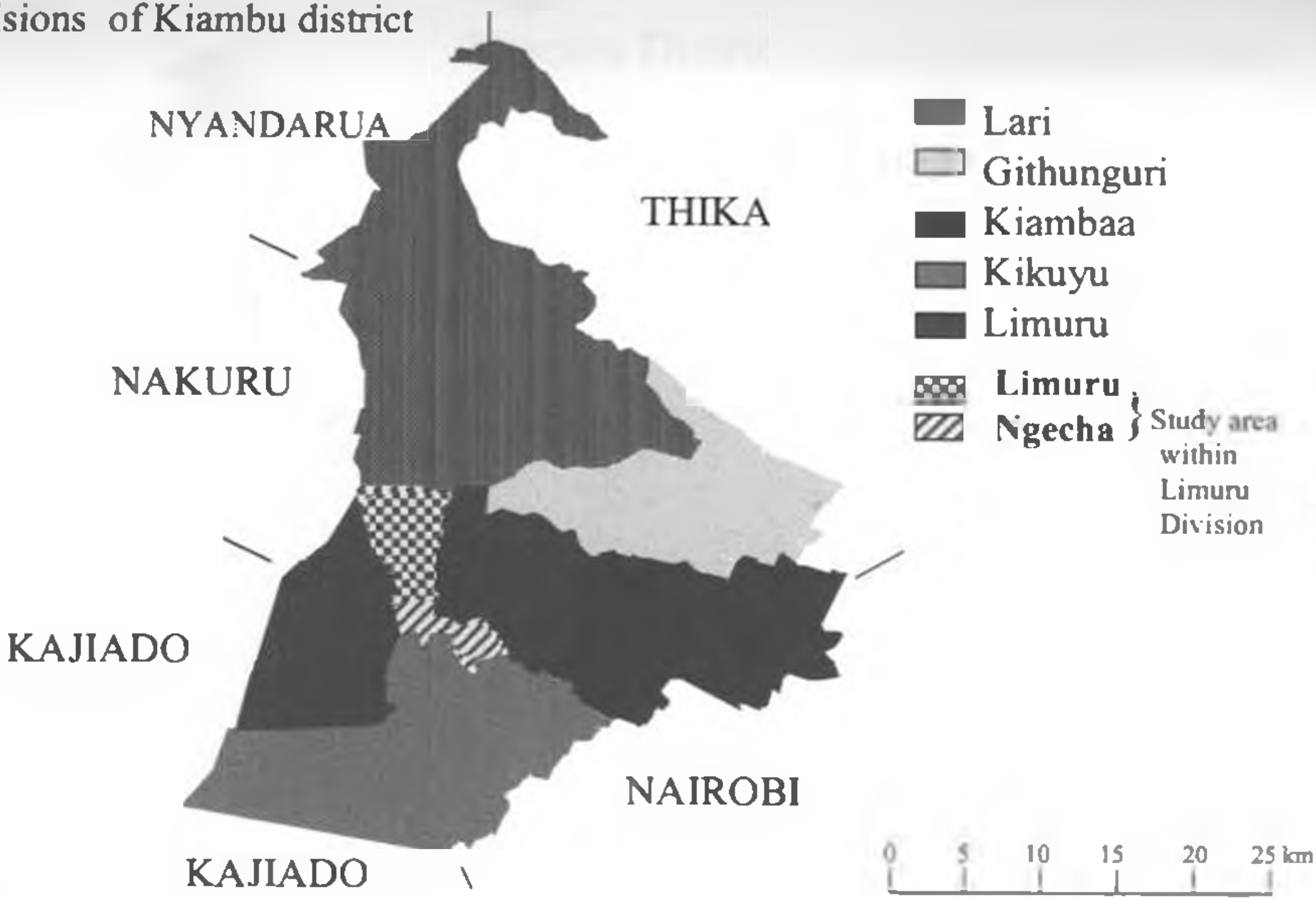
Map 1

Map of Kenya showing the Location of Kiambu District



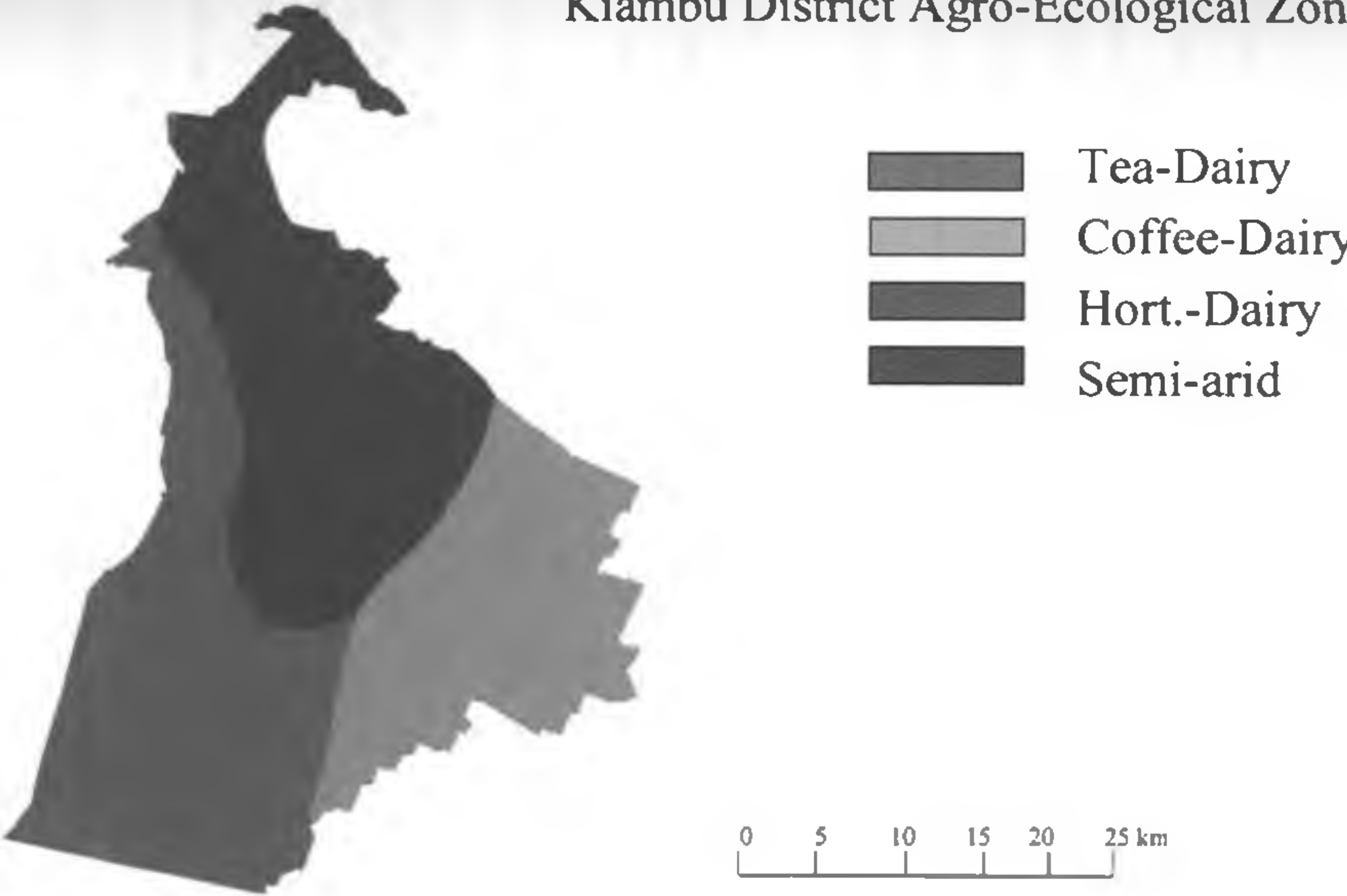
Source: Kenya Population Census, 1989 . Central Bureau of Statistics, Ministry of Economic Planning and National Development

Map 2
Divisions of Kiambu district



Source Kenya Population Census. 1989 . Central Bureau of Statistics, Ministry of Economic Planning and National Development

Map 3
Kiambu District Agro-Ecological Zones



Source:Farm management handbook of Kenya (Jaetzold & Schmidt, 1983)

1.8.3 Cattle Production Systems and Dairy Cooperative Societies

Kiambu District is a high potential agricultural District with a high number of smallholders active in dairying. It is located in a peri-urban area close to Nairobi where the demand for milk is high and continues to grow. However, there are pockets of low potential areas where Zebu cattle are grazed for beef production, but, mostly, the cattle production system in the District is intensive The District has an estimated 110,838 dairy cattle out of which only 10,043 are Zebu cattle (Mutuota, 1995). In the high potential areas, over 70% of farmers have at least one dairy cow According to Mutuota (1995), during drought years there is a scarcity of feed concentrates leading sometimes to extremely high prices

The farms covered in the study were from Locations which fall under either LH3-Horticultural/Dairy, LH2-Floriculture/Dairy or UM3-Horticultural/Dairy (Jaetzold and Schmidt, 1983) The farmers are served by Limuru Dairy Co-operative Society (LDCS), one of the most successful societies out of 13 active societies in the District

Since 1990 the society has been having the highest level of active members in the District followed by Githunguri Dairy Co-operative society with the former having an average of 3858 active members and the latter 2920 active members (Table 1 2) Until 1995 LDCS has handled the largest amount of milk in the District followed by Githunguri Dairy Co-operative Society (Table 1.3) The societies buy milk from members and sell some of it locally and the rest to Kenya Cooperative Creameries (KCC). Large amounts of milk (about 60% in 1995) is sold locally because the local market offers higher prices than that offered by KCC (Mutuota *et al*, 1995). Beside buying and selling milk other facilities offered by the LDCS include education loan, inputs in credit, A.I. and animal health services

Table 1.2

Number of Active Members of Dairy Cooperatives in Kiambu District, 1990-1995

Coop Name	Division	1990	1991	1992	1993	1994	1995	Mean
Gatamaiyu	Lari	1,220	1,036	1,393	1,227	1,064	1,265	1,201
Githunguri	Githunguri	2,800	2,600	3,000	2,898	3,042	3,178	2,920
Kabete	Kikuyu	382	407	441	482	519	489	453
Kamahia	Lari	335	375	350	345	389	405	367
Kiambaa	Kiambaa	250	300	300	340	350	360	317
Kikuyu	Kikuyu	239	248	197	214	240	290	238
Kinale	Lari	N/A[3]	190	250	280	320	370	235
Kiruta	Lari	1,220	1,580	1,750	1,830	1,60	1,980	1,720
Lari	Lari	90	98	100	105	118	126	106
Limuru	Limuru	3,500	3,650	3,800	3,900	4,100	4,200	3,858
Ndeiri	Kikuyu	729	898	1,080	1,204	1,330	1,485	1,121
Ndumberi	Kiambaa	1,460	1,387	1,100	1,350	1,200	1,182	1,280
Tigoni	Kikuyu	24	21	17	13	28	29	22

Source: Owango *et al*, 1995

Table 1.3

Description of Milk Purchase of Dairy Cooperatives in Kiambu District, 1990-1995 (Lt/Yr)

Coop name	Division	1990	1991	1992	1993	1994	1995
Gatamaiyu	Lari	1,675,873	1,434,545	1,512,924	1,134,042	1,137,031	1,163,696**
Githunguri	Githunguri	5,335,164	5,999,723	5,704,811	5,821,077	5,970,249	6,167,740*
Kabete	Kikuyu	989,800	1,210,522	1,218,393	1,075,412	1,295,402	1,694,000**
Kamahia	Lari	658,933	668,794	681,739	703,805	543,565	615,431**
Kiambaa	Kiambaa	907,092	905,704	844,315	775,376	886,801	10,118,858*
Kikuyu	Kikuyu	656,441	711,455	685,291	551,148	645,677	929,362*
Kinale	Lari	N/A	172,912	420,000	475,349	535,788	607,055*
Kiruta	Lari	3,125,552	3,192,305	3,624,288	3,635,227	2,495,876	3,074,556**
Lari	Lari	85,773	112,830	166,706	184,560	188,185	314,340*
Limuru	Limuru	6,725,836	6,511,246	7,875,304	6,419,802	6,612,931	7,569,603*
Ndeiri	Kikuyu	1,132,571	1,114,133	1,125,474	1,203,734	1,251,286	1,630,267*
Ndumberi	Kiambaa	2,825,432	3,031,388	3,171,804	3,475,893	3,575,460	3,487,975**
[illegible]	Kikuyu	[illegible]	193,741	221,386	157,871	140,911	208,303*

* Milk figures extrapolated for 1995

** Figures for 1994/1995 financial year

Source: Owango *et al*, 1995

1.9 Organization of the Study

This thesis is organized into five chapters. Chapter One gives background information to the study including the problem statement, objectives and hypotheses which were tested. Chapter Two presents a review of the literature relevant to this study. The research methodology is described in chapter Three. Chapter Four discusses the results of descriptive and quantitative analyses carried out. The summary, conclusions and recommendations arising from the study are given in Chapter Five.

CHAPTER TWO

LITERATURE REVIEW

2.1 Risk Concept in Farming

Risk is regarded by economists as "a situation in which the probability of obtaining some outcome is not precisely known" (Todaro, 1981) It is a pervasive element in agricultural production. Stochastic environmental factors strongly influence the agricultural production process thereby creating uncertain financial outcomes One group of environmental factors i.e. the climatological and biological (e g. infectious disease) factors, causes variability in the physical production The second source of risk concerns market price variability, composed of variability in input and product prices (Smidts, 1990). Risk and uncertainty influence the efficiency of resource use and the decision making process of farmers (Sonka and Patrick, 1984).

Sonka and Patrick (1984) classified sources of risks into five major groups, namely, (1) production or technical risk (2) market or price risk, (3) technological risk, (4) legal and social risk and (5) human sources of risk They grouped risk responses into two types, one concerning action for reducing the effects of risk in the farm business and the other one involving changes in a farmer's decision process Consequently, they said that an action is considered risk reducing if when repeated numerous times, it lowers the variability and the expected level of income compared to alternative action[6] Risk response involving changes in farmers decision process considers the uncertain events that can occur, outcomes expected, probabilities of each event's occurrence and a procedure for ranking alternatives

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[6] According to Sonka and Patrick, if an action both reduces income variability and increases expected income, it is unclear if such a decision is made to increase profit or reduce risk

While identification of sources of risk and farmers coping strategies is relatively easy, assessing how risks influence decision-making requires knowledge of the risk attitude of the farmers Decision-makers are assumed to hold expectations about the chances of occurrences of the uncertain events which bear on their choices as well as preferences for the possible consequences The beliefs are encoded as subjective probabilities (Thereby implying a probability distribution for the consequences associated with each possible choice) while the preferences can be captured via suitably elicited function of utilities (Anderson and Dillon, 1992) The utility functions help explicitly evaluate and account for the risk attitude of the decision-maker

However, in many farm-level studies, researchers have little knowledge of the attitudes of the decision maker Because estimating individual utility function is difficult and often unreliable, alternative approaches are sought (King and Robinson, 1984) As stated by King and Robinson (1984), a utility function relates the possible outcomes of a choice to a single-valued utility index of desirability As such, it is an exact representation of preferences Some of the problems with single-valued utility functions are overcome by using an efficiency criterion to order choices Given specific restrictions on the decision makers preferences, and in some cases, on the probability distributions of feasible alternatives, an efficiency criterion provides a partial ordering of choices. If enough alternatives are eliminated, decision makers can make a final choice from the efficient alternatives

According to King and Robison (1984), efficiency criteria are useful in situations involving a single decision maker whose preferences are not known, in situations involving several decision makers whose preferences differ yet conform to a specific set of restriction, and in analyzing policy alternatives or extension recommendations that affect many diverse individuals The two most commonly used criteria to rank farming systems into few efficient alternatives are Mean-variance (EV) and stochastic efficiency criteria The two criteria are equally effective when variables are normally distributed However, many variables of interest in agriculture are not normally distributed. According to Lee *et al* (1987) given two income distribution F(y) and G(y), the mean-variance criterion predicts F is preferred to G if the mean of F is larger than the mean of G and the variance of F is less than or equal to the variance of G But if F's mean and variance are both larger than G's mean and variance the mean-variance criterion cannot predict which distribution will be preferred without making additional assumptions about the farmer's utility function.

The stochastic dominance comparisons enable the preference for classes of decision makers within a group to be determined without knowing the quantitative measure of risk aversion for each individual producer (Lemieux, Richardson and Nixon, 1982). The stochastic dominance comparisons commonly used are, First-Degree Stochastic Dominance (FSD), Second-Degree Stochastic Dominance (SSD), Third-Degree Stochastic Dominance (TSD) and Stochastic Dominance With Respect to a Function (SDWRF).

According to Lee *et al* (1987), FSD asserts that given two cumulative probability distributions of income, F(y) and G(y), F is preferred to (dominates) G for all those who prefer more to less if:

$$[F(y) - G(y)] \leq 0 \text{ for all } y$$

If one graphs the two cumulative probability distributions of income, FSD of G by F occurs when the cumulative frequency distribution F always lies to the right of G However, the criterion is a simple one and cannot be used in selection of alternative risky choices whose cumulative frequency distribution intersect (Lee, Brown and Lovejoy, 1985)

Cumulative frequency distributions that cross each other may still be ranked using SSD Under SSD, F will be preferred to G by all who are risk averse ($U''(y)<0$) if:

$$\int_{-\infty}^{x} [F(y) - G(y)]\,dy \leq 0 \text{ for all } -\infty < y < \infty$$

$$< 0 \text{ for some } y$$

The two distributions may intersect many times as long as the accumulated negative areas (where G > F) remain larger than the accumulated positive areas (where F > G)

The TSD assumes that individuals became decreasingly risk averse as their income or wealth increases Under TSD. F will be preferred to G by all individuals who are risk averse ($U''(y) < 0$) and ($U'''(y) > 0$) if:

$$\int_{a}^{x}\int_{a}^{y} [F(z) - G(zb)]\,dz\;dy < 0$$

and

$$\int_{a}^{b} [F(y) - G(y)]\,dy < 0$$

Where x and y are elements of the sample space [a, b] of prospects (Whitmore, 1970) However, as observed by Othiambo (1983), TSD is an extension of FSD and SSD and hence the weakest of the three Although TSD exceeds SSD in ordering of uncertain prospects, there may be actual cases where the preference between two risky outcomes cannot be established Assuming that G(y) appears attractive relative to F(y) except one or more outcomes of G(y) are below all of the outcomes of the F(y) the TSD will not indicate that G(y) is preferred at least as well as F(y). In addition, there is lack of empirical evidence that $U'''(y) > 0$ (Lee *et* al, 1987).

Stochastic dominance theory has been extended to cover more than third order sense of dominance (N^{th} Degree Stochastic Dominance) However, the usefulness of the higher order stochastic rules in applied work is limited since they impose complex restrictions and unrealistic assumptions on the utility functions and behaviour of the decision maker (Anderson, 1974, Fishburn, 1980 and Othiambo, 1983).

Unlike FSD, SSD and TSD, Stochastic Dominance With Respect to a function (SDWRF) does not impose global restrictions on a decision makers' preference. It does not impose restrictions on the shape or the width of the specific area of aversion space (King and Robinson) as quoted by Lee, Ellis and Lacewell, (1987) The SDWRF orders uncertain choices for decision makers whose absolute risk aversion functions lie within specified lower and upper bounds The SDWRF will be used in this study.

2.2 Whole Farm Simulation.

Lemieux, Richardson and Nixon (1982) used whole farm simulation to simulate the effect of a farmers' participation in various levels of Federal Crop Insurance (FCI) coverage, the low yield disaster program and nonparticipation in disaster assistance over a 10 year planning horizon. A typical cotton farm on the Southern High Plains of Texas was used for the analysis The simulation results were compared using stochastic dominance to predict the probable participation or nonparticipation in the alternative programs by producers with various risk preferences

The stochastic dominance with respect to a function, rather than mean-variance was used to predict producer preference among the various insurance options and disaster programs The methodology was selected because they expected the probability distributions for after-tax net present value to be positively skewed The result was expected because the programs truncate the bottom of the yield distribution thus skew the probability distributions for such output variables as net present value

Lemieux, Richardson and Nixon (1982) used farm level income and policy simulation model (FLIPSIM IV) developed by Richardson and Nixon to develop probability distributions necessary for the stochastic dominance analysis Stochastic prices and yields were randomly selected from a multivariate normal distribution for each year of the 10-Year planning horizon The 10-year period was simulated recursively for 50-Year period to generate a sample probability distribution for after tax net present value

In the "Economic Evaluation of alternative livestock disease control methods in Kenya" Nyangito (1992) used Technology Impact Evaluation Simulator (TIES), a whole farm simulation model, to evaluate five alternative East Coast Fever (ECF) control methods The model included all the production and disposal activities of the farm as well as off-farm activities Production and price risks were estimated within the model using multivariate probability distribution for yields and prices

The model simulated annual production, marketing, financial management and family consumption activities of representative farms over a 10 year planning horizon The key output variables from the model were net present value, net worth, benefit cost ratio, internal rate of return and average annual cash and net farm income The simulated output results from alternative ECF control methods were used to analyze the financial and economic performance of farms, the probability of survival and the probability of economic success of the farms The alternative ECF control methods on farms were also evaluated using the stochastic dominance criterion to determine the most preferred alternative by farmers and to estimate the associated confidence premiums

According to Nyangito *et al* (1994) TIES model accounts for the Stochastic nature of yield, livestock production and prices Using the model the risk associated with these parameters are easily incorporated using probability distributions The model can use either available data or subjective estimates from the experience of producers, researchers or extension agents Thus the TIES model appears to be a useful tool that could assist researchers in developing countries to assess the impact of new or alternative technologies even in the absence of adequate time series data It also allows ranking of alternatives among the preferred efficient set while putting the risk attitude of the farmer into consideration These characteristics of the TIES model made it most appropriate for this study

2.3 Past Studies

Previous studies suggest that dairying represent a viable income-generating option for smallholder farmers (Kilungo, 1994; Murithi, 1990; Nyangito, 1992 and Schaik, 1994) and is actively being promoted as such in Kenya However, some studies indicate that smallholder dairy sector is characterized by many setbacks In a study of Meru District's smallholder milk producers, Murithi (1990) used production function analysis to look at the efficiency of resource use Although the study was designed to evaluate factors affecting the milk yield,, he also discussed some of the problems encountered by milk farmers in the District Inadequate water for animals, lack of irrigation schemes, unavailability of feeds and lack of credit were identified as the major milk production constraints Low and delayed milk payment by cooperative societies were also cited as a major source of concern for the dairy farmers Murithi (1990) estimated that to maximize profit the level of concentrate feeding would have to be increased from an average of 535 kg to 1601 kg per cow per year This would lead to milk yield of 4,773 kgs per cow per year

A study, in Kiambu District by Kilungo *et al* (1994) assessed input use by dairy farmers Comparisons of average inputs with average milk production and prices were done

The study indicated that smallholder dairy farmers on average fed 438 kg of concentrate per cow per year

In an economic study of smallholder dairy farms in Murang'a District, Schaik (1995) identified the major constraints and opportunities for increased productivity on smallholder dairy farms According to Schaik, the amount of concentrate fed to cattle significantly affected milk production positively ($p=0.01$) and calving interval negatively ($p=0.02$), and in turn affected the performance of the farm It appears that concentrate feeding increased milk production while it decreased the calving interval.

