AN EVALUATION OF SELECTED FACTORS AFFECTING THE ADOPTION OF ZERO-GRAZING DAIRY PRODUCTION SYSTEM BY SMALLHOLDER FARMERS IN KIRINYAGA DISTRICT, KENYA: THE CASE OF NATIONAL DAIRY DEVELOPMENT PROJECT (NDDP) 1987-1995

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A THESIS

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DECLARATION

I declare that this is my original work and has not been presented or published for examination in this University or any other University.

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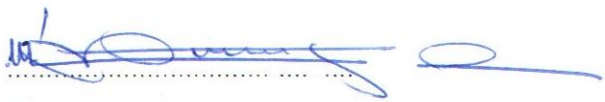
APPROVAL

This thesis has been submitted to the Graduate School with our approval as the University Supervisors



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DEDICATION

To my loving mother and brother, the late Milkah Wangui and John Kiibi

To my beloved wife Ann and son Ndegwa for their patience and understanding during my long stay away from home.

To my father, brothers, sisters and any other person for their encouragement during the study period.

ABSTRACT

A strong emphasis has been placed on Agriculture in Kenya because of the role the sector plays in the economy. Intensive farming is one of the methods that can be employed to increase agricultural production. One of the enterprises that require this method of production is the dairy industry. The National Dairy Development Project was started in Kirinyaga District in 1987 with the aim of helping smallholder dairy farmers intensify dairy production through zero grazing. The purpose of this study was to assess the impact of the factors that affected the adoption of zero grazing dairy production by smaller holder farmers in Kirinyaga between 1987 and 1995. The farmers though introduced to the technology did not take up the practice and adoption was low. Descriptive survey was used; proportionate stratified sampling was used to select a sample of 180 farmers. Data was collected by use of structured questionnaire. Descriptive statistics and inferential statistics namely Pearson's Correlation Coefficient was used to determine the relationship between adoption and the various variables. Hypotheses were tested with the level of significance set at .05. Only the relationship between adoption of zero grazing technologies and feed availability was found to be significant. The level of adoption of zero grazing was low due to feed unavailability, unstable milk market, low farmer- extension agent contact, high cost of both inputs and cost of constructing the zero grazing unit. It is recommended that a benefit analysis be carried out to ascertain the affordability and sustainability of the system.

TABLE OF CONTENTS

DECLARATION ii

APPROVAL iii

COPYRIGHT iv

ACKNOWLEDGEMENT v

DEDICATION vi

ABSTRACT vii

TABLE OF CONTENTS viii

LIST OF TABLES x

LIST OF FIGURES xi

CHAPTER ONE 1

INTRODUCTION 1

1.0 Background Information 1

1.1 Statement of the Problem 2

1.2 Purpose of the study 3

1.3 Objectives of the Study 3

1.4 Hypothesis 3

1.5 Significance of the Study 4

1.6 Assumptions of the Study 4

1.7 Limitations of the Study 4

1.8 Justification of the study 4

1.9 Definition of Terms 5

CHAPTER TWO 6

REVIEW OF LITERATURE 6

2.0 Introduction 6

2.1 Adoption process 6

2.2 The Adopter Categories 7

2.3 Attributes of a technology that influence its adoption 7

2.5 Factors that determine the adoption of a technology 11

2.6 Conceptual Framework 18

CHAPTER THREE 19
RESEARCH METHODOLOGY 19
3.0 Introduction 19
3.1 Research Design 19
3.2 Location of the study 19
3.3 Population of the study 20
3.4 Sampling procedures and samples 20
3.5 Instrumentation 22

CHAPTER FOUR 24
RESULTS AND DISCUSSION 24
4.0 Introduction 24
4.1 Conceptualization of adoption 24
4.2 Rates of technology adoption 25
4.3 Farmers personal characteristics 27
4.4 Adoption levels of zero grazing packages 38
4.4 Testing of Hypothesis 43

CHAPTER FIVE 49
5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS 49
5.1 Summary 49
5.2 Conclusion 50
5.3 Recommendation 50
REFERENCES 52
APPENDIX 1 58