A study by Oluoch-Kosura and Ackello-Ogutu (1995) investigated the role of credit in the uptake and continued use of dairy technology to improve milk production in Kenya The study found that farmers in Kiambu were aware of the dairy technologies considered but adoption was being constrained by credit as well as other socio-economic factors According to the study, farmers were not feeding concentrate in adequate quantities with the credit constrained farmers feeding their animals even less than the credit unconstrained The majority of the credit constrained farmers cited risk posed by loans as the reason for not borrowing An education campaign to reduce the risk adversity of farmers and make them be more willing to take risk was recommended

From the above studies it is evident that a great potential for increased milk production may still exist Socio-economic factors and other constraints remain a major hindrance to the realization of the full potential of smallholder farms Specifically, milk yields of smallholdings can be increased through optimization of concentrate feeding and other input use However, as shown by one of the studies (Oluoch-Kosura and Ackello-Ogutu, 1995) there is a possibility that the majority of smallholder farmers know about the potential benefits that can result from intensive dairying, but socio-economic factors such as risk aversion make them operate at the sub optimal levels[7] The majority of smallholder dairy farms are faced with risks arising from fluctuating milk prices, unavailability of inputs, threat of livestock diseases, poor marketing infrastructure and unpredictable weather

When planning their farms and annual activities, in order to assure household food security and livelihood, farmers put into consideration all sources of risks Farmers therefore make production and marketing decisions that conform to their perception of the economic and biophysical environments Risk management is important whenever decision out comes are uncertain as occurs for most farming situations (Sonka and Patrick, 1984) Because of these uncertainties, smallholder farmers apply risk-averse resource management strategies in their production and marketing activities They may offset the risk through mixing of farm enterprise, production technologies, marketing strategy or a combination of these

As stated by Anderson and Dillon (1992), farmers have always examined the environment for niches favourable to their own concept of welfare and often, through centuries-long trial and error, have established farming systems with technologies (such as risk-spreading multiple cropping) suited to their needs It can therefore be assumed that farmers, after rearing dairy animals and growing crops for many years[8] are able to approximate the optimal levels of operation given their economic environment and risk attitude

Farmers undertake different strategies to cope with different sources of risks These include production, marketing and financial strategies A comprehensive strategy integrating production, marketing and financial responses should reduce risk more than can the individual

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[7] Optimal level is that level of operation which maximizes profit (P) i.e. maximizing the difference between returns (R) and costs (C) in an equation P – R - C

[8] A period of 10 years and above which is considered enough for a farmer to form subjective probabilities of stochastic economic factors facing him

response to risk. The integrated strategy which is best for an individual producer depends on available resources, goals and attitudes, equity position, financing available, weather conditions, market availability and other factors (Sonka and Patrick, 1984)

However, most studies of smallholder livestock production have focused on the optimization of resource use, and constraints and general socio-economic factors affecting the productivity and marketing in dairying without looking at the effect of risk attitude (Gitau *et al*, 1994, Echessah, 1994, Kilungo, 1994, Mbogoh 1984, Murithi, 1990). Two studies that addressed risk in dairying focused primarily on livestock-specific risks (Nyangito, 1992 and Schaik, 1994)

Using stochastic dominance criterion Nyangito (1992) ranked alternative ECF control methods. The criterion incorporates the decision-makers risk attitude and ranks alternative choices by eliminating the inefficient ones. The alternative methods of ECF control ranked were in five scenarios reflecting different levels of ITM[a] adoption. In consideration of risk attitude of the farmers, the stochastic dominance ranked the scenario which reflected adoption of ITM accompanied by 75% reduction in acaricide use by farmers as the most preferable scenario

Schaik (1995) used stochastic prices and yields of crops and livestock to evaluate the effects of changes such as increased milk prices and concentrate feeding and animal health costs on performance indicators of dairy farms. However, she did not consider the risk attitude of the farmers and hence did not evaluate how appealing the increases (of milk prices, concentrate and animal health services) would be to the farmers. Also the two studies

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[a] An improved ECF control method called Infection and Treatment Method (ITM)

(Nyangito, 1992 and Schaik, 1995) did not consider other risk sources that exist in farm household and management strategies used by farmers and their effect to dairy enterprise

In view of the above gaps, this study seeks to identify the sources of risks associated with smallholder dairy farms, assess how risk management strategies affect the dairy enterprise and to come up with recommendations that will lead to low-risk dairy technologies leading to increased dairy intensification

CHAPTER THREE

RESEARCH METHODOLOGY

This chapter presents the methodologies used in selecting the farm households and collection of data It also outlines the analytical framework used in this study.

3.1 Source of Data

This study used primary and secondary data Primary data was collected from the smallholder dairy farmers, officials from Limuru Dairy Cooperative Society (LDCS), Ministry of Agriculture Livestock Development and Marketing (MoALDM), horticultural traders and local stockists of farm inputs Secondary data included time series data, such as milk and crop prices and yields for the last ten years, which were required for generating the empirical probability distributions needed to run the Technology Impact Evaluation System (TIES) model These data were obtained from the MoALDM annual reports and records from National Dairy Development Program (NDDP), Kenya Agricultural Research Institute (K A R I.) Tigoni station , LDCS and Limuru Pyrethrum Co-operative society

3.2 Methods of Data Collection

Before data collection began, the questionnaire was pretested and revised using two dairy farmers The approach used in data collection involved personal interviews of the farmer and members of the household from each farm using the pre-tested structured questionnaire Each farm was first visited to determine its willingness and suitability for inclusion in the sample study.

Data collection was conducted in July through October 1995 One to two farmers were interviewed per day depending on the number of enterprises the farmers had Local dialect was used during the interviews.

Completed questionnaires were checked before data entry Where problems such as omissions or doubtful figures were noted the respondent was revisited The data was then processed and analyzed as necessary

3.3 Sample and Sampling Design

3.3.1 Selection of Study Area

Limuru Division was chosen for the study for three reasons First, the Division lies in the central highlands of Kenya which has high dairy potential Second, being mainly a horticultural zone it allowed growing of variety of crops and consequently, flexibility in enterprise mixes thus could easily reflect farmers reaction in response to various enterprise risks This is in contrast with coffee and tea zones which show more fixity. Third, it consisted of smallholder dairy farmers who had participated in a research project on credit and livestock technology conducted in Kiambu District by Oluoch-Kosura and Ackello-Ogutu, (1995) The advantages of using farmers who had participated in another research was (1) the research provided a sample frame for dairy farmers from the area of interest, and, (2) the data from the entire research provides a base which could be used for comparison or to complement the present study

3.3.2 Sampling Procedure

Thirty-six farmers were sampled from a group of farmers from Limuru Division, Kiambu District, who had participated in a research project on credit and livestock technology Based on the information in the credit project data base and the help of Division livestock extension officers, farmers were grouped into non-agriculturally dependent farmers, if they received more than 60% of their expected total household income from off-farm activities and agricultural dependent farmers, if they received less than 60% from off-farm activities. However, this categorization of farmers was arbitrary because the proportion of off-farm income for rural families may vary from year to year This is so especially because a change in level of either farm income or off-farm income of the farms near the cut-off figure (60%) may lead to those in one category shifting to the other

From a total of 50 farms 18 candidate farms were randomly allocated to each of the two groups Only 35 farmers, however were successfully interviewed Of these only twelve farm households received more than 60 percent of their total income from off-farm activities and hence could be classified as non-agriculturally dependent (NAD) households The remaining twenty-three farm households received less than 60 percent of their total household income from off-farm sources and were consequently classified as agriculturally dependent (AD) households

3.4 Types of Data Collected

The data collection was done in two stages Stage one involved collection of data mainly required for whole farm simulation using TIES model Stage two involved collection of data required in understanding farmers perception regarding the importance of enterprises undertaken, risk sources and constraining inputs

Stage one (TIES) data included all farm resources and enterprises, yields, inputs, outputs and inputs prices, crop and livestock losses, production, marketing and resource management practices on the farm Data on farm assets, liabilities, off-farm investments and income, crop and livestock sales, consumption as well as food requirements by the household was also collected Field and farm crops acreage, livestock numbers and production inputs were also recorded (Appendix I)

Stage two involved collection of information regarding major sources of risks for households income and for each enterprise and farmers ranking them according to their order of importance Also recorded in this stage were risk management strategies and availability of inputs and markets for outputs (Appendix II)

The study relied heavily on farmer recall but recorded values were used where available

3.5 Modeling and Data Analysis

The data generated by this study were analyzed using descriptive and simulation analyses

3.5.1 Descriptive Analysis

Summaries compiled from the farmers' interviews were used to describe patterns of resource utilization and investment in dairy and net incomes from various enterprises on the selected farms Risk management strategies were also identified and their linkages to and any possible effects on the dairy enterprise analyzed

Statistical analysis was performed using Dbstats and SAS It involved constructing frequency distributions, calculating means and tabulations A two-tailed t-test analysis was used to test statistical significance at $p < 0.05$. Since the criterion for grouping the farms was based on off-farm net income variable, any significant difference between groups would imply that off-farm income is an important contributing factor. This was one simple way of establishing the role of off-farm income in stabilizing and increasing household incomes

3.5.2 Simulation Analysis

The methodology used in this study was whole farm simulation. To incorporate the risk element of agricultural production a ten year whole farm stochastic simulation was done. The simulation was conducted using the model, Technology Impact Evaluation System (TIES) to indicate financial performance of different management strategies. Using TIES, different scenarios were simulated and analyzed to assess their effect on various financial performance indicators. Stochastic dominance with respect to a function (SDWRF) was also done to rank different scenarios reflecting different management practices (existing and possible ones) under the assumption that farmers are risk averse.

Financial Analysis Indicators

The indicators used for financial analysis were the Net Present Value (NPV), the benefit-cost ratio (BCR), the internal rate of return (IRR), the average annual net farm income (AANFI) and the average annual net cash farm income (AANCFI).

The NPV is equivalent to the present value of benefit stream less the present value of cost stream (Putt *et al.*, 1987).

Mathematically.

$$NPV = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t}$$

Where t = individual years,

n = number of years over which the project is evaluated

B = the sum of benefits in a given year,

C = the sum of costs in a given year,

i = the interest rate expressed as a decimal

The NPV gives a good idea of the total profit, in present value terms, of an investment Difficulties arise when NPV is used to rank projects, since a large project with a relatively low net NPV would look as profitable as a far smaller project with a relatively high NPV in comparison to its overall level of costs and benefits. The rules for acceptability or rejection of an investment are: if NPV exceeds 0, then one accepts the investment, if NPV is equal to 0, one is indifferent, if NPV is less than 0, then one rejects the investment

The BCR is the sum of the discounted benefits (present value of benefits) divided by the sum of the discounted costs (present value of costs), representing the relative size of costs and benefits Mathematically:

$$BCR = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+i)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+i)^t}}$$

The BCR gives no indication, however, of the scale of the investment' which should be considered if alternative projects are being compared The decision rules for acceptability or rejection are if BCR is greater than 1, one accepts the project, if the BCR is equal to 1, one is indifferent; if the BCR is less than 1, one rejects the investment

The IRR is defined as the discount rate that would cause the sum of discounted costs to exactly equal to the sum of the discounted benefits. In mathematical terms, the IRR is that *i* for which

$$\sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t} = 0$$

The IRR is a useful criterion for comparing projects, especially since it can be expressed in annual percentage rate of return (Putt *et al*, 1987), making it readily comparable with real interest rate in alternative applications (e g. saving deposits) In this study a discount rate of 18% was used The figure was obtained from the Economic Survey, 1993 (Ministry of Agriculture. 1994), which shows considerable changes in interest rates for saving deposits of commercial banks, but a discount rate of 18% is chosen as an average interest rate for saving deposits

The average AANFI is the total cash income obtained from the farm plus the change in value of livestock and the value of the household consumption of products produced on the farm, minus down payments for replacement of machinery and the value of non-cash costs

The AANFCI is the total cash farm receipts minus total cash farm expenses and excludes family living expenses, principal payments and, costs of replacing capital assets

The chance of survival is the probability that the farm will maintain an equity to assets ratio equal to the minimum level for borrowing funds from commercial banks. Since farmers could borrow funds from LDCS the interest rate, 18%, charged by the co-operative was used as the minimum level for the ratio

The chance of economic success is defined as the probability that the farm will generate a rate of return greater than the discount rate (in this study 18%) used in calculating the NPV. Economic success was also analyzed using IRR, BCR and the ratio of ending net worth to beginning net worth Economic success using IRR was estimated as the probability that the calculated IRR was equal to or greater than the discount rate of 18%. For BCR, economic success was defined as the probability that the calculated BCR was greater than or equal to 1. Economic success using the ratio of ending net worth to beginning net worth was estimated as the probability of lowering real equity, which was defined as the probability that ending equity to beginning equity was less or equal to 1 (Nyangito, 1992).

The TIES Model

The TIES was developed by the Agricultural Experiment Station at Texas A&M University in collaboration with International Laboratory for Research on Animal Diseases, ILRAD (Richardson, Mukhebi and Zimmel, 1991) It was specifically meant for use in developing countries by incorporating farm production and consumption aspects characteristic to these countries It is a whole farm simulation model which simulates annual production, marketing, financial, management and consumption aspects of a farm over 10 year planning horizon The model also includes a family nutrition component which projects the impact of technology and management on the quantity and quality of food in the diet consumed by the household (Richardson et al, 1993) However, in this study the family nutrition component was not included The model uses one year as its step and simulates 10 years recursively by starting each with the ending debt and asset information for the previous year

The TIES is capable of simulating alternative livestock production and farming systems for smallholder farms in developing countries. It is based on Monte Carlo simulation and offers a flexible method of assessing and predicting the financial and economic impacts of new technologies on the farm (Schaik, 1995). It accounts for the stochastic nature of crop and livestock enterprises yields and prices by estimating probability densities and distributions associated with these variables over the period of 10 years The risk associated with crop yields, livestock production (calving rates, rates of gain in calves, death rates and milk production per cow), crop prices and livestock prices are estimated from empirical probability distributions for the farms being simulated A pseudorandom number generator is used to develop stochastic prices and project crop and cattle production levels from empirical probability distributions of these variables (Table 3.1) The pseudorandom number generator is also used to generate values from the distribution so that each technology is evaluated with the same sequence of random weather (crop and milk yield), market (price) and mortality conditions.

Figure 3.1 shows a schematic overview of the calculation steps in the TIES model. At the start, the model reads and processes an input file (data set) for the farm to be simulated The model determines whether the analysis will be deterministic (ITER = 1) or Stochastic (ITER = 100) based on the analysis specification for the particular data set

The key output variables projected by the model include

- net present value (NPV)
- present value of Ending Net Worth (PVENW)
- benefit cost ratio (BCR)
- internal rate of return (IROR)
- average annual family consumption

After the last iteration the statistics for all the output variables (mean, variance, standard deviation, coefficient of variations etc) were calculated and the results given

Comparisons of statistics of output variables, from TIES model, for different scenarios for AD and NAD households were done. This involved comparing the level and variability of incomes, BCR, IROR and probability of both survival and success of the farm business

Table 3.1
List of Stochastic Variables in the Multivariate Empirical Probability Distributions in TIES.

Crop Distribution
- Crop 1 yield
- Crop 2 yield

- Crop 10 yield
- Crop 1 price
- Crop 2 price

- Crop 10 price

Cattle Distribution
- Cow price
- Baby calf price
- Female calf 12-24 months price
- Female calf 24-36 months price
- Male calf 12-24 months price
- Male calf 24-36 months price
- Culled oxen price
- Culled bull price
- Milk production per cow
- Milk price
- Replacement cow price
- Replacement oxen price
- Replacement bull price
- Price of hides
- Price of manure
- Cow sale weight
- Female cow sale weight 1-12 months
- Female calf sale weight 12-24 months
- Female calf sale weight 24-36 months
- Male calf sale weight 1-12 months
- Male calf sale weight 12-24 months
- Male calf sale weight 24-36 months
- Oxen sale weight
- Bull sale weight

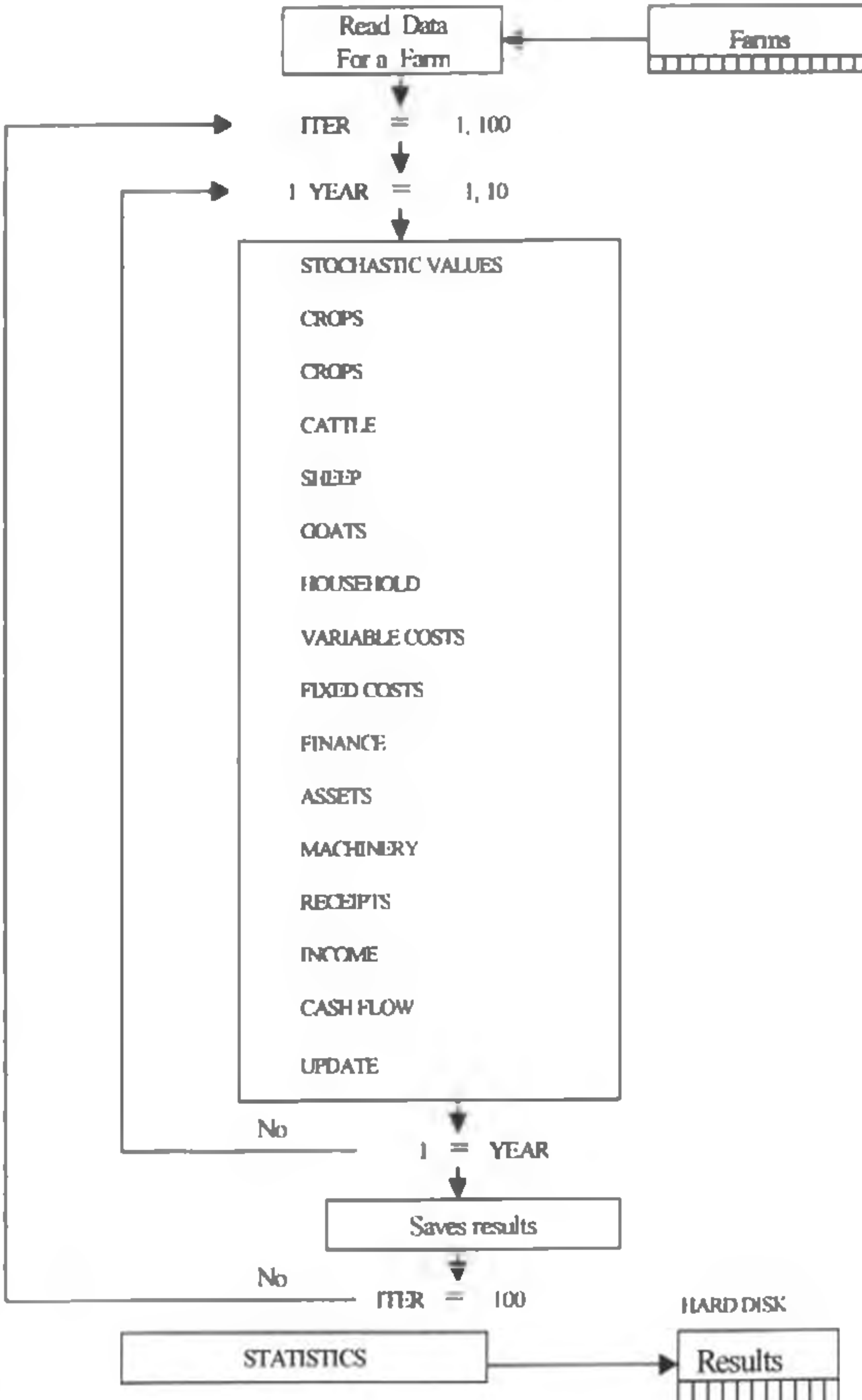

Figure 3 1 Schematic of the TIES Model

Stochastic Dominance Ranking

In this study Stochastic Dominance With Respect to a Function (SDWRF) was used to rank the simulated NPV probability density functions for different scenarios under the assumption that farmers are risk averse. This risk analysis criterion has been used widely in investment portfolio studies and in appraising technological studies to delineate the efficient choice set (Lee, Brown and Lovejoy, 1985; Lee *et al.*, 1987; Lemieux, Richardson and Nixon, 1982; Nyangito, 1992,). The stochastic dominance comparisons commonly used are, First-Degree Stochastic Dominance (FSD), Second-Degree Stochastic Dominance (SSD) and Stochastic Dominance With Respect to a Function (SDWRF). However, as shown in section 2.1, both FSD and SSD criteria are weak in that the former can not be used to rank cumulative distribution functions that intersect while the latter is useful only when the decision maker is risk averse. Unlike the FSD and SSD, Stochastic Dominance With Respect to a Function does not impose global restrictions on a decision makers' preference. It does not impose restrictions on the shape or the width of the specific area of aversion space (King and Robinson, 1981) as quoted by Lee, Ellis and Lacewell, (1987). The SDWRF orders uncertain choices for decision makers whose absolute risk aversion functions lie within specified lower and upper bounds. The absolute risk aversion function is defined by Pratt's or Arrow's risk aversion coefficient

$$R_a(Y) = \frac{-U''(y)}{U'(y)}$$

where U represents the utility function U

Y is the level of income

U' is first derivative with respect to y

U'' is second derivative with respect to y

R_a is a measure of individual attitudes towards risk as risk averse, loving or neutral More formally stated, SDWRF establishes necessary and sufficient conditions under which the cumulative distribution function F(y) is preferred to the cumulative distribution function G(y) by all individuals whose absolute risk aversion function lie everywhere between lower and upper bounds $r_1(y)$ and $r_2(y)$. As developed by Meyer (1977) the solution procedure to identify a dominant distribution using SDWRF requires the identification of a utility function $U_o(y)$ which minimizes the following:

$$\int_{-\infty}^{\infty} [G(y) - F(y)]\, U'(y)\, dy$$

Subject to the constraint

$$r_1(y) \leq \frac{-U''(y)}{U'(y)} \leq r_2(y) \text{ for all values of y.}$$

Arrow defined an individual as risk averse (loving) if, when faced with uncertainty, the individual is unwilling (willing) to accept a fair bet[10] (Robison *et al* 1984) A direct way of accounting for risk aversion is to elicit an empirical/subjective utility function through a carefully asked set of structured, cogent, hypothetical or real risk-indifference questions (Anderson, Dillon and Hardaker, 1977). However, since these questions are not easy to couch in such a way that they yield realistic, consistent and valid responses alternate procedures are commonly used

Nyangito (1992) used the procedure indicated by McCarl and Bessler (1989) where an upper bound risk aversion coefficient is estimated from the coefficient of variations and standard deviation of risky prospects According to Pratt (1964) derivation the upper bound

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[10] A fair bet may involve tossing a fair coin where if the head shows you receive Kshs 100 and if the tail shows you lose Kshs 50 A fair coin has 50% chances of head showing and 50% chances of tail showing

risk aversion coefficient is equivalent to twice the inverse of the coefficient of variation divided by the standard deviation of the expected income

Based on Pratt's (1964) derivation the risk aversion coefficients were calculated from the simulated NPV's for the base farms. The risk aversion coefficients were then used to rank farms under different scenarios. However, only 8 farms were ranked, due to the time limitation and tediousness of calculating risk aversion coefficients for individual farms and the fact that TIES perform stochastic dominance ranking of scenarios for one farm at a time

3.6 Alternative Scenarios Analyzed

In this study the two groups of households, AD and NAD were analyzed Both statistical analysis and 10 year stochastic simulations were done to assess the financial performance of the farms under the following scenarios

Scenario A

Scenario A is the Base scenario and considers the current level of dairy activity in terms of input use (concentrate and heath services) and existing enterprise mixes The actual concentrate and health costs obtained from the farm surveys were used The cattle mortality rates and productivity (live weights and milk production) levels used were obtained from MoALDM reports and the farms surveys. This scenario aimed at evaluating the current farming practices and household economy which then formed a base for comparison with other scenarios

Scenario B

Scenario B reflects intensified dairying with concentrate feeding and health services increased Concentrate feeding was increased to 4 kgs of dairy meal per day of lactation period to reflect the national extension recommendations and the actual amount farmers thought they were feeding Health services were increased to include immunization against foot and mouth diseases as a practice for all the farmers, while acaricide application was increased to once a week for all semi-zero grazers Farmers whose cattle had frequent attacks from mastitis had their control measures improved by including the use of preventative chemical and dry cow therapy Milk production was assumed to increase at a rate of 1.5 kgs per every extra 1 kg of concentrate fed to a cow, at a price of Kshs 7.30/kg

Scenario C

Under scenario C, 10% of an hectare was re-allocated between maize and napier grass for 8 selected farms Four farms from each group of household (AD and NAD) were selected based on size of napier grass land and their performance in NPV and net farm income per hectare Two farms in each group with napier grass land at least large enough to produce minimum amount of forage required to feed a cow per year (0 192 ha)[11], while the other two farms in each group had inadequate napier grass land For those farms with enough napier grass land their scenario C involved reduction of the napier grass land by 10%, while for those with inadequate napier grass land it was increased by a 10%. The performance of the 4 farms selected in each group were, two poor (one with and the other without adequate napier grass) and two good (one with and the other without adequate napier grass)

It was assumed that no costs were involved in re-allocation and labour was not a constraint The importance of this scenario was to find out how maize (grown to provide both food and fodder) compare with napier grass in stabilizing household economy

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[11] ‗0075 kgs was the minimum forage requirement assumed in this study

3.7 Data development and assumptions

Since smallholder farmers in developing countries rarely keep farm records it is difficult to obtain reliable data on farming activities that cover long periods Thus for single visit data collection, researchers have to rely on the memory of the farmers However, assumptions were made whenever the provided data were considered insufficient or inaccurate.

The majority of farmers were not able to estimate the amount of forage fed to a cow per day. However, from values given by a few farmers and the help of a MoALDM official, the average and minimum forage requirements per cow was estimated to be 23,725 and 20,075 kgs/ year respectively This was comparable to NDDP (1994) findings that, depending on milk production level and size, a cow needs between 20,000 to 29,000 kgs of napier grass per year

Similarly, most farmers could not provide napier grass yield, so the yield adopted for these farmers was 104.6 t/ha (42,340 kg/acre) per year, an average of the limited yields data obtained during the survey from 8 farmers and an official from MoALDM However, this yield was comparable to the research findings at KARI, Muguga station (Anindo and Potter, 1994) and yields estimates by Schaik (1995) for the Murang'a survey According to Anindo and Potter, on average, 20-25 tonnes DM of high quality napier grass can be produced per hectare per year in the Kenya highlands. Assuming that fresh napier grass is 20% dry matter, this is equivalent to 100-125 tonnes per hectare Schaik (1995) estimated napier grass yield in Murang'a to be 102 tonnes per hectare

Although the majority of farmers fed thinned maize plants to cattle, no farmer was able to estimate the total amount of maize forage used this way Since there was no data available for use, estimates were done based on residue yields studies done in Western Kenya and

Katumani According to de Leeuw and Nyambaka (1995), data on actual residue yields are scarce and most estimates are based on assumptions of ratios between residues and grain yields that range from 1:1 to 6.1 for high and low yields respectively.

Onim *et al* (1986) indicated that the mean stover DM yield of commercial hybrids was 7.8 t/ha while their mean grain yield was 5.861 t/ha, giving a ratio of 1.33:1. Using the ratio, and since the average maize grain yield for the sample farmers was 3,703 kg/ha/yr (in two seasons), the maize residues DM was estimated to be 4,925 kg/ha/yr, equivalent of 24,625 kg of fresh forage (assuming 0.2 DM content)

The sample farmers normally sow 3-4 maize seeds per hill, in a spacing of 75 by 30 cm, and thinned the crop as it grows to eventually have 2-0 plants per hill To estimate the forage obtained from thinning it was assumed that farmers thinned 1st maize plant when 3 months old, 2nd when 4 months old and 3rd when 4.5 months old. Late thinning was assumed because most farmers grew maize purposely to produce both fodder and food grains. To estimate the total forage obtained this way, extrapolation of maize growth models obtained at Katumani (Wafula and Keating, 1987) was done to fit maize grown in Limuru Growth and development of both hybrid and Katumani maize were assumed to be proportional to the time after germination According to the model, when Katumani Composite was 50, 67 and 75% old the total (leaf, stem and ear) dry weight were equal to 39.2, 65.4 and 78.4% of total dry weight at harvesting time, respectively These percentages were used in calculations of the total maize forage obtained through thinning and was estimated to be 51.83 t/ha (20,984 kgs/acre)

Equally difficult to estimate was the price of 1 kg of napier grass and maize forage Farmers were not able to estimate the weight of forage loads they carry on their back or in donkey carts and in most cases overestimated the price of forage However, using the prices given in per area of forage bases by a few farmers, maize forage and napier grass were estimated to be Kshs 0.30 and Kshs 0.25 per kg respectively, in Kabuku sub-Location and Kshs 0.25 and 0.20 per kg respectively, in Kamirithu sub-Location The difference between the two sub-Locations can be attributed to high population density and hence smaller land holdings in former sub-Location as compared to the latter These prices though comparable were lower to the real price of maize stover, Kshs 1.08 per kg in Western Kenya as estimated by Onim *et al.*, (1985) and quoted by Onim *et al.*, 1986 A forage shortage of 20% of the minimum amount necessary to maintain the herd was taken as a drought In a drought situation young stock were assumed to be culled first to allow sufficient forage to maintain the dairy cows The mortality rates for female and male calves were 13.1 and 35.8%s respectively (Gitau *et al.*, 1994)

The family size was expressed in Adult Equivalent Consuming Units using conversion factors for age groups (Leegwater *et al.*, 1990) Crops and milk produced on the farm were partly used by the family and the surplus was sold

The interest rate used in the model depended on sources of loans, otherwise the Co-operative Bank interest rate was used since all sample farmers belonged to LDCS and could obtain loans from the society Inflation rate was excluded from all prices hence all simulations over the ten year period were at current price levels Due to the current economic changes (of a liberalizing economy) and lack of data forecasting of future prices was not possible. However, assuming the rate of deflation or inflation for both prices and costs would be equal, the use of real prices for base year was plausible because general nominal price changes would not affect the profitability of an enterprise

For every individual farmer, probability distribution of yields, live weights and prices were calculated The farmers were asked for a minimum, average and maximum figure With these and data from the other case farms and from secondary data the probability distributions were constructed

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter presents the results of the descriptive and simulation analyses and their interpretations

4.1 Descriptive Analysis

This section presents the description of pattern of farm households resource utilization, sources of income, sources of risks and the risk management strategies used by the sample farmers in the survey

4.1.1 Farming Systems of the Sample Farms

The farms studied were farm families in which most members permanently resided on the farms and acted as the main source of labour In an effort to be self-sufficient in food and hedge against various risks, farmers in the study area produced many different types of crops in addition to livestock Households also engaged in crop and dairy marketing to earn cash income and to cover for food shortages A high percentage of these farmers, 77%, had off-farm sources of income (Table 4.5).

The 35 sample farms, all of which were dairy farms, consistently grew a small number of major or dominant crops, and several minor crops that differed from farm to farm (Table 4.4). Most crops were intercropped but a few such as pyrethrum and flowers were mono-cropped The farmers selected and managed these crops and livestock so as to exploit crop/ animal relationships (Figure 4.1) and to ensure the highest relatively stable income. Mixed farming is typically complementary in an "on-average" technical sense, through more efficient use of labour and land resources and through exploitation of intermediate joint products such as biologically fixed nitrogen, and grazing of growing (and failed) crops and crop residues (Anderson and Dillon, 1992) Furthermore, this diversification is a risk response by the smallholder farmers to safeguard household food security, protecting the household against starvation in case one or two activities fail Even if all the activities are somewhat risky, as long as the risks are at least partially independent of each other, the household increases its safety by undertaking more activities (Gittinger *et al.*, 1990).

The fact that farm sizes were small, averaging only 0 895 hectares (Table 4 1), farmers maximized land use through intensification and relay cropping, i.e one to three months before a crop is harvested from the farm, farmers sow another crop in between the lines of the first one Most of the farmers had zero grazing units[10] and practised cut-and-carry system of feeding Poultry and livestock such as dairy cows and sheep were also fed on residues from crops such as maize and kale To maintain soil fertility, farmers applied livestock manure but some bought chemical fertilizers whenever available manure was not adequate. Poultry waste was used as cattle feed and sometimes applied in the farms

4.1.2 Gender Aspect

A general observation showed that women provided most of the labour engaged in dairying Labour provided included cutting and carrying of fodder, feeding and milking of cows and transporting of milk to the collection centers Children sometimes assisted in carrying fodder and milk transportation However, building of cow sheds and fencing were mainly done by men (either husbands or hired male labour). The purchase of inputs such as

[10] Structural units in which cattle are enclosed and fed

concentrate was done by either the wife or husband depending on who had another mission requiring him/her to travel to the nearby town or market

Women made most of the day-to-day decisions regarding farm operations in the majority of farms In other farms decision making was in consultation with the husbands However, in most cases decisions on sensitive issues, such as income utilization, were only made by the husbands Even when a husband worked away from the farm and came home infrequently, he still controlled the farm incomes and made major farm decisions (e g selling of a sickly or unproductive animal).

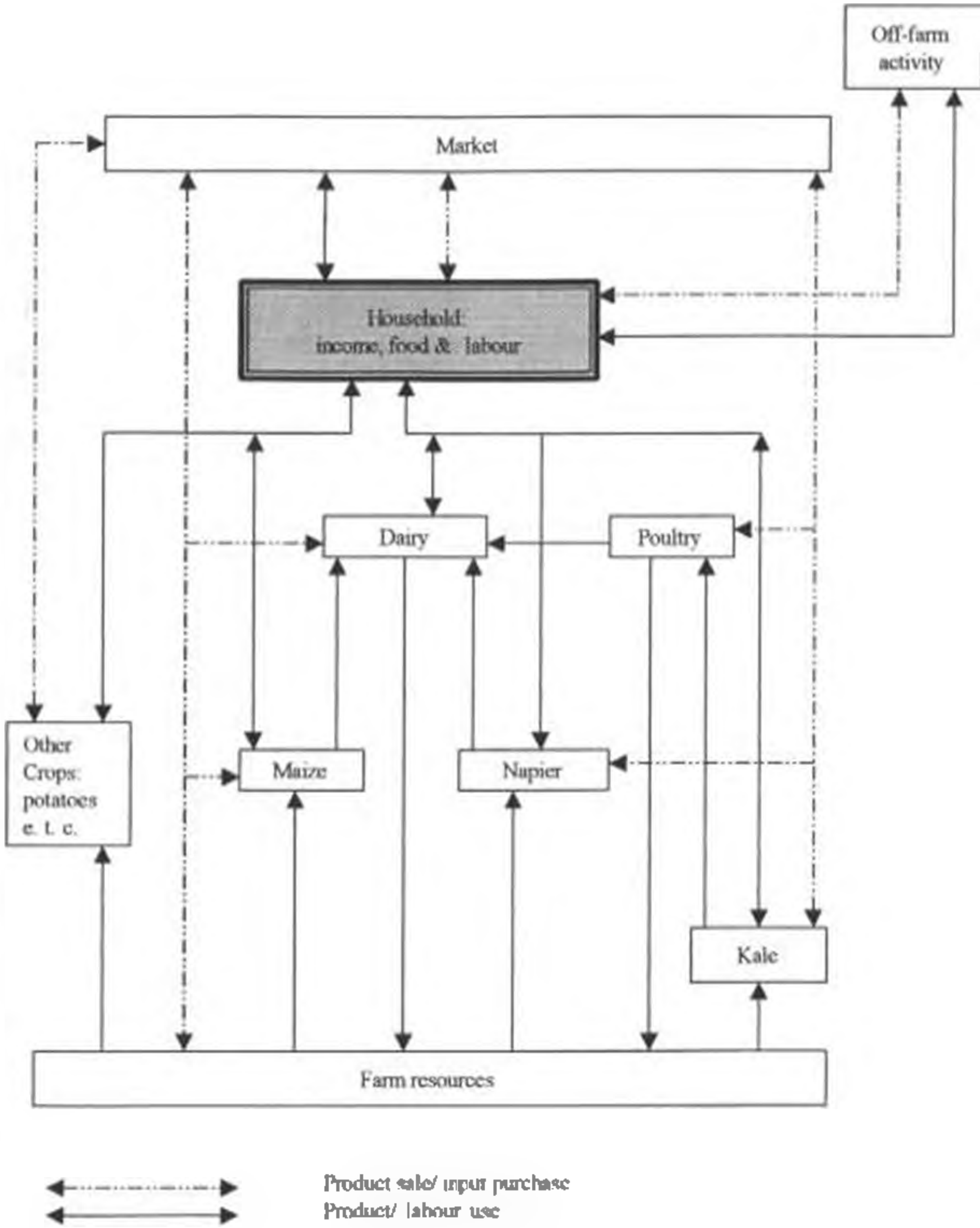

Figure 4.1 Sample Farm Activities and their Interrelationships

4.1.3 Household Resource Utilization

Observations made from the sample farms indicates that AD farmers invest more in farm activities than NAD farmers The mean number of farm enterprises for farm dependent and non-farm dependent farmers, 6 65 and 5 42 respectively, were found to be significantly different (p=0.004) Although only significantly different at 10% critical level (p=0.08) the AD households had more land available to them than the NAD households with the former owning on average 1.069 hectares and leasing 0.263 hectares, while NAD households owned 0.563 and leased 0.194 hectares (Table 4.1).

The lease cost per hectare of land was significantly different (p=0.06) at 10% significant level with a tendency of NAD group leasing cost per hectare (with average Kshs 5558) being higher than that of AD group (with average Kshs 3809)[13]

The proportions of available land used for crops and napier grass production for AD and NAD households were 64% and 77% respectively This was an indication that homesteads, paddocks, forests and others used more of the available land in AD farms than in NAD ones This is further supported by the fact that 9 of the 10 semi-zero grazers[14] belonged to AD farms.

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13 Since the incomes of AD group were lower and more unstable compared to those of NAD group the AD group accepted the lease only when the lease cost was adequately low- a rate that did not appear to adversely affect the farms economy

14 System of farming where farmers partly keep and feed their cattle in an enclosed structural unit and partly graze them out in the field

Table 4 1
Summary Description of Land use in Sample Farms

Feature	Overall n = 35	AD Household n = 23	NAD Households n = 12
Farm size (hectares)	0 895 (0 895)	1 069 (0 850)	0 563 (0 915)
Hectares leased	0.247 (0 457)	0.275 (0.499)	0.175 (0.164)
Lease cost per hectare (Kshs)	4,683 (2,715)	3,809 (2,065)	5,558 (2,927)
Cropland (ha)	0.543 (0 401)	0.603 (0 425)	0.425 (0.344)
Napier grass field (ha)	0.215 (0 174)	0.254 (0 191)	0 140 (0 098)
Number of farm activities	6 23 (1.55)	6 65 (1 47)	5 42 (1 44)

Figures in parentheses are standard deviations about the means
Source Survey Results, 1995

4.1.4 Sample Farms Incomes and Expenditures.

To increase the household income level and stability, family members engage in off-farm activities such as wage employment Out of all 35 farmers sampled 27 (77%) had off-farm sources of income The results indicated that the off-farm activities were more profitable for these households than farming alternatives, and as a consequence contributed more towards stabilizing income and reducing risk For a given variability of income, the higher the income is on average, the lower the risk that income will fall below the level necessary to ensure an adequate level of food consumption (Gittinger *et al* , 1990) There was significant difference (p=0 00) between the means of the net incomes received from off-farm activities by NAD farms, Kshs 151,406, and that received by AD farms, Kshs 32,139 (Table 4 2) The mean of the net incomes received from on-farm activities were also significantly different (p=0.01), with NAD group receiving only Kshs 48,925 while AD group received Kshs 116,372 This can be attributed to the fact that the AD households had more available land than the NAD households

Table 4.2
Description of Sample Farms Cash Incomes and Expenditures

Feature		Overall n = 35	AD Household n = 23	NAD Households n = 12
Dairy cash production cost (Kshs/yr)		20,649 (21,334)	22,041 (25,794)	17,864 (7,004)
Annual net cash income from (Kshs/yr)	Dairy	32,231 (37,959)	36,184 (42,966)	24,655 (24,019)
	Crops	13,794 (27,312)	18,190 (32,444)	5,368 (9,291)
	Poultry[15]	47,223 (84,207)	61,998 (98,136)	18,903 (36,391)
	On-farm	93,247 (87,092)	116,372 (113,389)	48,925 (36,690)
	Off-farm	73,030 (87,661)	32,139 (39,203)	151,406 (102,376)
	Total (on- + off-farm)	166,278	148,511	200,332
Expenditures (Kshs/yr)	Household	74,297 (39,066)	68,559 (35,775)	85,295 (44,235)
	Education	20,649 (17,672)	19,435 (17,992)	22,977 (17,575)
	Total	94,946	87,994	108,272
Overall Net cash income[16]		71,332	60,517	92,060

Figures in parentheses are standard deviations about the mean
Source Survey Results, 1995

[15] High poultry incomes of few farmers, 4 NAD and 10 AD, greatly affected the average poultry incomes of the whole sample

[16] Incomes from sale of culled cows, male calves, sheep and goat and other miscellaneous sales are excluded

The NAD households' sum of annual net cash incomes from both farm and off-farm activities (Kshs 200,332) and total annual household expenditure (Kshs 85,295) were higher compared to means of sum of annual net cash incomes (Kshs 148,511) and that of total annual household expenditure (Kshs 68,559) of the AD households. Also, the overall annual net cash income for the NAD households (Kshs 92,060) was much higher than that of AD households (Kshs 60,517)

Dairying was the single most important farming activity among the two groups of farms Dairy net cash incomes composed 50% and 31% of the on-farm incomes of NAD and AD groups respectively[17], while the net cash incomes from crops composed only 11% and 16% of on-farm cash incomes of NAD and AD groups respectively However, a large proportion of the produced crops was consumed at home level

4.1.5 Dairying in Sample Farms

A majority of the sample farmers had zero grazing units and only one NAD household and 9 AD households practised semi-zero grazing On average the sample farmers had 1.74 cows per household with the AD group having 1.91 cows while the NAD group had 1 42 cows on average (Table 4.3). Though the NAD households had higher mean of annual milk yield per cow (2,916 kg) than that of AD households (2,581 kg), the latter earned more net income per cow milk per year (Kshs 18,945) than the former (Kshs 17,363). This may be explained by the fact that since NAD households had approximately one cow on average, there was less milk left for sale after home consumption while, with approximately two cows, the AD households had more milk available for sale after home consumption The concentrate

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[17] Although incomes from poultry were very high only 16 farmers kept them

costs and health cost per cow for NAD group were respectively 10% and 44% higher than that of AD group. The sum of concentrate and health costs of NAD group was 16% higher than that of AD group This may explain the 13% higher milk yield per cow of the NAD group compared to AD group Since NAD group had relatively higher net incomes than AD group it would imply that, comparatively, the former is less credit constrained than the latter This closely agrees with the findings by Oluoch-Kosura and Ackello-Ogutu (1995) that credit constrained farmers were using lower amounts of inputs than non-credit constrained farmers

No significant differences were found with respect to the lactation period (p=0 13) and calving interval (p=0 11) which were 331 and 394 days respectively, for AD households, and 408 and 473 days respectively, for the NAD households. According to Whittemore (1980) the maximum annual yield appears to accrue if the cows are mated to calve once every 350 to 370 days and have a lactation of high peak and good persistency lasting 300 to 320 days Schaik (1995) indicated that a farm could benefit with as much as 29% increase in its gross margin by shortening the calving interval by 24-28 days. Therefore, it appears that, despite the NAD group having higher milk yield per cow it stands to gain more in terms of increased milk yield and number of calves through adjustments of both the lactation period and calving interval.