LIST OF TABLES

Table 1. Sample size according to category 21
Table 2. Summary of Statistical Procedures 23
Table 3. Percent Distribution of Respondents by reasons for adoption 26
Table 4. Percent Distribution of Respondents by Reason of Non-adoption 26
Table 5. Percent Distribution of Respondents by Reasons for Discontinuation 27
Table 6. Percent Distribution of Respondents' Age by category 29
Table 7. Percent Distribution of Respondents' Gender by category 30
Table 8. Percent Distribution of Respondents by Level of Education by category 31
Table 9. Percent Distribution of Respondents' Farm Size by Category 32
Table 10. Percent Distribution of Respondent by Source of Fodder 33
Table 11. Percent distribution of farmers by type feeds fed to the animals 34
Table 12. Percent Distribution of Respondents Labour Source by category and mean hours spent for livestock activities 35
Table 13. Percent Distribution of Respondents by Contact with Extension Agents 37
Table 14. Percent Distribution of Respondents Personal Characteristics according to Category 38
Table 15. Frequency and Percent Distribution of Respondents levels of Adoption of Housing components of the zero grazing units 40
Table 16. Percent Distribution of Respondents by Adoption of recommended feed 41
Table 17. Percent Distribution of Respondents by Adoption of Fodder Management Practices 42
Table 18. Percent Distribution of Respondents by Adoption of Calf rearing package 43
Table 19. Chi-square Tests for Gender 44
Table 20. Correlation of Adoption and Farmers' Situational characteristics. 46
Table 21. ONE WAY ANOVA – Number of hours 46
Table 22. Post Hoc Tests (Tukey HSD) 46
Table 23. Aggregate Adoption Levels of Four Selected Zero grazing Packages 48

LIST OF FIGURES

Fig 1. Conceptual Framework Model Identifying factors influencing the adoption of zero grazing system by farmers 18

CHAPTER ONE

INTRODUCTION

1.0 Background Information

Kenya's economy is dependent on agriculture, and the sector contributes approximately 25 percent of the nations Gross Domestic Product (GDP). During the last two decades, Kenyan agriculture has been characterized by a low output of her major food and cash crops. As a consequence, the demand for food has consistently exceeded the supply, resulting in widespread hunger. To counteract these developments, the government has adopted agricultural policies and projects aimed at increasing food and export crop production through various support programmes smallholder farmers. Many of these projects and programmes have been aimed at encouraging smallholder farmers to adopt improved technologies to increase yields.

Livestock production is a major component of agriculture, contributing 10% of the GDP (National Development Plan, 2002-2006). The dairy industry has played a significant role in agricultural development since the 1920s and is one of Kenya's important food and cash earner. Smallholder farmers produce most of the milk that account for about 80% of the milk produced in the country (MOA, 1997). A large number of these farmers practice extensive dairy production systems leading to low milk yields per cow. The population of dairy cattle in the country was estimated at 3.2 million in 1998/99 (Omiti and Muma, 2000), majority of which are exotic breeds and their crosses.

The rapid population growth has resulted in a rising demand for fresh milk and milk products. Annual milk production is estimated at 2.5 billion litres against an estimated demand of 2.3 billion litres. However, it is estimated that this demand will outpace supply by the year 2005 when the demand is expected to reach 3.4 billion litres. Annual per capita milk consumption is estimated at 125 litres and 19 litres in the urban and rural areas respectively (MOA, 1996).