Although the land under napier grass was significantly different (p=0.03) for the two groups of households, the land under napier grass per cow and maize per cow were not significantly different. Land under napier grass for AD group was on average 0.254 hectare while for NAD group was only 0 140 hectare. Land under maize and napier grass per cow for the AD households was 0.161 and 0 130 hectares respectively, while for NAD was 0 189 and 0.099 hectares respectively Assuming maize forage available from thinning is 51 83 t/h and napier grass yield is 104 58 t/ha (section 3 7) the available forage per cow was 21,940 kg and 20,150 kg for AD and NAD households respectively

Assuming the average forage (napier grass or maize forage) price is Kshs 0 25 per kg (section 3 7) then with Kshs 323, which is the cost of forage purchased per cow during the time of shortage, the AD household purchase 1,292 kg of forage while with Kshs 1,317 NAD households purchase 5,268 kg of forage per year. Therefore, on average total forage fed to a cow per year amounts to 23,232 kg for AD group, 25,418 kg for NAD group and 23,981 kg for both groups Since this amount almost tally with the earlier estimate of average forage requirements per cow (23,725) and the NDDP figures (section 3.7), forage obtained from thinning of maize was assumed to be estimated with reasonable accuracy This further confirms the assertion by Tanner (1996) that farmers are attuned to supply/requirement characteristics of their farms

Table 4.3
Summary Description of Dairying in Sample Farms

Feature	Overall n = 35	AD Household n = 23	NAD Households n = 12
Number of cows	1 74 (1 20)	1 91 (1 35)	1 42 (0 79)
Lactation period(days)	357 (119)	331 (90)	408 (153)
Calving interval (days)	421 (115)	394 (89)	473 (145)
Milk yield/cow/year (kg)	2,693 (611)	2,581 (623)	2,916 (547)
Maize land/cow (ha)	0 169 (0 142)	0 161 (0 154)	0 189 (0 114)
Napier grass land/cow (ha)	0 121 (0.098)	0 130 (0 107)	0.099 (0 055)
Concentrate costs/cow (Kshs)	5,553 (2,545)	5,370 (3,002)	5,919 (1271)
Health costs/cow	1,389 (1,429)	1,212 (1,027)	1,743 (2,036)
Forage costs/cow (Kshs)	595 (1,193)	323 (372)	1,317 (2,402)
Number & percentage of semi-zero grazing farmers	10 29%	9 39%	1 8%

Figures in parentheses are standard deviations about the mean
Source Survey Results, 1995

Table 4 4
Number of Crops Produced by Sample Farmers

	Number of crops	Number of farmers	Percentage of sample farmers
	3	1	2.9
	4	15	42 9
	5	11	31.4
	6	6	17.1
	7	2	5.7
Total	-	35	100.0
Mean	4.8 (0.96)	--	—

Table 4 5
Sample Farm Enterprises in Order of their Frequencies

Enterprises	Frequency	Percentage
Napier	35	100%
Maize	35	100%
Dairy	35	100%
Irish Potatoes	29	83%
Kale	28	80%
Off-farm activities	27	77%
Field Beans	18	51%
Poultry	16	46%
Pyrethrum	8	23%
Sheep/goats	8	23%
Cut flowers	5	14%
Other	≤3	9%

Source Survey Results, 1995.

4.1.6 Differences in Sub-Locations

The two sub-Locations sampled differed both ecologically and in population density Kamirithu sub-Location, which borders Kajiando District has less rainfall and population density than Kabuku sub-Location. The farm sizes of the two locations were significantly different (p=0.02), with Kabuku farms averaging 0.572 hectare and Kamirithu 1 439 hectares

(Table 4 6) Although the leased land was not significantly different (p=0.78) on average Kamirithu farms leased more land (0 28 ha) than Kabuku farms (0.23 ha). Grazing systems were also different, with 8 farms out of 13 practising semi-zero grazing in Kamirithu sub-Location while only 2 out of 22 practised semi-zero grazing in Kabuku sub-Location

Table 4.6
Summary Description of Sample Farms Based on Sub-Locations

Feature	Kabuku sub-Location n = 22	Kamirithu sub-Location n = 13
Owned Land (ha)	0 572 (0 598)	1.439 (1 064)
Leased land (ha)	0 226 (0 289)	0.280 (0.672)
Number of farm activities	5 82 (0 85)	6 92 (1 38)
Out of farm grazing/yr (days)	0.00 (0.00)	25.38 (42.15)

Figures in parentheses are standard deviations about the mean
Source Survey Results, 1995

The number of times cows were grazed away from owners farms were significantly different (p=0 05) with Kamirithu farmers grazing outside farms 24 days per year while cows in Kabuku do not leave owners' farms According to Mcintire *et al.* (1992) rising population necessitate the expansion of cultivated area, replacing pasture and thereby reducing the grazing area for animals

The grazing systems may explain why there were more incidence of Tick Borne Diseases (TBD) in Kamirithu sub-Location than in Kabuku sub-Location The fact that the sub-Location lies *en route* of beef cattle moving from a major cattle market in Kajiando to Nairobi poses higher disease risk to the extensive form of dairying

With low population density and extensive production, there is a cost advantage to specializing in crop or animal production and interacting through markets (Mcintire *et al.*,

1992) However, despite lower population and larger farms, the number of farm activities undertaken by farmers in Kamirithu sub-Location was significantly higher (p=0 02) (6.9) than those undertaken by farms in Kabuku sub-Location (5.8) This may be a management strategy to cope with risk posed by inadequate rain and cattle diseases It supports the theory that the higher the risk facing the household economy the more the farmer tends to diversify

4.1.7 Sources of Risks Associated with the Sample Farms

Sources of risks in the study area were mainly of two types. (1) production or technical risk, and (2) market or price risk Production or technical risk is a random variability inherent in a farm's production process The sources of this risk in the area include among other factors, weather, diseases, pests and theft Market or price risk occurs through purchased inputs and marketed outputs. It is assumed that pattern of input and output prices in past years affects the farmers' choices and combinations of enterprises and their management practices Short-run fluctuations in input prices can cause considerable income losses and cash shortfalls (Barry, 1984) and this will affect farmers' future production decisions

Although farmers cited production risks as most critical it is important to acknowledge the complementarity that exists between production and market efficiency in stabilizing farm household economy Competitive prices, in the context of being "right" prices enhance the ability of a household to cope with production risks Similarly, efficient production helps buffer the household economy against instability occasioned by market risk

For ease of analysis, risk sources were grouped into livestock risks and crop risks (Table 4.7 and 4.8). This allowed ordering of risk sources according to their incidence in the sample farms Consequently, comparisons of different risk sources was possible

Table 4 7
Risk Cited on Sample Farms and their Incidence

Risks	Frequency	Incidence (%)
Livestock risks		
East Cost Fever	21	17
Mastitis	21	17
Anaplasmosis	12	10
Newcastle's disease	12	10
Gumboro	10	8
Other diseases	8	6
Theft	6	5
Typhoid	5	4
Pneumonia	5	4
Diarrhoea	4	3
Low rainfall	4	3
Foot and Mouth Disease	3	2
Helminthiasis	2	2
Lack of market	2	2
Low prices	2	2
Diseases in general	1	1
Poor quality concentrates	1	1
Coccidiosis	1	1
Crop risks		
Low rainfall	93	30
Blight	42	14
Theft	25	8
Moles	23	8
Poor seed quality	16	5
Shortage of labour	11	4
Maize stalk borer	9	3
Bacterial wilt	9	3
Aphids	9	3
Cut worms	8	3
Lack of market	8	3
Moths	8	3
Excessive rainfall	5	2
Very low temperatures	4	1
Maize streak virus	4	1
Low prices	4	1
Frost	2	1
Shortage of manure	2	1
Lack of fertilizer	2	1
Lack of seed	2	1
Maize smut	2	1
Other diseases (7 diseases)	≤2	5
Other pests (6 pests)	≤2	3

Source Survey Results, 1995

Table 4 8

Three Major Risks for Main Enterprises on Sample Farms

Livestock risks		Incidence (%)	Management strategies (%)		Effectiveness
Dairy 35[a]	- East Coast Fever	60 (21)	- prophylactic	86 (18)	- very good
			- curative	10 (2)	- good
			- nothing	5 (1)	____
	- Mastitis	60 (21)	- prophylactic	81 (17)	- good
			- curative	19 (4)	- good
	- Anaplasmosis	30 (12)	- prophylactic	83 (10)	- very good
			- curative	17 (2)	- good
Poultry 16[a]	- Newcastle's disease	75 (12)	- prophylactic[b]	92 (11)	- very good
			- curative	9 (1)	- good
	- Gumboro	63 (10)	- prophylactic[b]	100 (10)	- good
	- Typhoid	31 (5)	- prophylactic[b]	100 (5)	- good
Crop production risks		**Incidence (%)**	**Management strategies (%)**		**Effectiveness**
Napier 35[a]	- Low rainfall	69 (24)	- nothing	58 (14)	____
			- grow a lot	21 (5)	- good
			- mulching	17 (4)	- good
			- buy hay	4 (1)	- good
	- Moles	46 (16)	- trap /poison	100 (16)	- good
	- Labour shortage	11 (4)	- nothing	100 (4)	____
Maize 35[a]	- Low rainfall	83 (29)	- nothing	76 (22)	____
			- timely planting	14 (4)	- good
			- early planting	10 (3)	- good
	- Theft	54 (19)	- early harvesting	37 (7)	- good
			- nothing	32 (6)	____
			- guarding	16 (3)	- good
			- maize grown at different sites	11 (2)	- good
			- grow less maize	5 (1)	- good
	- Poor seed quality	20 (7)	- nothing	57 (4)	____
			- hybrid selection	29 (2)	- good

			- mix own and certified seed	14 (1)	- very good
Potatoes 29[a]	- Blight	97 (28)	- prophylactic[c]	82 (23)	- very good
			- nothing	11 (3)	—
			- curative	4 (1)	- good
			- hybrid selection	4 (1)	- good
	- Low rainfall	41 (12)	- nothing	42 (5)	—
			- timely planting	33 (4)	- good
			- early planting	25 (3)	- good
	- Theft	17 (5)	- nothing	60 (3)	—
			- guard	20 (1)	- very good
			- crop grown at different sites	20 (1)	- good
Kale 28[a]	- Low rainfall	36 (10)	- nothing	40 (4)	—
			- irrigation	30 (3)	- very good
			- timely planting	20 (2)	- good
			- mulching	10 (1)	- very good
	- Cut worms	25 (7)	- nothing	57 (4)	—
			- prophylactic[d]	29 (2)	- very good
			- curative	14 (1)	- good
	- Blight	21 (6)	- nothing	100 (6)	—
	- Moths	21 (6)	- curative	67 (4)	- good
			- nothing	33 (2)	—
Beans 18[a]	- Low rainfall	67 (12)	- timely planting	42 (5)	- good
			- nothing	42 (5)	—
			- early planting	17 (2)	- good
	- Blight	22 (4)	- nothing	100 (4)	—
	- Aphids	22 (4)	- nothing	75 (3)	—
			- curative	25 (1)	- fair
	- Excess rainfall	22 (4)	- nothing	75 (3)	—
			- timely planting	25 (1)	- good

a = number of farmers engaged in the activity
b = prophylactic drugs used
c = prophylactic spraying done
d = protective chemicals applied
Figures in parentheses are number of farmers citing the risk.
Source: Survey Results, 1995

4.1.8 Risk Management Strategies Used by the Farmers and their Relation to and Effect on Dairy Enterprise.

Household Economy

To ensure household food security, farmers use different methods of risk mitigation and these determine how the available resources are utilized. Traditional methods of handling risk can be divided into risk-minimizing and loss-management mechanisms. Risk-minimizing practices are adjustments to production and resource use before and during a production season (Frankenberger and Goldstein, 1990). This involves practices such as diversification, and adjustments such as relay cropping. Farm diversifications involve having many different on-farm income-generating activities and may include off-farm income sources.

In spite of having small farm sizes (owning 0.895 ha and leasing 0.247 ha), to minimize the effect of production and market risks to household economy the sample farms had diversified into 6.23 farm activities as shown in section 4.1.3. Also, 77% of the farmers had off-farm sources of income. The enterprises undertaken determine how the available resources are utilized and managed. This supports the theory that farmers use diversification as a risk mitigation strategy to stabilize household economy.

When asked what they consider to affect household economy most seriously, 54% of the farmers said dairy cattle diseases while 46% said crop failure. This indicates how important both dairying and crop production are in supporting the households. According to 74% of the sample farmers dairy cattle diseases affect household economy more seriously than does a *bad market*[11] while only 26% of farmers found *bad market* more serious. This may be explained by

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[11] Situation characterized by high input prices (thus high production cost) and inadequate market for farm produce leading to low output prices, as was the case during 1993 when inflation rate stood at 46%.

assuming that farmers are following the safety-first rule where a decision maker first satisfies a preference for safety in organizing a firm's activities and then follows a profit-oriented course of action (Robison *et al.*, 1980) Since farmers are producing most of their home consumption requirements they do not find *bad market* a big threat to household food security. This may explain the fact that, although most farmers grew many crops (food crop mainly) averaging 4 8 (Table 4 4) total cash income obtained from crops was relatively low compared to that of other activities Most of the food crops produced on farms were used by the households This supports the theory that to ensure household food security farmers practise "matching" as a way of mitigating market (price) and inflation risks "Matching" is a risk mitigation strategy where a household reduces its exposure to price risks by producing more of the food it consumes

As shown in Table 4.5, all sample farms were dairy farmers and produced maize The next most important crops were Irish potatoes, kale and field beans which were produced by 83%, 80% and 51% of farmers respectively Farmers in the study area use *Githeri*, a meal made of maize and beans, with or without potatoes as the main diet Increasingly important in their diet is *Ugali*, a mash meal made of maize flour, and is normally eaten together with kale Milk is mainly taken with tea although sometimes it is taken with *Ugali*

Out of the 16 farmers who keep layers 69% said they feared poultry diseases more than dairy diseases while only 31 feared dairy diseases more than poultry diseases. This may be explained by the fact that the poultry diseases which farmers said they fear most can cause a high economic loss through sudden death of all birds or a large proportion of them With this in mind, farmers keeping poultry invested heavily in poultry disease control measures such as proper housing and feeding, vaccinations and treatments

Dairying

All 35 sample farmers were dairy farmers, though during the survey period five farmers did not have a mature cow. Four farmers had lost their cows through; E.C.F., milk fever, after birth complication, poisoning from poisonous flowers and a fatal skin disease The fifth farmer had sold his cow after having frequent attacks from mastitis

The two diseases, E.C.F and mastitis were each cited by 60% of the sample farmers as major sources of dairying risk However, only mastitis had high actual attacks of 46% in the sample farms despite the use of prophylactic measures such as medicated milking salves On average farmers spent Kshs 1,026 per year on treatment of mastitis

Zero grazing units have helped control tick borne diseases (T.B.D.) greatly This was evident because although most farmers rarely sprayed their cattle, high attacks of E.C.F were reported only in Kamirithu location where semi-zero grazing was practised The zero grazing system has also helped control Anaplasmosis which was cited by 30% of the farmers as a dairying risk

Although lack of rain was not cited by many farmers as a risk to dairying, it indirectly affects dairying as a risk to both napier and maize, which are the main fodder for dairy production

Farmers also fed their dairy animals with concentrates, mainly dairy meal, but only when the cow is in milk They fed concentrates at the rate of between 2 to 2.5 kgs per day, though they thought they gave 4 kgs per day This is because the 2 kgs *Kasuku*[19] container they use actually holds between 1 to 1.25 kgs of concentrates when full This leads to feeding concentrates at the rate of between 714 to 892.5 kgs per cow per year This rate is low

[19] A local brand of cooking fat, the empty containers of which often serve as a unit of measurement

compared to the optimal rate (1601 kgs/cow/year) estimated by Murithi (1990) but it is twice the rate reported by Kilungo, *et al.* (1994), 438 kgs/cow/year, for Kiambu District The difference is understandable because this survey covered the area considered by many to have the best smallholder dairy farmers in the District Twenty farmers also fed their cattle with poultry waste This help in reducing the high cost of feeding cattle with pure concentrate, while providing the animals with the high amount of protein required for milk synthesis (Kayongo and Muinga, 1985)

Poultry (Layers)

Of 16 sample farmers who kept poultry 75%, 63% and 31% cited Newcastle's disease, Gumboro and typhoid, respectively, as major sources of risks in poultry. All farmers preferred use of prophylactic drugs to control these diseases, save one farmer who preferred curative treatment in controlling Newcastle's disease

Napier grass

Napier grass and maize were grown by all farmers in the sample and were ranked as the first and second most important crops (Table 4.9). This suggests the importance of dairying to the farmers In order 18, 6 and 8 farmers ranked napier grass as their 1st, 2nd and 3rd most important crop respectively Maize was ranked 1st, 2nd and 3rd by 14, 12 and 7 farmers respectively.

Although low rainfall was cited by a majority of farmers as the main risk for most crops most farmers said they did nothing to address the situation They expressed sense of helplessness and attributed availability of rain to the wish of God However, farmers used management practices such as mulching, early planting, manure application and contour planting to ensure maximum utilization of available rain by the crops.

Of the 69% of farmers who cited low rainfall as source of risk in napier grass production, to address the problem. 58% said they do nothing, 21% grow a lot of napier grass, 17% apply mulching and 4% buy hay to control the problem Although the risk control measures applied by the farmers might not be the best to an outsider it is important to note that farmers found these measures adequate and this justifies their use Farmers classified almost all risk control measures they use as good or very good A rational decision is one that is consistent with the decision-maker's beliefs and preferences and thus corresponds to choices of the action whose probability distribution of the consequences maximizes the decision-makers subjective expected utility (Anderson and Dillon, 1992).

All the 46% of the farmers who said they feared moles' invasion in napier grass field control them by trapping or poisoning The 11% who feared labour shortage said they did nothing to control the problem

Maize

The fact that maize is grown both as a food and fodder crop may explain why all the sample farmers produced it and 33 of them ranked it within the top three positions as compared to 32 for Napier grass Also, 26 farmers ranked maize within the top two positions as compared to 24 for napier grass It is the most important component in the diet of the local people Cooked together with beans they form *Githeri*, the main dish of the local people As indicated earlier it is also used to make *Ugali*

Production of maize, a staple food in the area, reduces reliance on markets for household food security and provides fodder for the dairy which also generates a cash and food product Instead of farmers growing napier grass alone which yield more forage compared to maize as shown in section 3.7, they prefer to produce less forage but at least be assured of some food rather than produce more forage and depend wholly on market for maize This further supports the theory of "matching"

The first hypothesis stated that "matching as a risk mitigation strategy is not a major determinant of the pattern of resource utilization and investment in dairying" In the context of this study and using the rule of the thumb, the term "major" is justifiably taken to imply anything above 50% Therefore, on the basis of this definition and in view of the above results the first hypothesis is rejected.

The importance of maize as both a fodder and as a risk management crop is also evident from the production and marketing strategies used by the farmers

Production strategies:

- As the maize crop grows large proportion of it is thinned to provide fodder
- Maize is normally cultivated from February to September but farmers grow maize whenever there is rain and space. If the crop is successful it provides both food and fodder, but if the crop produced is not suitable for food, the entire lot becomes fodder This applies even during the normal cropping season, allowing farmers to minimize income and food losses occasioned by poor weather

Although 76% of 29 farmers who said low rainfall was a risk in maize production said they did nothing to control the problem the above production practices help reduce the impact of low rainfall to the household economy About 14 and 10% of the farmers said they use timely planting and early planting, respectively, to control the problem

Marketing strategies

The majority of the sample farmers sold their maize green This maximizes the cropping intensity and provides dairy animals with green stover which are more nutritious and palatable than dry (Onim *et al.*, 1986, Sanda, 1995). It also minimizes losses through theft which was cited by 54% of farmers as a source of risk In addition to solving the problem of uncertainty of future prices, it reduces costs of handling and the possibility of pre- and post harvest pest attack Also, the historical price data from Kiambu District indicate that, more often than not, green maize is more profitable than dry grain

To control theft 37% of the farmers said they practice early harvesting, 32% said they do nothing while 16% guard their fields while 5% grow small maize acreage.

Poor seed quality was another source of risk in maize production cited by 20% of the sample farmers Although 57% of these farmers said they do nothing to address the risk the flexibility of the crop use as explained above serves as a control measure About 29% of these farmers said they keep changing hybrids depending on their performance while 14% mix certified and uncertified seeds when planting

Potatoes

Potatoes were produced by 29 of the sample farmers and were ranked in 1st and 2nd position by 13 farmers Hence potatoes may be ranked as the 3rd most important crop in the survey area after maize and napier grass It is an important component of the diet of the local people and is either used together with maize and beans to make *Githeri* or mixed with kale to make stew for eating together with *Ugali*

A majority, 82%, of the 28 sample farmers who cited blight as a risk spray potatoes using prophylactic chemicals and found it effective About 11% of the farmers said they do nothing, 4% do hybrid selection while another 4% treated the crop for blight only when attacked

Low rainfall was also cited as a risk by 41% of the sample farmers To control the problem 42% said they do nothing while 33 and 25 said they practised timely planting and early planting respectively

About 17% of farmers growing potatoes cited theft as a risk in potatoes production and to control it 60% said they do nothing, 20% guard the crop while the other 20% grow crops at different sites

Kale

Kale was the 4th most important crop grown by 28 of the sample farmers and ranked by 11% of the producers within 1st and 2nd positions It was grown for both home consumption and cash sale Farmers eat it mainly together with *Ugali* but sometimes eat it mixed in *Githeri*. Farmers who keep poultry also feed them with kale

Of 36% of the sample farmers who cited low rainfall as a risk in kale production 40% said they do nothing, 30% irrigate, 20% time the planting while the other 20% practice mulching

Cut worms, blight and moths were other risks cited by 25%, 21% and 21%, respectively, of the producing sample farmers Except for cut worms control where 29% of the farmers said they apply prophylactic chemicals, the majority of farmers did nothing or only treated the crop affected by cut worms, blight or moths The kale that does not do well due to any of risks mentioned is fed to the livestock, especially poultry.

Beans

Beans were ranked 5th with 18 farmers producing it and 11% of producers ranking it within the 1st and 2nd positions As shown earlier the crop is important in the diet of the local people in preparation of *Githeri*

A majority of farmers, 67%, said low rainfall was a risk in field bean production To control the risk, 42% said they do nothing, 42% time their planting while 17% practice early planting Other risks in field bean production were blight, aphids and excess rainfall Except for aphid attack, for which 25% of farmers treated the crop when affected, and case of excess rainfall where farmers said they timed the planting, the majority of farmers said they do nothing to control the three risks in bean production

Table 4 9

Crop Enterprises According to their Importance as Ranked by Sample Farmers

Crop	Ranking by producing farmers							Combined rankings 1st & 2nd (Producing farmers only)
	1st	2nd	3rd	4th	5th	6th	7th	
Napier	51% (18)	17% (6)	23% (8)	3% (1)	6% (2)	0	0	69% (24)
Maize	40% (14)	34% (12)	20% (7)	6% (2)	0	0	0	74% (26)
Potatoes	7% (2)	38% (11)	17% (5)	34% (10)	3% (1)	0	0	45% (13)
Kale	4% (1)	7% (2)	25% (7)	46% (13)	14% (4)	4% (1)	0	11% (3)
Beans	0	11% (2)	39% (7)	28% (5)	22% (4)	0	0	11% (2)
Flowers	0	20% (1)	20% (1)	40% (2)	0	20% (1)	0	20% (1)
Sweet potatoes	0	0	0	50% (1)	0	50% (1)	0	0% (0)
Carrots	0	0	0	0	67% (2)	33% (1)	0	0% (0)
Cabbage	0	0	0	0	100% (1)	0	0	0% (0)
Pyrethrum	0	13% (1)	0	25% (2)	0	50% (4)	13% (1)	13% (1)
Peas	0	0	0	0	67% (2)	33% (1)	0	0% (0)
Fruits	0	0	0	0	100% (1)	0	0	0% (0)

Figures in the parentheses are number of respondents

Source Survey Results, 1995

4.1.9 Farmers Perceptions and Attitudes towards Various Economic Factors and Undertakings

Farmers' Perceptions and Beliefs

When asked the reason for diversifying their household economy 54% of the farmers said they wanted to safeguard both food and income security, 34% wanted to safeguard food security and, 11% wanted to safeguard income security While the three reasons are related, farmer's goals will affect his or her choices and priorities They will determine how the farmer utilizes the resources available to him or her and what combination of risk mitigation measures to apply Which integrated strategy is best for an individual producer depends on the available resources, goals and risk attitudes, equity position, financing available, weather conditions, market availability, and other factors (Sonka and Patrick, 1984) The economic structure that provides the least risk is the outcome of four distinct considerations diversification, skewing, matching and input parsimony (Gittinger *et al* , 1990)

According to Gittinger *et al*, (1990) for a given expected income, diversified income sources will reduce fluctuations as long as the incomes from the different activities do not all vary in the same direction at the same time Also, a household may reduce the fluctuation in its income by skewing its resources away from high-risk activities and matching its production structure more closely to its consumption structure, that is, by producing more of the food it consumes Under input parsimony a household reduces fluctuations in net income by restricting the use of inputs

Farmers Expectations

When farmers were asked what they expect to happen to their household income and food security if use of five inputs were increased only fodder and acaracide application resulted in more than 50% of the sample farmers saying increased use would worsen the household's economic position (Table 4.10). Zero grazing dairying is an intensive system considered advantageous for smallholder dairy production (Mcintire *et al*, 1992 and NDDP Survey, 1990) as it helps control risk posed by tick borne diseases (T.B.D). This may explain why 91% of farmers considered increased use of acaricide application to be a waste of resources. To complement T.B.D. risk control, a majority of farmers said they avoid cutting fodder from common lands. The 9% of the farmers who considered increased use of acaricide worthwhile practised semi-zero grazing, and had high incidence of T.B.D. on their farms. However, they found acaricide expensive, and hence did not apply it at the level they considered optimal.

Only 43% of the sample farmers felt they were not giving cows enough fodder. These were the farmers who did not have enough land to allocate to fodder growing and/or lacked adequate labour.

According to Oluoch-Kosura and Ackello-Ogutu (1995) most farmers in Kiambu District are aware of modern dairy technology. This is further supported by the fact that the majority of sample farmers, 77%, knew or believed they could improve their household economy through increased milk yield per cow by increasing concentrate feeding. This is also in line with the earlier mentioned fact that the average concentrate feeding rate for the sample farmers (892.5 kgs/cow/yr) was less than the estimated optimal rate of 1601 kgs/cow/yr. (Murithi, 1990). Among these same farmers, 92% gave their reason for not increasing the concentrates as the high cost of the feed. This may be described as input parsimony because the farmers know that the extra cost of increasing concentrates is more than off set by the extra income received from resulting yield For a given expected net income, the more inputs the household uses the more it is exposed to risk (Gittinger *et al*, 1990) The same explanation may be extended to fertilizer use. of the 60% of sample farmers who said they expected household economy to improve with increased use of fertilizers, 95% of them found fertilizers to be too expensive to purchase. Farmers fear the loss of income that could result from increased input use should production fail due to stochastic events, such as weather, diseases, pests and prices Farmers also minimize production costs by intensive use of slurry as fertilizer

Table 4 10
Expected Changes in Household Income and Food Security in Response to Increased Input Use.

Input Increased	Expectation			Reason for NOT increasing
	Incr.	Decr.	Other	
Concentrates	77% (27)	20% (7)	0% (0)	92% (25)-expensive 8% (2)-not available
Fodder	43% (15)	57% (20)	0% (0)	60% (9)-fodder shortage 40% (6)-labour shortage
Cow	100% (35)	0% (00	0% (0)	54% (19)-expensive 23% (8)-fodder shortage 14% (5)-labour shortage 9% (3)-other reasons
Fertilizers	60% (21)	29% (10)	11% (4)	95% (20)-expensive 5% (1)-other reasons
Labour	51% (18)	49% (170	0% (0)	83% (15)-expensive 11% (2)-labour shortage 6% (1)-others
Acaricide application	9% (3)	91% (32)	0% (0)	100% (3)-expensive

Figures in parentheses are number of respondents
Source Survey Results, 1995

Based on these results, and using the rule of the thumb, the second hypothesis which stated that " farmer's input parsimony behaviour is not a major determinant of the pattern of resource utilization and investment in dairying" is rejected

Only half of the sample farmers (51%) said they would expect improvement in the household economy if labour use was increased by employing an extra worker Of these: 83% said labour was too expensive and could not employ an extra worker, 11% said workers were not available; while 6% had other reasons. While the same justification for not increasing concentrates and fertilizers can be extended to hired labour it is important to note that the majority of farmers used family labour only.

All of the sample farmers said an additional cow would boost the household economy but 54% found it too costly, 23% feared fodder shortages, 14% feared labour shortages, and 9% had other reasons

Inputs Availability

Except a few, most of facilities were available for the farmers (Table 4.11). A.I services were available for all farmers while over 90% of the farmers said health services and transport for crop produce to market were adequately available About 86% and 83% of farmers said milk transport and manure availability respectively, were adequate The 14% who said milk transport was not available were all from Kamirithu sub-Location where there was no milk collection centre near the farmers Five of the 6 farmers who said manure available was not enough for their farm blamed it on having few cows while one farmer blamed it on extensive grazing system he used

All 23% of farmers who said milk market was poor blamed it on low prices offered by co-operative society Similarly all 25 and 31% of farmers who said crop and egg markets were poor blamed it on low prices. Seventy-seven of farmers said crop storage facilities availability were inadequate. Of 8 farmers who said they lacked adequate storage facilities 6 blamed it on high cost of building while 2 cited high pest problem

Of 40% of farmers who said technical advisors were not available 71% of them (10 farmers) were from Kamirithu sub-Location This may explain why farms in this sub-Location were performing relatively poor compared to those in Kabuku sub-Location However, 3 out of 11 farmers who said technical advisors are not available agreed to being apathetic

Only seed and cash/credit availability was critical with over 50% of farmers citing shortages About 57% of farmers said there was shortage of hybrid seeds while 71% of farmers said the quality of available hybrid was often poor, leading to low yield. This high scepticism of seeds quality amount to a farmer having a subjective distribution function that allot a high probability to a chance that the available seeds would be of poor quality. This becomes another source of risk and has impact on household food security. Cash/credit availability was the most critical input with 97% citing shortage. Of these, 65% felt loaning procedure was wanting and only 35% blamed money shortage on high household expenditure. About 38% of farmers felt that the amounts approved by credit sources was low compared to their requirement This is in line with a study done earlier in the District (Oluoch-Kosura and Ackello-Ogutu, 1995) About 15% felt that credit terms were difficult to meet while 12% feared loss of collateral

As shown in this section the household food and income security plays a central role in farm planning and day-to-day decision making in smallholder farms To control production and marketing risks in the sample farms farmers use risk mitigation strategies such as diversification, matching and input parsimony which in turn affect the pattern of resource utilization The risk mitigation strategies employed also affect the extent of investment in each enterprises, dairy included Therefore, on the bases of these results, a general hypothesis stating that "risk management strategies (matching, input parsimony and diversification) undertaken by farmers are not major determinants of pattern of resource utilization and investment in dairying" would be rejected.

Table 4.11
Availability of Inputs/Facilities to the Farmer

Facility/input	Available?		Reason not available
	Yes	No	
A.I. services	100% (35)	0% (0)	A.I. services adequately provided to all farmers
Animal health services	94% (33)	6% (2)	50% (1)-not available 50% (1)-others
Technical advise	60% (21)	40% (14)[a]	79% (11)-not available 21% (3)-do not seek advice
Market of - milk	77% (27)	23% (8)	100% (8)-low prices offered by cooperative
crop[b]	75% (21)	25% (7)	100% (7)-low market prices
eggs[c]	69% (11)	31% (5)	100% (5)-low market prices
Transport of - milk	86% (30)	14% (5)	100% (5)-collection centre is too far
crop	97% (34)	3% (1)	100% (1)-transport is expensive
Maize seed- quantity desired	43% (15)	57% (20)	100% (20)-hybrid seeds not stocked
quality desired	29% (10)	71% (25)	100% (25)-poor seed quality packed
Cash/credit	3% (1)	97% (34)	38% (13)-little credit money 35% (12)-high h/h expenditure 15% (5)-difficult credit terms 12% (4)-fear loss of collateral
Crop storage	77% (27)	23% (8)	75% (6)-expensive to build 25% (2)-pest problem
Manure *(is it adequately produced at home?)*	83% (29)	17% (6)	83% (5)-too few cows 17% (1)-extensive grazing system

Figures in parentheses are number of farmers
a = 10 farmers were from Kamirithu sub-location where farmers said they were not served by any agricultural extension officer
b = only 28 farmers sell their crop produce
c = only 16 farmers keep layers
Source: Survey Results, 1995

4.2 Simulation Analysis

This section presents the simulation results of both AD and NAD households under three different scenarios Ranking of 8 farms under different scenarios using SDWRF (Stochastic Dominance With Respect to a Function) is also presented The scenarios that were analyzed are discussed in detail in chapter three The farms were simulated stochastically for a period of ten years using the TIES model

4.2.1 Results of Scenario A (Base Scenario)

Simulation results of the base scenario indicated that AD farms were performing better in farm activities than NAD farms, with the former having AANFI of Kshs 161,520 while the latter had only Kshs 61,220 (Table 4 12) However, the overall household financial performance of NAD farms was better than that of AD farms The NPVs of NAD farms was both higher and more stable[20] than that of the AD farms Despite the NPVs of NAD farms being higher, Kshs 530,890, than that of AD farms, Kshs 489,110, the former had smaller standard deviation, 12,640 than the latter, 27,490 The standard deviations of the two groups were significantly different (p=0 01) Using any simple method of ranking (Mean-variance, FSD or SSD), it is clear that NAD household economy was preferable to that of AD households On average the IROR and BCR of NAD farms were 91.09 and 24.27 respectively, and were higher than those of AD farms, which were 33.27 and 17.00 respectively

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[20] This may be due to the assumed stability of off-farm income

Table 4 12

Summary of Financial Performance of Sample Farms under Scenario A

Performance Indicator[a]		Overall n = 35	AD Households n = 23	NAD Households n = 12
Probability IROR > 18.0 (no of farms)	100% <100%	21 14	12 11	9 3
Probability BCR ≥ 1 0 (no of farms)	100% <100%	34 1	23 0	11 1
Probability of Survival (no of farms)	100% <100%	34 1	23 0	11 1
Probability of Success (no of farms)	100% <100%	34 1	23 0	11 1
Probability of Lower Real Equity (no of farms)	0% >0%	27 8	17 6	10 2
NPV in Kshs 1000		503 44 (22.40)	489 11 (27 49)	530 89 (12 64)
IROR		53 09 (5 04)	33.27 (3 61)	91 09 (7 78)
BCR		19 49 (0 97)	17 00 (1 17)	24 27 (0 58)
AANCFI in Kshs 1000		108 86 (6 92)	144 70 (8 52)	40 15 (3 86)
AANFI in Kshs 1000		127 13 (7.20)	161.52 (8.73)	61.22 (4 26)

[a] Legend of definitions

Probability of IROR > 18 - Chances that a farm will generate an internal rate of return greater than the discount rate, 18%

Probability of BCR ≥ 1 - Chances that a farm will generate a benefit cost ratio greater than or equal to one

Probability of Survival - Chances that a farm will not be declared insolvent, i e , equity to asset ratio greater than the minimum of 0.18

Probability of Economic Success - Chances that a farm will earn a return on initial equity greater than 0.18 (discount rate used in this study)

Probability of Lower Real Equity - Chances that a farm will experience a decrease in net worth after adjusting for inflation

NPV (Net Present Value) - After tax net return to initial equity, assuming an after tax discount rate of 0 18

IROR (Internal Rate of Return) - Calculated rate of return to capital invested in the farm operation

BCR (Benefit Cost Ratio) - The ratio of present value of annual returns divided by present value of annual costs

AANCFI[11] (Average Annual Net Cash Farm Income) - Total cash receipts minus total cash expenses excludes family living expenses, principal payments, and costs to replace capital assets

AANFI[12] (Average Annual Net Farm Income) - Net cash farm income plus value of household consumption and change in livestock value minus value of non-cash costs and depreciation allowance of machinery

Figures in the parenthesis are means of the standard deviations of given variable

Source Author's calculations

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11 AANCFI = total farm cash receipt - total farm cash expenses

12 AANFI = AANCFI + value of produce consumed at home + change in livestock value - (value of non-cash cost + machinery depreciation allowance)

The stability of NAD farm incomes is further demonstrated by relatively smaller standard deviations of their IROR and BCR compared to those of AD farms. Out of 23 AD farms 11 farms had less than 100% chances of the IROR exceeding 18%, while out of 12 NAD farms only 3 farms had such chances. Also, only 2 NAD farms had some chances of their real equity lowering while 6 of AD farms had such low chances.

However, except one NAD farm all other farms had 100% chances of Survival. Success and BCR exceeding 1. The poor performance by the single NAD farm could be due to the high household expenditure which averaged Kshs 112,695 while total net income was only Kshs 53,930. The farmer had also acquired a business loan although the business was not doing well during the survey time. These factors could have contributed to the poor performance of the household.

The stability of the NAD household incomes may be attributed to having a large proportion of off-farm income. In the simulation, off-farm income was assumed constant throughout the simulation period. Off-farm income, such as from a business or employment is relatively stable since it is not affected directly by the stochastic variables which affect farming businesses. Inflation is the main cause of variability in off-farm sources of income, especially employment. However, other market factors are important cause of variability in incomes from off-farm businesses. On the other hand, stability of on-farm incomes is highly affected by both production and marketing risks. The instability of on-farm income in the study area was caused by the highly stochastic variables which include rainfall, crop and animal disease and pests, input and output prices and other risk sources listed in section 4.1.7. This implies that farm households highly dependent on on-farm incomes were exposed to more risk sources than those highly dependent on off-farm incomes. It explains why the incomes of the NAD households showed more stability compared to those of AD households.

The tendency of NAD group to have high level of concentrate feeding and animal health services as shown in section 4.1.5 may be attributed to the high level and stability of their incomes compared to that of AD group. This is associated with the former having higher annual milk yield per cow compared to the latter

On the bases of the above results which show that off-farm dependent farms had predominantly higher and significantly more stable incomes compared to that of AD farms the fourth hypothesis which stated that "sources of income do not affect the household economy (level and variability of income)" is rejected.

In section 4.1.3 it was shown that the number of farm activities of AD farms were significantly higher ($p = 0.004$) than those of NAD farms Therefore, the indication that AD farms had more risky incomes further supports the theory that the more risky the household income is the more the farmer tends to diversify if the resources allow. Since in section 4.1.6 the number of farm activities of farms in Kamirithu sub-Location (which was exposed to higher production risk) was shown to be significantly higher ($p=0.02$) than that of farms in Kabuku sub-Location and there was no interaction of number of activities between major source of income and locations then it shows that diversification was a deliberate risk mitigation strategy by the farmers Therefore, on the bases of these results, the third hypothesis which stated that "the pattern of resource utilization and investment in dairying is not affected by the farmer's need to diversify " is rejected

4.2.2 Results of Scenario B

Under scenario B, concentrate feeding was increased to 4 kgs of dairy meal per day for the period the cow is in milk Health services were also increased to include immunization against foot and mouth diseases for all the farmers, while acaricide application was increased to once a week for all semi-zero grazers Farmers whose cattle had frequent attacks from mastitis had their control measures improved to include use of preventative chemical and dry cow therapy On average the milk yield of all farms was increased by 37%, from 2,693 to 3,692 kgs per cow per year

Simulation results indicated general increase in the level NPV, IRR, BCR and other financial indicators over scenario A The AANFI of AD farms increased by Kshs 20,970 to Kshs 182,490 while that of NAD farms increased only by Kshs 11,580 to Kshs 72,800 (Table 4 13). Lower increase in AANFI of NAD farms can be attributed to the fact that NAD group had fewer number of cows per farm and their increases in concentrate and health costs per cow per year were lower than those of AD farms This is because the concentrate and health costs per cow for the NAD group in base scenario were Kshs 5,919 and Kshs 1,743 respectively, while those of AD group were Kshs 5,034 and Kshs 1212 respectively However, on average AANFI of all farms improved by 14%, from Kshs 127,130 to Kshs 144,880 (Table 4.14)

Table 4.13

Summary of Financial Performance of Sample Farms under Scenario B

Performance Indicator[a]	Overall n = 35	AD Households n = 23	NAD Households n = 12
Probability IROR > 18 0 100% (no of farms) <100%	24 11	15 8	9 3
Probability BCR > 1 0 100% (no of farms) <100%	35 0	23 0	12 0
[illegible] 0% (no of farms) 100%	34 1	23 0	11 1
Probability of Success 100% (no of farms) <100%	35 0	23 0	12 0
Probability of Lower Real Equity 0% (no of farms) >0%	32 3	21 2	11 1
NPV in Kshs 1000	557.05 (27.09)	555.87 (33 41)	559 31 (14 98)
IROR	59 31 (6 56)	38 25 (4 06)	99 66 (11 35)
BCR	20 61 (1 02)	18 89 (1 23)	23 90 (0 63)
AANCFI in Kshs 1000	126 24 (8.41)	165 10 (10 33)	51 76 (4 74)
AANFI in Kshs 1000	144 88 (8 65)	182 49 (10 53)	72 80 (5 05)

[a] See definitions page 81

Source Author's calculations

The number of farms with less than 100% chance of IROR exceeding 18% reduced to 11 from 14 for all farms, with only those of AD group reducing by 3 Only one farm, a NAD farm, had less than 100% chances of survival, while no farm had less than 100% chances of success or of BCR exceeding 1 However, two farms in AD group and one farm in NAD group had some chances of their Real Equity lowering The NPVs of all farms increased by 11%, with that of AD and NAD groups increasing by 14 and 5% respectively However, the standard deviations increased by 21% for all the farms, 22% for AD farms and 19% for NAD farms The relatively higher standard deviations which meant that the incomes were more unstable. This may justify the input parsimony behaviour of the farmers

The IRORs of all farms increased by 12% with that of AD group increasing by 15% and NAD group by 9%. The standard deviations increased by 30, 12 and 46% respectively The BCRs of all farms increased by 6% with that of AD farms increasing by 11% However, the BCRs of NAD farms decreased by 2% Despite a decrease in BCRs of NAD farms their standard deviations increased by 9 percent while that of AD farms increased by 5%. This is a further indication of how unstable the stream of benefits are under intensified dairying It also shows the weakness of BCR criterion method when used to rank projects The benefit-cost ratio discriminates against projects with relatively high gross returns and operating costs, even though these may be shown to have a greater wealth-generating capacity than that of alternatives with a higher benefit-cost ratio (Gittinger, 1982)

Increased concentrate feeding and health services implies that a farmer would incur higher cost of milk production than in base scenario On average, milk production cost for both farm groups was increased by Kshs 5,310 per cow per year As shown above, the increased cost of milk production increases the variability of incomes as indicated by 21% and 20% increase of standard deviations of NPV and AANFI, respectively. This may mean more risky incomes, especially if the increased incomes are accompanied by occasional fall of the incomes below the level necessary to ensure adequate levels of basic needs[23]

[23] Included here is food, shelter and education

Table 4.14
Summary Description of Effect of Intensive Dairying on NPV and AANFI

	Production cost per cow	Milk yield	NPV Kshs	NPV Std[a]	AANFI Kshs	AANFI Std
Scenario A	9,457	2,693	503,440	22,400	127,130	7,200
Scenario B	14,767	3,692	557,050	27,090	144,880	8,650
Percentage change (%)	50	37	11	21	14	20

[a] Standard deviation about the mean
Source Author's calculations

4.2.3 Stochastic Dominance Ranking of Scenarios A and B

Due to lengthiness of stochastic dominance ranking procedure and time limitation only NPV probability density functions of 8 selected farms were used in ranking of the scenarios Since the 8 farms used in ranking were selected to represent AD and NAD farms with poor, average and good performance they were assumed to represent the whole sample Four farms from each group of household (AD and NAD) were selected based on their performance in milk yield per cow, NPV and net farm income per acre. The performance of the 4 farms selected in each group were: poor (2), average (1) and, good (1)

According to the simulation results, the performance of intensified dairying (scenario B) was financially superior to the current practice (base scenario) for all farms However, this criterion is not robust enough to rank unequivocally the most preferred alternative while taking into consideration the risk attitude of the farmer Such ranking is necessary to aid decision makers in selecting among alternative dairying methods based on risk preference The NPVs, which were stochastically generated for each scenario, SDWRF was used to rank the generated probability density functions under the assumption that farmers are risk averse The risk aversion coefficient bounds used in ranking were calculated for each farm using the procedure described in Chapter Three

Due to the differences in the number of cows the farmers had and varying levels of concentrate feeding and health services in base scenario dairy production cost in scenario B increased by between 17 to 453% (Table 4 15) The percentage changes in NPVs were also affected by the level of NPV in base scenario with the higher NPVs appearing to increase by relatively small percentage in scenario B However, all the NPVs of the 8 farms increased by 3 to 49% Except the standard deviations of one farm which decreased by 40%, others increased by 11% to 932%.

As indicated earlier (section 2.1), mean-variance criterion cannot be used to rank the two scenarios for the 7 farms because both the level and standard deviations of their NPVs are larger for scenario B than for scenario A. Using mean-variance criterion, it appears that scenario B is preferable to scenario A for farm number 8, whose NPV increased as the standard deviation decreased with intensification of dairying However, since this criterion fails to consider the distribution function of the NPV and the risk aversion of the farmer, hence his utility function is ignored, the criterion is considered inappropriate Stochastic dominance ranking was therefore considered to be most appropriate

The results of SDWRF rankings for the two scenarios are shown in Table 4 16 The results indicate that Scenario A was the most preferred practice (most efficient) for 7 out of the 8 selected farms This indicates that 88% of the farms preferred the base scenario It means that the expected incomes from base scenario, though lower are preferred to those of scenario B (intensive dairying) because they are more stable and maximize expected utility of the risk averse farmers This means that, though the mean of NPV of scenario B is higher than that of scenario A, incomes in scenario B fall below critical levels[24] occasionally (or more often), which is not acceptable to the risk averse farmers. Although the standard deviation decreased in scenario B for farm number 8, using SDWRF ranking scenario A was preferable to scenario B for the farmer. However, scenario B of one farmer (farm number 4) appeared to be most preferred to scenario A. This would mean that increased concentrate feeding and health services appeared to increase household income with no additional threat to household safety as far as basic needs are concerned.

Table 4.15
Changes in Level and Variability of NPV of 8 Farms under Scenarios A and B

	AD Farms				NAD Farms			
	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6	Farm 7	Farm 8
Scenario A								
No. of Cows	2	3	1	3	1	2	1	2
Dairy Production cost[25] (Kshs)	14,840	20,886	2,647	33,089	9,853	15,494	5,971	17,398
NPV in Kshs 1000	268.92	1061.09	177.59	457.49	897.14	303.85	322.22	182.25
Std	6.32	19.93	1.33	46.93	7.05	5.58	4.71	18.34
Scenario B								
Dairy Production cost[26] (Kshs)	29,988	49,356	14,642	38,796	14,483	25,914	14,758	25,848
NPV in Kshs 1000	400.37	1246.92	231.76	496.82	923.69	320.51	378.50	259.10
Std	12.59	28.93	13.72	52.04	8.69	7.07	7.72	11.01
Scenario changes								
Dairy production cost (%)	+102	+136	+453	+17	+47	+67	+147	+49
NPV (%)	+49	+18	+31	+9	+3	+5	+17	+42
Std (%)	+99	+45	+932	+11	+23	+27	+64	-40

Source: Author's calculations

[24] Minimum level of incomes necessary to ensure adequate levels of basic needs are met, for each farm household. basic need here included food, shelter and education.

[25] With concentrate and health costs as obtained from the survey.

[26] After adjusting concentrate and health costs to reflect intensified dairying.

However, it is important to note that among the selected 8 farms this farm had the least increase (17%) in dairy production cost[27]. Despite the fact that simulation results indicated that if the farmer increased concentrate feeding and health services, leading to increased milk yield, the household income would improve with no additional risk, it is not clear why he was not increasing the concentrate feeding and health services

Table 4 16
SDWRF Ranking of NPV Probability Density Functions for Scenario A and B.

	Dairy Management Strategies							
	AD Farms				NAD Farms			
Rankings	1	2	3	4	5	6	7	8
Most preferred Scenario	A	A	A	B	A	A	A	A
Least preferred Scenario	B	B	B	A	B	B	B	B

Source Author's calculations

The fifth hypothesis stated that "intensive dairying decreases both the level and variability of household income (Net Present Value), with no bearing to household income security" The simulation results of Scenario B indicated that although on average farms may benefit from increased concentrate feeding and health services the household incomes would be more unstable The SDWRF ranking also indicated that intensified dairying was less

[27] The farm fed concentrate at a rate of 3 90 kgs per day per cow, hence there was minimal increase (0 10 kg/cow/day) in concentrate feeding in scenario B The insignificant change in household economy may be attributed to the minimal change in concentrate feeding

preferable to the current practice (with current level of concentrate feeding and health services) In view of these results the above hypothesis is also rejected

4.2.4 Results of Scenario C

Scenario C involved simulation of 8 farms after re-allocation of 10% of an hectare between maize and napier grass The results showed inconsistent changes of NPVs and standard deviations (Table 4 17). The re-allocation raised NPVs of 5 farms and lowered NPVs of 3 farms It showed that farm income would be raised by reducing napier grass production to the minimum necessary and producing more maize instead Although any extra napier grass produced is sold to the neighbours, these farmers were better off producing just enough and then growing more maize All the 4 farms (from both farm groups) which had their napier grass production decreased and maize production increased had their NPVs raised However, the standard deviations of their NPVs were inconsistently affected, with those of good performers being lowered while those of poor performers were raised This indicates that additional maize production at the expense of napier grass production would increase the income stability of the 2 farms and decrease that of the other 2 farms No good reason was forthcoming, however, about how performance might have affected the income stability of the two farms

Results of increasing napier grass production to the minimum required (at the expense of maize production) indicated that farms would not necessarily benefit due to the opportunity cost The forgone maize production was important and affected the household economy. The changes increased the NPVs of only 1 farm while it decreased incomes of 3 farms Like the case of reduced napier grass, the NPVs' standard deviations were also inconsistently affected, with those of good performers being lowered while those of poor performers were raised

Table 4.17

Changes in NPV caused by Interchanging Napier Grass and Maize Land

	AD Farms				NAD Farms			
	Adequate Napier grass		Inadequate Napier grass		Adequate Napier grass		Inadequate Napier grass	
	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6	Farm 7	Farm 8
Scenario A								
No of Cows	3	1	3	2	2	1	1	2
Napier land (ha)	0.607	0.283	0.270	0.174	0.405	0.200	0.051	0.162
Maize land (ha)	0.060	0.251	0.329	0.405	0.668	0.190	0.202	0.405
NPV in Kshs 1000	1061.09 (19.93)	131.29 (3.93)	457.49 (46.93)	268.92 (6.34)	794.82 (13.77)	11.19 (18.23)	303.85 (5.58)	182.25 (18.34)
Scenario C								
10% of land re-allocated(ha)	0.061	0.028	0.027	0.018	0.040	0.019	0.005	0.016
Change in N/M land	N↓ M↑	N↓ M↑	N↑ M↓	N↑ M↓	N↓ M↑	N↓ M↑	N↑ M↓	N↑ M↓
NPV in Kshs 1000	1070.88 (19.85)	132.60 (4.02)	468.76 (41.00)	268.84 (6.34)	797.30 (13.68)	15.71 (18.96)	303.34 (5.56)	179.34 (18.36)
Effect of re-allocation								
NPV (%)	+ 0.92	+ 1.00	+ 2.46	-0.03	+ 0.31	+40.39	- 0.17	- 1.60
Std (%)	- 0.40	+ 2.29	-12.64	+0.32	- 0.65	+ 4.00	- 0.36	+ 0.11

Figures in parenthesis are standard deviations around the mean

N↑(↓) Napier grass land increased (decreased) by 10%

M↑(↓) Maize crop land increased (decreased) by equivalent of 10% of napier grass land

Source Author's calculations

These results show that, while the tendency to produce just enough forage from napier grass would lead to increased incomes, reduction of maize production in favour of increased napier grass production was not necessarily favourable. However, to be more categorical, the risk attitude of the farmers need be considered.

The differences in contribution of additional 10% of napier grass production to the household economy of the 1 verses 3 farms vis-a-vis that of reduced maize production may be as a result of differences in household characteristics and management practices The marketing strategies used, such as selling maize dry or green, affect the incomes from maize fields

The cost and effect of fertilizer applied also affect the economics of maize production Also, although the practice of growing 3-4 maize seeds per mound and subsequent thinning to provide forage is done by all farmers, the timing of the 1st, 2nd and 3rd thinning will affect the total amount of forage obtained This timing was not considered by the TIES model

4.2.5 Stochastic Dominance Ranking of Scenarios A and C

Results of SDWRF ranking indicated that, scenario C was most preferable for all farms whose napier grass production was reduced while increasing maize production (Table 4.18) This means that, although the standard deviations of NPVs of some of these farms increased, the reduction of napier grass production posed no additional risk to the household economy However, as indicated by descriptive analysis allocation of relatively large land to napier grass production was used as a risk management strategy against low rainfall. This might explain why farmers were not decreasing napier grass land to the minimum level possible

On the other hand, stochastic dominance ranking indicated that 3 out of 4 farms were better off with base scenario than with scenario C, which involved increasing napier grass production while reducing maize production This means that reduction of maize production in favour of increased napier grass production would expose the household economy to a greater risk and farmers would not be willing to do so This shows the delicate balance that exist in trying to minimize household food and income insecurity However, the re-allocation was favourable for 1 AD farm hence the move may not be inappropriate for all farms

Table 4 18
SDWRF Ranking of NPV Probability Density Functions for Scenario A and C.

	Farming systems and napier grass production							
	AD Farms				NAD Farms			
	Adequate napier		Inadequate napier		Adequate napier		Inadequate napier	
Rankings	1	2	3	4	5	6	7	8
Most preferred Scenario	C	C	C	A	C	C	A	A
Least preferred Scenario	A	A	A	C	A	A	C	C

Source: Author's calculations

Therefore, as earlier observed, the results of this study could not unequivocally tell whether the risk management strategy of growing maize as both food crop and fodder was superior to growing napier grass alone as the major source of forage To establish the superiority of either method a strategic study would be necessary

CHAPTER FIVE

SUMMARY, CONCLUSIONS, RECOMMENDATIONS AND POLICY IMPLICATIONS

5.1 Summary

The dairy sector continues to play an important role in the development and growth of Kenya's economy In particular, the Kenya government aims at increasing milk production so as to meet the increasing national demand resulting mainly from population growth As population growth continues to put pressure on land the need for intensification of the resulting smallholdings increases Therefore, in line with achieving national food security, all policies of agricultural sub-sectors must aim at increased productivity of the available agricultural land

In a liberalized economy effective policies must facilitate competitive, efficient and self-sustaining systems of farming Smallholder farms in Kiambu are faced with risks arising from fluctuating milk prices, unavailability of inputs, threat of livestock diseases, poor marketing infrastructure and unpredictable weather This makes it difficult for them to make definite market oriented decisions and plans As farmers thrive to realize maximum profits from their farm businesses, of major importance to them is the need to undertake management strategies to cope with different sources of risks that may threaten household food security Strategies used include production, marketing and financial responses Therefore, policies aimed at increasing productivity through adoption of appropriate technologies must conform to the need of smallholder farms of ensuring household food security. Technologies that appear to expose households to higher risk are slow in diffusion regardless of their potential returns It is therefore important to identify sources of risks facing the smallholder farms and investigate how they affect economic activities of the farms, and in particular, the investment in dairying This will enable the policy makers and researchers to develop and adopt appropriate strategies to increase productivity in dairying. To address these problems, the present study set out to.

- document sources of incomes, patterns of farm household resource utilization and investment in dairying on the selected farms in Kiambu District.
- describe the risk management strategies used by these farmers and to determine how these strategies relate to and affect the dairy enterprise.
- evaluate how adoption of national extension recommendations on intensive dairying would affect household's income.
- explore alternative avenues of reducing whole-farm risk with a view to increasing resource investment in the dairy enterprise

To meet the study objectives, data were collected during the period from July through October 1995 Thirty-five farmers from Kiambu District, Limuru Division were randomly sampled from a group of 50 farmers and then grouped to non-agriculturally dependent (NAD) farmers or agriculturally dependent (AD) farmers depending on the proportion of their incomes that come from off-farm sources Farmers were grouped as NAD if they received more than 60% of their expected total household income from off-farm activities and AD if they received less than 60% from off-farm activities The NAD group had 12 farms while AD group had 23 farms The analysis of the data was carried out using descriptive and quantitative analysis that involved simulation analyses with TIES (Technology Impact Evaluation System) model

The study showed that farmers maximized land use through animal and crop intensification The sample farms had diversified into 6.23 farm enterprises, with AD group having significantly more enterprises than the NAD group On average the annual milk yield per cow of NAD households was 13% higher than that of AD households This higher milk yield was attributed to the higher sum of concentrate and animal health costs of NAD group compared to that of AD group

A major difference was noted between farming activities in Kamirithu and Kabuku sub-Locations. The former had 6.9 farm activities while the latter had 5.8 farm activities per farm Out of 13 farms in Kamirithu sub-Location 8 practised semi-zero grazing while in Kabuku sub-Location only 2 out of 22 practised semi-zero grazing

All sample farms were dairy farmers and produced both napier grass and maize The next most important crops were Irish potatoes, kale and field beans Farmers found both crop failure and dairy cow diseases big drawbacks to the household economies They cited production risks as the major sources of risk The major risk sources cited in dairying were, E.C.F. and mastitis Although most farmers rarely sprayed their cattle, only in Kamirithu location where mainly semi-zero grazing was practised was high attacks of E.C.F reported Farmers fed their dairy animals with concentrates, mainly dairy meal, but only when the cow is in milk Twenty farmers also fed their cattle with poultry waste

The major risk source cited in napier grass production was low rainfall, while in maize, low rainfall and theft were the major sources of risk. Although low rainfall was cited by a majority of farmers as risk source for the two crops, most farmers said they did nothing to address the situation However, it was observed that farmers used management practices such as mulching, early planting, manure application and contour planting to ensure maximum utilization of available rain by the crops

Maize was grown both as a food and fodder crop by all sample farmers Farmers used it as risk management crop and used both production and marketing strategies to achieve this Production strategies used were (1) farmers planted three-four maize seeds per mound and as the crop grew it was thinned to provide cattle with fodder By the time of harvesting there was two-zero plants per mound and, (2) farmers sew maize whenever there was rain and space in the farm If the crop was successful it provided both food and fodder, but if it failed whatever was available formed fodder The major marketing strategy used involved selling or using maize green to allow cows eat maize residues when green, and also increase cropping intensity It also reduced theft cases which was cited by 54% of farmers as a risk source in maize This also reduced handling cost and reduced possible loss through post-harvest pest

The majority of sample farmers believed they could increase their household incomes through increased milk yield per cow by increasing concentrate feeding However, most of them cited high cost of concentrates as the reason for not increasing the concentrate fed Similar reason was advanced by the majority of farmers who believed that increased use of fertilizers would increase their incomes

In regard to availability of inputs, only seed and cash/credit was critical Farmers felt that the terms of obtaining credit were unnecessarily harsh

Simulation results of scenario A, the base scenario, which considered the current level of dairy intensification in terms of input use (concentrate and heath services) and existing enterprise mixes, indicated that NAD farms incomes were higher and more stable compared to those of AD farms Despite the average NPV of NAD farms being higher than that of AD farms, the average standard deviation of the former was smaller than that of AD farms

Scenario B, reflected intensified dairying, which involved increasing concentrate feeding to a minimum of Kshs 10,404 per cow per year and health costs to the minimum necessary according to animal health need of individual farm Milk production was assumed to increase at a rate of 1.5 kg per every extra kg of concentrate fed to a cow, at a price of Kshs 7.30/kg The simulation results indicated a general increase in incomes which was however, accompanied by higher instability.

Ranking of 8 selected farms using SDWRF indicated that Scenario A (base scenario) was the most preferred practice (most efficient) over scenario B (intensified dairying) for 7 of the 8 selected farms This indicated that intensive dairying exposed farms to higher risk thus was less preferred by the risk averse farmers

Scenario C reflected re-allocation of land between napier grass and maize for 8 selected farms For those farms with enough napier grass land their scenario C involved reduction of the napier grass land by 10%, while for those with inadequate napier grass land it was increase by a 10% The results of scenario C showed that farm income would be raised by reducing napier grass production to the minimum necessary and producing more maize instead However, the standard deviations of NPVs' of 2 farms increased while that of two other farms decreased Results of increasing napier grass production to the minimum required indicated that farms would not necessarily benefit due to the opportunity cost of the maize forgone The changes increased the NPVs of only 1 farm while it decreased incomes of 3 farms The NPVs' standard deviations were inconsistently affected, with those of two farms being lowered while those of other two were raised

Results of SDWRF ranking indicated that, scenario C was most preferable for all farms whose napier grass production was reduced while increasing maize production This means that, although the standard deviations of NPVs of some of these farms increased, the reduction of napier grass production posed no additional risk to the household economy Ranking of farms whose scenario C involved increasing napier grass production while reducing maize production indicated that 3 out of 4 farms were better off with base scenario than with scenario C This means that reduction of maize production in favour of increased napier grass production would expose the household economy to a greater risk and the concerned farmers would not be willing to do so.

5.2 Conclusions

It is important to note some few aspects about this study when drawing general policy inferences First, the study was carried out in a region where commercial smallholder dairying is considered to be relatively advanced compared to other parts of the country Secondly, the socio-economic, cultural and physical environment of the study area is different from other areas of Kenya In view of these facts, it may not be appropriate to generalize the results for all dairy farmers in the country except for those ones who operate under similar economic environment and/or on aspects that affect all farmers. However the results are important for main dairying areas

With these qualifications the following appeared plausible

(I) Risk management strategies used by the dairy farmers appear to interfere with intensification and expansion of dairying The strategies include

- matching, where a farm produces much of the food it consumes reducing household exposure to market risk. Farmers produced most of the food consumed at home This reduced the resources available for dairying Also, although maize crop produced less forage compared to napier grass all farmers preferred using the two crops as source of fodder so that maize could also supply some food for household,

- input parsimony, where a household reduce fluctuations in net income by restricting the use of inputs Although 77% of the sample farmers believed their household economy would improve if they increased concentrate feeding, they were not willing to increase the amount of concentrate fed to cattle,

- diversification, where a household expected income is stabilized by diversifying income sources and ensuring the incomes do not all vary in the same direction and at the same time Despite small farm sizes, averaging 0.895 hectare, farmers had diversified into at least 6.23 farm activities which reduced farm resources available for dairy enterprise.

(ii) Sources of incomes, such as off-farm incomes, that stabilize household economy tend to facilitate intensification of dairying Farm households that received more than 60% of their incomes from off-farm sources (NAD) had higher and more stable incomes than farm households that received less than 60% from off-farm sources (AD) Consequently, compared to AD farms, the NAD farms spent more in concentrate feeding and animal health services and hence had higher milk yield per cow per year.

(iii) Intensification of dairying which involves increased concentrate feeding and animal health services increase both the incomes (Net Present Values) and their standard deviations by 11% and 21% respectively This implies that though the level of incomes go up the incomes are less stable hence more risky. The SDWRF also indicated that intensification would result to a less preferred scenario hence farmers would rather continue with their current practice. The instability of household economy that accompany intensive dairying was therefore found to be a barrier to intensification of the enterprises.

(iv) Cash and credit appeared to be the major constraint with 97% of farmers citing shortage. About 65% of these farmers cited credit terms, little credit money available and fear of loss of collateral as the major problems This lead to inadequate cash flow thus expansion of working capital and meeting household expenses becomes problematic It also becomes a constraint to adoption of dairy technologies

(v) Risk posed by the quality of hybrid maize seed appeared to be an important constraint in the study area About 71% of farmers were skeptical of the quality of maize seed

Poor quality seed lead to low maize yield affecting the household food security This in turn affect resource apportionment and management in the farm.

(vi) Poultry waste was an important form of dairy concentrate in the study area which was used by 57% of farmers It helps reduce the cost of feeding dairy cattle and reduce the dependency of farmers on commercial concentrates

5.3 Recommendations and Policy Implications

Based on the study results, various recommendations for policy action can be proposed Since household food and income security was suspected to be a key factor in adoption of dairy technologies there is a need to ensure that technologies meant to increase productivity in dairying do not expose households to greater risk otherwise farmers will not adopt them As shown in the study, farms with more stable incomes (NAD group) are more willing to adopt intensive dairying than those with unstable incomes (AD group)

To boost the adoption of intensive dairying in a liberalized economy, policies should aim at creating a competitive milk sector which will lead to potentially high and relatively more stable milk prices More competition should be encouraged in the dairy sector (e g by encouraging more processors and retailers in the sector) to increase efficiency in milk marketing This would lower market risk and operation cost and hence benefit the dairy farmers through increased incomes High incomes (through competitive high milk prices) buffer the potential serious impact of production risks. It would also reduce the implicit risk associated with increasing concentrate feeding and animal health services, hence lower farmers' input parsimony behaviour, leading to more intensive and efficient dairying This is because market and production efficiency complement each other in the way they affect household economy Milk policies should also be consistent (e g by avoiding incoherent milk policies) to help reduce price fluctuations which increases market risk This would enable farmers reap the benefits of the adopted technologies and improve their planning capabilities

Infrastructure such as roads should be improved to enable easy transportation of milk throughout the year Access roads should be build and/ or maintained to allow majority of farmers reach the markets This would also enhance farmers accessibility to agricultural inputs (such as concentrates and fertilizer) throughout the year reducing their seasonal price fluctuations caused by poor or lack of roads

With liberalization, cooperatives should be encouraged to broaden their services and undertake most of the services previously provided by the government For example, beside providing A I and animal health services a dairy cooperative should be able to provide technical advices on crop husbandry and credit according to the needs of the members.

Farmers should also be encouraged to venture into activities which reduce the cost of dairy production as they adopt intensive dairying Backward integration, such as production of concentrates from farm by-products may help lower milk production cost enabling the farmers to adopt intensive dairying without exposing their households to additional risk

Farmers should be encouraged to undertake additional off-farm activities which stabilize household incomes to enable them adopt dairy technologies without exposing their households to additional risk Farmers who rely wholly (or mainly) on on-farm incomes face higher risk (due to high production risk in agriculture) thus are less willing to take the extra risk accompanied by adoption of new technologies Off-farm incomes such as from an urban-employed family member or an off-the-road shop help stabilize household income enabling it adopt new technologies To help stabilize farmers incomes dairy cooperatives should also be encouraged to engage in milk packaging and high scale milk marketing whenever possible

There is a need to increase credit availability and especially improve the lending terms and amount loanable Technology adoption that involves extra cost of operation impinge on the household cash flow pattern and, although the average income may be increased, the extra cost adds to the loss occasioned by both production and market risks Increased credit availability would help farmers adopt dairy technologies without necessarily exposing their households to additional risk of insecurity. Policies should encourage more specialized agricultural banks and/ or increased participation of the existing banks in agricultural sector with the aim of increasing lending to the smallholder farmers The lending terms should be improved so as to lower both the risk and cost of borrowing To reduce the risk of borrowing these banks should use a flexible loan repayment schedule that is sensitive to crop failure that may be occasioned by drought Group lending can also be used to overcome the risk posed by use of collateral Where possible cooperatives such as dairy cooperatives should be encouraged to offer a wide range of credit services (including for non-dairy activities) to their members

Based on the results of scenario C and assumptions adopted in calculation of forage yields from napier grass and maize, there is a need for further agronomic and economic study to clearly establish the opportunity cost of growing maize for both food and livestock feed as opposed to growing napier grass as the source of forage only Such a study would quantify the total amount of forage obtained through thinning of maize and maize residue and evaluate the opportunity cost of this practice against growing napier grass

The practice of feeding cows with poultry waste mixed with dairy meal lowered the cost of milk production Since this helps stabilize household economy a study to investigate the economics and nutrition implication of integrating poultry and dairy production, thereby substituting poultry waste for the costly commercial concentrates is also important to establish the suitability of the practice

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APPENDIX I

STAGE ONE (TIES) DATA

DISTRICT .... DIVISION ....

DATE .... ECOLOGICAL ZONE ....

CATTLE TYPE .... TIMES GRAZED OUT ..../MTH/YR.

1. HOUSEHOLD INFORMATION

1.1 NAME OF THE RESPONDENT/S.................................

1.2 HOUSEHOLD MEMBERS

	NUMBER					
AGE GROUP (YEARS)	0-3	3-5	5-10	10-18	18-59	60+
MALE	......	......	....	....	....	......
FEMALES	......	......	....	....	....	......

1.4 HOUSEHOLD LIVING EXPENSES . (SCREEN 1.6E.3.2 CARDS 14 AND 17)

ITEM	MINIMUM ANNUAL EXPENSES (KSHS)	MAXIMUM ANNUAL EXPENSES (KSHS)
1. EDUCATION	....	....
2. FOOD & CLOTHING	....	....
3. OTHERS	....	....
TOTAL	....	....

2. FARM ASSETS AND RESOURCES

2A LAND INVENTORY (SCREEN 1.6E.1.1 AND CARDS 3 AND 18)

HOW MANY FARMS DO YOU HAVE ? ....

SIZE AND LOCATION OF THE FARMS

	FARM 1 (THIS FARM)	FARM 2	FARM 3
SIZE	....	....	....
LOCATION	....	....	....

IN FARM 1.

CROPLAND OWNED .... PASTURELAND OWNED ....

ACRES DEVOTED TO LOADS AND HOMESTEAD......... OTHER- .... ACREAGE ....

2B CASH LEASE EXPENSES (SCREEN 1.6E.4.3 AND CARD 18)

CROPLAND RENTED .... HA/AC. CROPLAND LEASED ....HA/AC

PASTURELAND RENTED .... HA/AC. PASTURELAND LEASED ....HA/AC

CROPLAND LEASE COST .... KSHS. PASTURELAND LEASE COST........KSHS

2C MARKET VALUE (SCREEN 1.6E.1.2 AND CARDS 3,4 AND 10)

CROPLAND ....KSHS/AC PASTURELAND...........KSHS/AC

IMPROVEMENT & BUILDINGS ....KSRS

2D. LABOUR (SCREEN 1.6E.4.1.AND CARD 17)

1. PERMANENT LABOURERS......./YEAR SALARY (KSHS)........../MONTH

2. OTHER LABOUR CASH COST KSHS ....

2E MACHINERY AND EQUIPMENT (SCREEN 1.6E.5.1 AND CARD 30)

TABLE FOR MACHINERY AND EQUIPMENT INFORMATION

NAME	NUMBER	YEAR OF PURCHASE	PURCHASE PRICE KSHS	CURRENT PRICE KSHS	USEFUL LIFE (YES)	SALVAGE VALUE KSHS	DEPRE-CIATION LIFE
1. JEMBES & HOES	....	....	....	......	....	....	....
2. PANGAS & SLASHERS	....	....	....	......	....	....	....
3. AXES	....	....	....	......	....	....	....
4. FORAGE CHOPPERS	....	....	....	......	....	....	....
5. SPADES	....	....	....	......	....	....	....
6. WHEEL-BARROWS	....	....	....	......	....	....	....
7. CARTS	....	....	....	......	....	....	....
8. OX-PLOUGH & EQUIP.	....	....	....	......	....	....	....
9. SPRAY PUMP	....	....	....	......	....	....	....
10. SPRAY RACE	....	....	....	......	....	....	....
11. MILK CANS & EQUIP.	....	....	....	......	....	....	....
12. WATER PUMPS	....	....	....	......	....	....	....
13. WATER PIPES	....	....	....	......	....	....	....
14. TRACTORS	....	....	....	......	....	....	....
15. TRACTORS PLOUGHS	....	....	....	......	....	....	....
16. BICYCLES	....	....	....	......	....	....	....
17. MOTOR VEHICLES	....	....	....	......	....	....	....
18. OTHERS. 1......	....	....	....	......	....	....	....
2......	....	....	....	......	....	....	....

* CURRENT PRICE OBTAINED FROM LOCAL SUPPLIERS.

2E. VALUE FOR STORED INPUTS AND PRODUCTS AT THE BEGINNING OF THE YEAR.

INPUT/PRODUCT	AMOUNT (KGS)	VALUES (KSHS)
1. FERTILIZERS	....	....
2. CROP SEEDS	....	....
3. CROP CHEMICALS	....	....
4. SPRAY/DIP ACARICIDE	....	....
5. MOTOR FUEL	....	....
6. GRAINS A.MAIZE	....	....

B.WHEAT	....	....
C.MILLET/SORGHUM	....	....
D.OTHERS	....	....
7. PULSES (BEANS AND PEAS)	....	....
8. NUTS	....	....
9. CONCENTRATES	....	....
10.MINERALS	....	....
11.OTHERS		
1.........	....	....
2.........	....	....

3. CROP ENTERPRISES (SCREEN 1.6E.6.)N AND CARDS 23,24,25 AND 26).
FOR EACH CROP USE THE TABLE GIVEN NEXT PAGE TO GIVE DETAILED INFORMATION ON PRODUCTION, UTILIZATION AND DISPOSAL. THE INFORMATION RELATES TO 1994/95 CROP SEASON ANY CROP MIXTURE IS TREATED AS A SINGLE CROP ENTERPRISE. FOR A CROP GROWN MORE THAN ONCE A YEAR EACH PRODUCTION (LONG RAINS SEASON OR SHORT RAINS SEASON) IS TREATED AS A SEPARATE CROP.

FOR EACH CROP DEVELOP AN EMPIRICAL PROBABILITY DISTRIBUTION FOR THE CROP'S YIELD/HA.(SCREEN 1.6E.6.1.3 AND CARDS 50 & 54)

	MIN	MAX	HIST1	HIST2	HIST3	HIST4	HIST5	HIST6	HIST7	HIST8	HIST9	HIST10
CROP1	......	......	......	......	......	......	......	......	......	......	......	......
CROP2	......	......	......	......	......	......	......	......	......	......	......	......
CROP3	......	......	......	......	......	......	......	......	......	......	......	......
CROP4	......	......	......	......	......	......	......	......	......	......	......	......
CROP5	......	......	......	......	......	......	......	......	......	......	......	......
[illegible]	......	......	......	......	......	......	......	......	......	......	......	......
CROP7	......	......	......	......	......	......	......	......	......	......	......	......
CROP8	......	......	......	......	......	......	......	......	......	......	......	......
CROP9	......	......	......	......	......	......	......	......	......	......	......	......
CROP10	......	......	......	......	......	......	......	......	......	......	......	......

FOR EACH CROP DEVELOP AN EMPIRICAL PROBABILITY DISTRIBUTION FOR THE CROP'S PRICE/UNIT (SCREEN 1.6E.4.1.5 AND CARDS 50 & 54)

	MIN	MAX	HIST1	HIST2	HIST3	HIST4	HIST5	HIST6	HIST7	HIST8	HIST9	HIST10
CROP1	......	......	......	......	......	......	......	......	......	......	......	......
CROP2	......	......	......	......	......	......	......	......	......	......	......	......
CROP3	......	......	......	......	......	......	......	......	......	......	......	......
CROP4	......	......	......	......	......	......	......	......	......	......	......	......
CROP5	......	......	......	......	......	......	......	......	......	......	......	......
[illegible]	......	......	......	......	......	......	......	......	......	......	......	......
CROP7	......	......	......	......	......	......	......	......	......	......	......	......
CROP8	......	......	......	......	......	......	......	......	......	......	......	......
CROP9	......	......	......	......	......	......	......	......	......	......	......	......
CROP10	......	......	......	......	......	......	......	......	......	......	......	......

1.CROP TABLE: FARM NO. ......

CROP NAME .... WHO CONTROLS OUTPUTS ....

ACRES PLANTED..........MONTH PLANTED......... CROPS/YEAR.......

3.1 PRODUCTION COST (SCREEN 1.6E.6.1.6 AND CARD 22)

ACTIVITY	QUANTITY USED	VALUES (KSHS)
AMOUNT OF SEED USED	....	....
FERTILIZER & CHEMICALS	....	....
LAND PREPARATION	....	....
PLANTING CASUAL LABOUR	....	....
WEEDING CASUAL LABOUR	....	....
FERTILIZER AND HERBICIDES APPL. CASUAL LABOUR	....	....
IRRIGATION FUEL OR OTHER FUEL	....	....
HARVESTING CASUAL LABOUR	....	....
HARVESTING GUNNY BAGS AND OTHER MATERIALS	....	....
TRANSPORTING & MARKETING COST (GRAD, ETC.)	....	....

3.2 ANNUAL CROP UTILIZATION AND DISPOSAL (SCREEN 1.6E.....)

ACTIVITY	UNIT	QUANTITY	MONTH	PRICE (KSHS)	
1.HARVESTED GREEN	KGS/BAGS	....	....	...N/A..	
2.HARVESTED DRY	"	....	....	...N/A..	
3.SOLD AT HARVEST	"	....	..N/A..	GREEN.......	DRY.......
4.STORED FOR SALE (MAX) & MTH/YR SOLD	"	....	....S/N	....	STORAGE COST ....
5.USED/KEPT FOR FAMILY CONSUMPTION	"	....	..N/A..	...N/A..	
6.GIVEN TO WORKERS	"	....	..N/A..	...N/A..	

7. AMOUNT FED TO LIVESTOCK (SPECIFY LIVESTOCK AND FEED TYPE).

LIVESTOCK TYPE	FEED TYPE1	AMOUNT KGS/YR	VALUE KSHS	FEED TYPE2	AMOUNT KGS/YR	VALUE KSHS	TOTAL KSHS
1.CATTLE	....	....	....	....	....	....	....
2.SHEEP	....	....	....	....	....	....	....
3.GOAT	....	....	....	....	....	....	....
4.PIGS	....	....	....	....	....	....	....
5.POULTRY	....	....	....	....	....	....	....
TOTAL		....	....		....	....	....

4.1 HIGHEST YIELD EXPERIENCED........../ACRE LOWEST YIELD ..../ACRE

AVERAGE YIELD ..../ACRE

4. LIVESTOCK ENTERPRISES

4.1 CATTLE

4.1B COW HERD INFORMATION (SCREEN 1.6E.7.1.1.1 AND CARD 11)

AVERAGE DEATH LOSS (FRAC.) ....

NUMBER OF COWS IN THE HERD	....	AVERAGE SALE WEIGHT	....
AVERAGE FRACTION CULLED ANNUALLY	....	AVERAGE MILK PER COW PER YEAR	....
AVERAGE MANURE PER HERD PER YEAR	....	AVERAGE FRACTION OF COWS CONSUMED PER YEAR	....
AVERAGE CALVING FRACTION	....	CALVING INTERVAL (MTHS)	....
MAXIMUM NUMBER OF COWS IN THE HERD	....	LACTATION PERIOD MTHS/YES	....

	HEIFERS < 12 MTHS	HEIFERS 1-2 YES	HEIFERS 2-3 YES	MALES < 12 MTHS
SCREEN	(1.6E.7.1.2)	(1.6E.7.1.1.3)	(1.6E.7.1.1.4)	(1.6E.7.1.1.5)
	(CARD 12)	(CARD 13)	(CARD 14)	(CARD 15)
INITIAL NO. OF HEAD	....	....	....	....
DEATH LOSS	....	....	....	....
FRACTION SOLD/GIVEN OUT (E.G. FOR DOWRY)	....	....	....	....
AVERAGE SALE WEIGHT	....	....	....	....
FRACTION CONSUMED	....	....	....	....
MANURE /HEAD /YEAR	....	....	....	....
PURCHASED REPLACEMENT DURING THE YEAR (NO)	....	....	....	....

	MALES 1 2 YES	MALES 2-3 YES	BULLS
SCREEN	(1.6E.7.1.1.6)	(1.6E.7.1.1.7.)	(1.6E.7.1.1.9)
	(CARD 16)	(CARD 17)	(CARD 19)
NUMBER OF HEAD	....	....	....
DEATH LOSS	....	....	....
FRACTION SOLD/GIVEN OUT (E.G. FOR DOWRY)	....	....	....
AVERAGE SALE WEIGHT	....	....	....
MANURE/HEAD/YEAR	....	....	....
FRACTION CONSUMED	....	....	....
PURCHASED REPLACEMENT DURING THE YEAR (NO.)	....	....	....

CATTLE HERD REPLACEMENT INFORMATION (SCREEN 1.6E.7.1.3 AND CARD 110)

NUMBER OF YEARS COWS ARE IN THE HERD	....	NUMBER OF YEARS BULLS ARE IN THE HERD	....
AVERAGE AGE AT FIRST FIRST CALVING	....	ANNUAL CASH COST PER BULL	....

4C CASH PRODUCTION COSTS FOR COWS & CALVES (SCREEN 1.6E.7.1.4. AND CARD 111)

*** BASED ON WHOLE HERD BUT CALCULATED LATER ON PER COW BASE***

ITEM	UNIT	QUANTITY	PRICE/UNIT	TOTAL COSTS KSHS
1. BREEDING (A.I./BULL	NO/YEAR)	....	....	....
2. CONCENTRATES	KGS/BAGS	....	....	....

3. SALT/MINERAL KGS	....	....	....
4. FORAGES (HAY ETC) KGS	....	....	....
5. WATER LITRES	....	....	....
6. ROPES NO/YEAR	....	....	....
7. DIPPING NO/YEAR	....	....	....
8. SPRAYING ACARICIDE KGS/LITRES	....	....	....
9. VACCINATION NO/YEAR	....	....	....
10. TREATMENT TBD* NO/YEAR			
1. ECF	....	....	....
2. ANAPLASMOSIS	....	....	....
3. OTHERS	....	....	....
11. MASTITIS NO/YEAR	....	....	....
12. TREATMENT OTHER NO/YEAR	....	....	....
13. HELMINTHS NO/YEAR	....	....	....
14. OTHER MEDICAL DRUGS NO/YEAR	....	....	....
15. OTHER EXPENSES (DEHORN CASTRATION ETC NO/YEAR	....	....	....
16. MILKING SALVES ETC	....	....	....
17 TOTAL COSTS	....	....	....

** TICK BORNE DISEASES

4.1.D ANNUAL CATTLE HERD OUTPUTS UTILIZATION FOR THE YEAR

ITEM & UNIT	QUANTITY SOLD	QUANTITY USED BY H\H	LABOURERS	RELATIVES/OTHERS
1. MILK (KGS/YEAR)	....	......	....	....
2. MANURE (KGS/YEAR)	....			

EMPIRICAL PROBABILITY DISTRIBUTION FOR CATTLE PRICES PER WEIGHT UNIT (SCREEN 1.6E.7.1.8.1-24 AND CARDS 156 & 157) EACH OF THESE ARE DEFINED ACCORDING TO A MINIMUM, MAXIMUM AND HISTORICAL DISTRIBUTION.

[illegible]	MIN	MAX	HIST1	HIST2	HIST3	HIST4	HIST5	HIST6	HIST7	HIST8	HIST9	HIST10
CULLED COW	......	....	......	......	......	......	......	......	......	......	......	......
CALF	......	....	......	......	......	......	......	......	......	......	......	......
HEIFER 1-2YEAR	......	......	......	......	......	......	......	......	......	......	......	......
HEIFER 2-3YEAR	......	......	......	......	......	......	......	......	......	......	......	......
MALE 1-2YEAR	......	......	......	......	......	......	......	......	......	......	......	......
MALE 2-3YEAR	......	......	......	......	......	......	......	......	......	......	......	......
CULLED BULL	......	......	......	......	......	......	......	......	......	......	......	......
REPLACEMENT COW	......	......	......	......	......	......	......	......	......	......	......	......
REPLACEMENT BULL	......	......	......	......	......	......	......	......	......	......	......	......
MILK	......	......	......	......	......	......	......	......	......	......	......	......
HIDES	......	......	......	......	......	......	......	......	......	......	......	......
MANURE	......	......	......	......	......	......	......	......	......	......	......	......

EMPIRICAL PROBABILITY DISTRIBUTIONS FOR CATTLE PRODUCTION (SCREEN 1.6E.7.1.8.16-1.6E.7.1.8.23 AND CARDS 156 & 158)

SALE WEIGHT (KGS)

	MIN	MAX	HIST1	HIST2	HIST3	HIST4	HIST5	HIST6	HIST7	HIST8	HIST9	HIST10
COWS	......	......	......	......	......	......	......	......	......	......	......	......
HEIFER < 1 YR	......	......	......	......	......	......	......	......	......	......	......	......
HEIFER 1-2YEAR	......	......	......	......	......	......	......	......	......	......	......	......
HEIFER 2-3YEAR	......	......	......	......	......	......	......	......	......	......	......	......
MALE < 1 YR	......	......	......	......	......	......	......	......	......	......	......	......
MALE 1-2YEAR	......	......	......	......	......	......	......	......	......	......	......	......
MALE 2-3YEAR	......	......	......	......	......	......	......	......	......	......	......	......
CULLED BULL	......	......	......	......	......	......	......	......	......	......	......	......
MILK PRODUCTION (KGS)	......	......	......	......	......	......	......	......	......	......	......	......

CATTLE CULLED IN A DROUGHT (SCREEN 1.6E.7.1.9. AND CARD 159) ENTER THE DROUGHT
CULLING FOR EACH CATEGORY OF CATTLE AS A FRACTION.
1-12 MONTHS CALVES..... 1-2 YEAR OLD HEIFERS..... 2-3 YEAR OLD HEIFERS.....

1-2 YEAR OLD MALES...... 2-3 YEAR OLD MALES ....

COWS ...... BULLS ....

FORAGE SHORTAGE THAT CONSTITUTE A DROUGHT ....

CHANGE IN CATTLE PRICES FOR A DROUGHT (FRACTION) ....

FORAGE REQUIREMENT (SCREEN 1.6E.7.2. AND CARD 138)
ENTER MINIMUM AND AVERAGE AMOUNT OF FORAGE REQUIRED PER ANIMAL TYPE PER YEAR

	COW	EWE	DOE	SOW
MINIMUM (KGS)	....	....	....	....
AVERAGE (KGS)	....	....	....	....

4.1 SHEEP FLOCK (SCREEN 1.6E.7.3.1, 1.6E.7.3.2.& 1.6E.7.3.4 & CARDS 160,161 & 162)
4.1A INVENTORY CHANGES DURING THE YEAR

FACTOR	AGE AND SEX GROUP					
	ADULT MALES	ADULT FEMALES	IMMAT. MALES	IMMAT. FEMALES	MALE LAMB	FEMALE LAMB
1. NO BEGINNING	.....	....	.....	.....	.....	.....
2. NO BORN	.....	....	.....	.....	.....	.....
3. NO BOUGHT	.....	....	.....	.....	.....	.....
4. NO SOLD	.....	....	......	.....	.....	.....
5. NO CONSUMED	.....	....	......	.....	.....	.....
6. NO GAVE OUT	.....	....	......	.....	.....	.....
7. NO. GIVEN	.....	....	......	.....	.....	.....
8. AVERAGE SALE WEIGHT	.....	....	......	.....	.....	.....
9. AVERAGE DEATH/YR....		....	......	......	.....	.....

10.AVERAGE LAMBING FRACTION ....

11.FRACTION OF FEMALE LAMBS KEPT FOR REPLACEMENT.......

12.AVERAGE FRACTION OF EWES CULLED ANNUALLY.......

13.FRACTION OF RAMS CULLED ANNUALLY ....

14.AVERAGE SALE WEIGHT (EWES) KSHS ....

15.MANURE/FLOCK/YEAR ....

4.2B SHEEP AND SHEEP PRODUCT SALES FOR THE YEAR

CLASS	QUANTITY SOLD	PRICE KSHS/ FLOCK
1.WOOL (KGS)	....	....
2.SKIN	....	....
3. MANURE	....	....

4.2C LIST QUANTITIES OF INPUTS AND COSTS USED IN SHEEP PRODUCTION

ITEM	UNITS	QUANTITIES PER FLOCK	COSTS (KSHS) PER FLOCK
1. PURCHASED FORAGE	KGS	....	....
2. PURCHASED FEED	KGS	....	....
3. TREATMENT & DRUGS	KGS/NOS	....	....
4. OTHERS		....	....
TOTAL		....	....

EMPIRICAL PROBABILITY DISTRIBUTIONS FOR SHEEP PRICES PER WEIGHT UNIT (SCREEN [illegible].2.3.7.5 AND CARDS [illegible] & 167) EACH OF THESE ARE DEFINED ACCORDING TO A MINIMUM, MAXIMUM AND HISTORICAL DISTRIBUTION

[illegible]	MIN	MAX	HIST1	HIST2	HIST3	HIST4	HIST5	HIST6	HIST7	HIST8	HIST9	HIST10
CULLED EWE	......	......	......	......	......	......	......	......	......	......	......	......
LAMB	......	......	......	......	......	......	......	......	......	......	......	......
REPLACEMENT EWE	......	......	......	......	......	......	......	......	......	......	......	......
CULLED RAM	......	......	......	......	......	......	......	......	......	......	......	......
WOOL	......	......	......	......	......	......	......	......	......	......	......	......

4.2D SHEEP CULLED IN A DROUGHT (SCREEN 1.6E.7.3.8 AND CARDS 168). ENTER THE NUMBER OF EACH CATEGORY OF SHEEP AS A FRACTION OF TOTAL EWES IN THE FLOCK.

EWES .... 1-2 MONTHS LAMBS ....

REPLACEMENT EWES .... RAMS ....

FRACTION OF CHANGE IN SHEEP PRICES FOR A DROUGHT ....

4.3 GOATS FLOCK (SCREEN 1.6E.7.5.1 & 1.6E.7.5.2 & CARDS 170, 171 & 172)

4.3A INVENTORY CHANGES DURING THE YEAR

FACTOR	AGE AND SEX GROUP					
	ADULT MALES	ADULT FEMALES	IMMAT. MALES	IMMAT. FEMALES	MALE KIDS	FEMALE KIDS
1. NO BEGINNING	.....	....	.....	.....	.....	.....
2. NO BORN	.....	....	.....	.....	.....	.....
3. NO BOUGHT	.....	....	.....	.....	.....	.....
4. NO SOLD	.....	....	.....	.....	.....	.....
5. NO CONSUMED	.....	....	.....	.....	.....	.....
6. NO GAVE OUT	.....	....	.....	.....	.....	.....
7. NO. GIVEN	.....	....	.....	.....	.....	.....
8. AVERAGE SALE WEIGHT	.....	....	.....	.....	.....	.....
9. AVERAGE DEATH/YR.	.....	....	.....	.....	.....	.....

10. AVERAGE KIDS PER DOE ....

11. FRACTION OF FEMALE KIDS KEPT FOR REPLACEMENT ....

12. AVERAGE FRACTION OF DOES CULLED ANNUALLY......

13. FRACTION OF KIDS CULLED ANNUALLY ....

14. AVERAGE SALE WEIGHT (DOES) KSHS ....

15. MANURE/FLOCK/ YEAR ....

4.3B GOATS AND GOAT PRODUCTS SALES FOR THE YEAR

CLASS	QUANTITY SOLD	PRICE KSHS/ FLOCK
1. SKIN (NO.)	....	....
2. MANURE (KGS)	....	....

4.3C LIST QUANTITIES OF INPUTS AND COSTS USED IN GOAT PRODUCTION

ITEM	UNITS	QUALITIES PER FLOCK	COSTS (KSHS) PER FLOCK
1. PURCHASED FORAGE	KGS	....	....
2. PURCHASED FEED	KGS	....	....
3. TREATMENT & DRUGS	KGS/NOS	....	....
4. OTHERS		....	....
TOTAL		....	....

EMPIRICAL PROBABILITY DISTRIBUTIONS FOR GOAT PRICES PER WEIGHT UNIT (SCREEN 1.6E.7.5.6.1-1.6E.7.5.6.4 AND CARDS 176 & 177). EACH OF THESE ARE DEFINED ACCORDING TO A MINIMUM, MAXIMUM AND HISTORICAL DISTRIBUTION.

PRICE	MIN	MAX	HIST1	HIST2	HIST3	HIST4	HIST5	HIST6	HIST7	HIST8	HIST9	HIST10
CULLED DOE	......	......	......	......	......	......	......	......	......	......	......	......
KID	......	......	......	......	......	......	......	......	......	......	......	......
CULLED BUCK	......	......	......	......	......	......	......	......	......	......	......	......

GOAT CULLED IN A DROUGHT (SCREEN 1.6E.7.3.8 AND CARDS 168). ENTER THE NUMBER OF EACH CATEGORY OF GOAT CULLED AS A FRACTION OF TOTAL EWES IN THE FLOCK.

DOES .... 1-2 MONTHS KIDS ....

REPLACEMENT DOES .... BUCKS ....

FRACTION OF CHANGE IN GOAT PRICES FOR A DROUGHT ....

4.4 PIG HERD (SCREEN 1.6E.7.4.1 & 1.6E.7.4.2 AND CARDS 180 & 181).

4.4A INVENTORY CHANGES DURING THE YEAR

FACTOR	AGE AND SEX GROUP					
	ADULT MALES	ADULT FEMALES	IMMAT. MALES	IMMAT. FEMALES	MALE PIGLETS	FEMALE PIGLETS
1. NO BEGINNING	.....	....	.....	.....	.....	.....
2. NO BORN	.....	....	.....	.....	.....	.....
3. NO BOUGHT	.....	....	.....	.....	.....	.....
4. NO SOLD	.....	....	.....	.....	.....	.....
5. NO CONSUMED	.....	....	.....	.....	.....	.....
6. NO GAVE OUT	.....	....	.....	.....	.....	.....
7. NO GIVEN	.....	....	.....	.....	.....	.....
8. AVERAGE SALE						

WEIGHT ....

9. AVERAGE DEATH/YR.... ....

10. AVERAGE PIGLETS PER SOW ....

11. FRACTION OF FEMALE PIGLETS KEPT FOR REPLACEMENT........

12. AVERAGE FRACTION OF SOWS CULLED ANNUALLY.......

13. AVERAGE DEATH LOSS (FRAC) ....

14. AVERAGE SALE WEIGHT (SOWS) KSHS ....

15. MANURE/FLOCK/ YEAR
QUANTITY PRODUCED ....

QUANTITY SOLD ....

4.4C LIST QUANTITIES OF INPUTS AND COSTS USED IN PIG PRODUCTION

ITEM	UNITS	QUANTITIES PER FLOCK	COSTS (KSHS) PER FLOCK
1. PURCHASED FORAGE	KGS	....	....
2. PURCHASED FEED	KGS	....	....
3. TREATMENT & DRUGS	KGS/NOS	....	....
4. OTHERS		....	....
TOTAL		....	....

EMPIRICAL PROBABILITY DISTRIBUTIONS FOR PIG PRICES PER WEIGHT UNIT (SCREEN 1.6E.7.5.6.1-1.6E.7.5.6.4 AND CARDS 176 & 177). EACH OF THESE ARE DEFINED ACCORDING TO A MINIMUM, MAXIMUM AND HISTORICAL DISTRIBUTION.

PRICE	MIN	MAX	HIST1	HIST2	HIST3	HIST4	HIST5	HIST6	HIST7	HIST8	HIST9	HIST10
CULLED SOWS	......	......	......	......	......	......	......	......	......	......	......	......
GILTS AND BARROWS	......	......	......	......	......	......	......	......	......	......	......	......
REPLACEMENT SOWS	......	......	......	......	......	......	......	......	......	......	......	......
CULLED BOARS	......	......	......	......	......	......	......	......	......	......	......	......
MANURE	......	......	......	......	......	......	......	......	......	......	......	......

4.4D PIGS CULLED IN A DROUGHT (SCREEN 1.6E.7.4.7 AND CARD 187). ENTER THE NUMBER OF EACH CATEGORY OF PIGS AS A FRACTION OF TOTAL SOWS IN THE HERD.

SOWS .... 1-2 MONTHS PIGLETS...........

REPLACEMENT SOWS .... BOARS ....

PIG PRICE CHANGES IN DROUGHT (FRAC.) ....

4.5 OTHER LIVESTOCK

4.5A INVENTORY FOR OTHER LIVESTOCK FOR THE YEAR

TYPE OF LIVESTOCK	NUMBER	TOTAL VALUE (KSHS)
1. CHICKEN	....	....
2. DUCKS	....	....
3. DONKEYS	....	....
4. OTHERS	....	....

4.3B OUTPUTS (SALES) AND INPUTS FOR OTHER LIVESTOCK DURING THE YEAR.

LIVESTOCK NAME	TOTAL INPUTS QUANTITIES (KSHS/UNIT)	VALUE (KSHS)	TOTAL OUTPUTS QUANTITIES (KSHS/UNIT)	VALUES (KSHS)
1. CHICKEN	....	....	....	....
2. DUCKS	....	....	....	....
3. DONKEYS	....	....	....	....
4. OTHERS	....	....	....	....
TOTAL	....	....	....	....

5. LIABILITIES (SCREEN 1.6E.2)

LOAN TYPE	SOURCE OF LOAN	AMOUNT KSHS	LOAN LIFE	CURRENT DEPT	INTEREST RATE %
1. LAND DEBT (SCREEN 1.6E.2.1 & CARD 6)	....	......	....	.....	....
2. MACHINE DEBT (SCREEN 1.6E.2.2 & CARD 7)	....	......	....	.....	....
3. LIVESTOCK DEBT (SCREEN 1.6E.2.3 & CARD 7)	....	......	....	.....	....
4. EDUCATION LOANS	....	......	....	.....	....

5. NEW LOANS (1995) (SCREEN 1.6E.2.4 & CARDS 8 & 9)

LOAN TYPE	SOURCE	AMOUNT (KSHS)	LIFE (YEARS)	INTEREST RATE (%)
....	....	....	....	....
....	....	....	....	....

6. OPERATING LOANS SCREEN 1.6E.2.5. AND CARD 7)

CROPS LOANS AMOUNT (KSHS) .... INTEREST RATE %.........

LIVESTOCK LOANS AMOUNT (KSHS) .... INTEREST RATE % ....

6. OTHERS FIXED ANNUAL EXPENSES (SCREEN 1.6E.4.2 AND CARDS 13 & 17)

FIXED COST	AMOUNT
1. MAINTENANCE AND REPAIRS COSTS OF BUILDINGS EQUIPMENTS, IMPLEMENTS AND OTHER ASSETS	....
2. INSURANCE	
CROP INSURANCE	....
LIVESTOCK INSURANCE	....
VEHICLES AND MACHINERY INSURANCE	....
TOTAL INSURANCE	....
3. LEGAL AND ACCOUNTANT FEES	....
4. OTHER MISCELLANEOUS FIXED COSTS	....

6.A OTHER FARM INCOME (SCREEN 1.6E.3.3 AND CARD 14)

REVENUE FROM OTHER ENTERPRISES KSHS .... EXPENSES FOR OTHER ENTERPRISES KSHS ....

6.B OCCUPATIONS OFF THE FARM AND EARNINGS (*** MEMBERS STAYING ON THE FARM PERMANENTLY OR THOSE STAYING AWAY FOR A MAXIMUM OF 6 MONTHS IN A YEAR***) (** INDICATE HOUSEHOLD MEMBER AS (HEAD, ADULT MALE , ADULT FEMALE, CHILD MALE, CHILD FEMALE***) (SCREEN 1.6E.3.4 AND CARD 14)

FAMILY MEMBER	INCOME SOURCE	MINOR/MAJOR	INCOME (KSHS)
1	....	....	....
2	....	....	....
3	....	....	....
4	....	....	....
5	....	....	....
6	....	....	....
7	....	....	....
8	....	....	....

TOTAL SALARY INCOME ....

NON-SALARY INCOME KSHS ....

INCOME FROM OFF-FARM INVESTMENTS ....

TOTAL OFF -FARM INCOME ....

6.C CASH AVAILABLE AT START OF THE YEAR.

1. AT HAND KSHS............ 2. CASH AT BANK KSHS ....

3. INTEREST RATE FOR CASH RESERVE ....

APPENDIX II

STAGE TWO DATA
(GENERAL INFORMATION OF THE FARMER AND HIS PERCEPTION AND ATTITUDE TOWARDS VARIOUS ECONOMIC FACTORS, RISKS AND UNDERTAKINGS).

1.WHAT IS THE FARMERS REASON FOR DIVERSIFICATION . . . .

2.WHICH ONE OF THE FOLLOWING IS CONSIDERED TO AFFECT H/H INCOME MORE SERIOUSLY.

(I). (A) CROP FAILURE (B) DAIRY CATTLE DISEASES . . . .

(II). (A) BAD MARKET (B) DAIRY CATTLE DISEASES . . . .

(III).(A) .... (B) DAIRY CATTLE DISEASES . . . .

3.WHAT IS PREFERRED IN DAIRY ENTERPRISE?

(I) (A) PROPHYLAXIS OR (B) CURATIVE TREATMENT . . . .

(II) REASONS . . . .

4.WHAT DOES THE FARMER EXPECT TO HAPPEN TO THE H/H INCOME LEVEL (OR OTHERWISE) IF THE FOLLOWING INPUTS ARE INCREASED AND WHAT IS THE REASON FOR NOT INCREASING.

INPUT	EXPECTATION	REASON FOR NOT INCREASING
CONCENTRATES	....	....
FODDER	....	....
COW	....	....
FERTILIZER	....	....
LABOUR	....	....
ACARICIDE APPL.	....	....

5.DOES THE FARMER HAVE ENOUGH OF THE FOLLOWING FACILITIES/ INPUTS?. IF NOT GIVE REASONS.

FACILITIES/INPUT		YES/NO	REASON
CASH		......	....
A.I. SERVICES		......	....
TECHNICAL ADVICE		......	....
HEALTH SERVICES		......	....
STORAGE FACILITIES FOR	-MILK	......	....
	-CROP PRODUCE	......	....
	-OTHERS	......	....
TRANSPORT FOR	-MILK	......	....
	-CROP PRODUCE	......	....
	-OTHERS	......	....
MARKET FOR	-MILK	......	....
	-CROP PRODUCE	......	....
	-OTHERS	......	....
MANURE		......	....
SEEDS	-QUALITY	......	....
	-QUANTITY	......	....

6. RISK SOURCES, MANAGEMENT STRATEGIES AND EFFECTIVENESS OF THE STRATEGIES IN VARIOUS ENTERPRISES

ENTERPRISES	RISKS (IN ORDER OF MAGNITUDE)			OVERALL RANKING	MANAGEMENT STRATEGIES & EFFECTIVENESS					
i. CROPS (FOOD & FODDER)	RISK 1	RISK 2	RISK 3		RISK1	EFF.	RISK2	EFF.	RISK3	EFF.
ii. DAIRY CATTLE	RISK 1	RISK 2	RISK 3		RISK1	EFF.	RISK2	EFF.	RISK3	EFF.
iii. OTHER FARM ENTERPRISE	RISK 1	RISK 2	RISK 3		RISK1	EFF.	RISK2	EFF.	RISK3	EFF.
iv. NON-FARM ACTIVITIES	RISK 1	RISK 2	RISK 3		RISK 1		RISK 2		RISK 3	

SOURCES OF RISKS	CONTROL STRATEGIES USED	EFFECTIVENESS
1.WEATHER (E.G. RAINFALL)	1.IRRIGATION	0. NOT EFFECTIVE
2.DISEASES (E.G. E.C.F.)	2.EARLY PLANTING	1. MILD EFF.
3.PESTS	3.LATE PLANTING	2. " "
4.SEED QUALITY	4.EARLY HARVESTING	3. FAIR
5.SEED AVAILABILITY	5.VARIETY/HYBRID SELECTION	4. "
6.LABOUR AVAILABILITY	6.CURATIVE TREATMENT	5. "
7.FERTILIZER AVAILABILITY	7.PROPHYLAXIS	6. GOOD
8.A.I. AVAILABILITY	8.CONTRACT FARMING	7. "
9.CONCENTRATES QUALITY	9.HEDGING	8. "
10.CONCENTRATES AVAILABILITY	10.NEIGHBOURS BULL	9. VERY GOOD
11.DRUGS AVAILABILITY	11.NOTHING	10 "
12.PRICE FLUCTUATIONS	12.CAPITAL INVESTMENT	
13.TRANSPORT AVAILABILITY	13.COOPERATIVE MEMBERSHIP	
14.AVAILABILITY	14 WOMEN/MEN GROUP	
15.INFLATION	15.INVEST IN CHILDREN'S EDUCATION	
16.CASH AVAILABILITY	16.VOCATIONAL/OTHER SELF TRAINING	
17.MARKET AVAILABILITY	17.PLANT CROP AT DIFFERENT SITE	
18.THEFT	18.ADDITIONAL PLOTS	
19.ACCIDENTAL DEATH	19.VARY PLANTING TIME	
20.LOW PRICES	20.INTERCROPPING	
	21.MULCHING	
	22.HOME MADE	
	23.TIMELY PLANTING	
	24.CROP ROTATION	
	25.CERTIFIED SEEDS	
	26.HOUSING	
	27.GROW/KEEP LESS VULNERABLE	
	28.GROW/KEEP LESS	
	29.TRAPPING	
	30.ALTERNATIVE MARKET	