There is considerable potential for increased productivity; increased employment and income generation in the dairy sub-sector if it is intensified through appropriate technologies, improved management and appropriate policy. Socio-economic factors,

marketing and prices of produce, non-availability of feed, high cost of labour and inputs, poor infrastructure, poor extension coverage and lack of credit are some of the factors affecting dairy production by small scale farmers. In Kirinyaga District 33.5 million litres of milk were produced against a demand of 42 million litres (District Livestock Production Officer, Annual report). To reverse the decline in milk production, the government of Kenya and the Netherlands government instituted the National Dairy Development Project (NDDP) which was designed to enable small holder dairy farmers practice intensive dairy cattle management under zero grazing systems. All farmers in the high potential areas with 0.1 to 4 ha of land practicing mixed farming were the targets. The Project was started in Kirinyaga, a high potential area, with the long-term objectives of: Maintaining self-sufficiency of dairy products, contributing to balanced diet of the population in rural and urban areas through higher milk production, increasing the family income of rural farmers, realizing high output per acre of land and creating employment in the rural areas (NDDP Phase 5 report, 1990). Farmers were made aware of the zero grazing through public meetings, outreach training, field days and educational tours however; many farmers did not take up the practice.

The NDDP project started in Kirinyaga district in 1987. The project recommended a designed multi component zero grazing units to the farmers. The unit had the following components, cubicles, calf pen, milking palour, walking area, fodder-chopping area, store, feed and water trough and manure pit. In addition one had to plant 0.4 hectares of napier grass per cow. During the period 1987 – 1995, 1687 farmers expressed some interest in the project. Out of this, only 253 adopted the zero grazing system, 15 farmers adopted and then discontinued the practice.

1.1 Statement of the Problem

There has been a decline in milk production in Kenya since the liberalization of the dairy industry in 1992. The demand for milk by the country's ever increasing population cannot be met by the supply. Milk production in Kirinyaga district has also been on the decline, 33.5 million litres of milk was produced in the district against a demand of 42 million litres (District Livestock Officer Annual Report 2000). The NDDP was introduced in the Kirinyaga district in 1987 with the aim of helping small holder

dairy farmers improve their milk production through improved practices under the zero grazing system. Though farmers were sensitized about the project, many did not take up the practice. There was need, therefore, to assess the impact of selected factors that affected the adoption of the zero grazing dairy production system in the district.

1.2 Purpose of the study

The purpose of the study was to assess the impact of the factors that affected the rate and level of adoption of zero grazing technologies by small-scale dairy farmers in Kirinyaga from 1987 – 1995.

1.3 Objectives of the Study

The following were the main objectives of the study:

1. To determine the rate of adoption, reason for adoption and non-adoption of the zero grazing technology in Kirinyaga district.
2. To determine the relationship between farmers' personal characteristics and adoption of zero grazing in Kirinyaga district.
3. To determine the relationship between farmers' situational characteristics and adoption of zero grazing.
4. To determine the relationship between farmers' contact with extension agents and adoption of zero grazing.
5. To determine and evaluate the levels of adoption of selected zero grazing packages by smallholder farmers in Kirinyaga district.

1.4 Hypothesis

The following were the null hypotheses of the study.

H_{O1}. There is no significant relationship between farmer's personal characteristics and adoption of zero grazing system by smallholder dairy farmers in Kirinyaga district.

H_{O2}. There is no significant relationship between farmer's situational characteristics and adoption of zero grazing system by smallholder dairy farmers in Kirinyaga district.

H_{03}. There is no significant relationship between common extension methods and frequencies of contact with extension agents and adoption of zero grazing system by smallholder dairy farmers in Kirinyaga district.

1.5 Significance of the Study

Zero grazing is a better system for smallholder dairy farmers practising mixed farming in high potential areas than the extensive dairy production method. The farm sizes in Kirinyaga district are very small and therefore zero grazing is an appropriate system in that due to the small land size, high stocking rate, efficient utilization of feeds, production of high yielding fodder crops and recycling of nutrients is possible. The study is therefore designed to determine reasons for the low rate and level of adoption of zero grazing system. The information obtained will help researchers, and extension agents to find solutions to reasons that hinder adoption of zero grazing system.

1.6 Assumptions of the Study

- It was assumed that the respondents gave frank and true information.
- It was assumed that zero grazing is appropriate system and every small holder dairy farmer would adopt the technology.
- The three divisions where the study was carried out were homogenous.

1.7 Limitations of the Study

The researcher was constrained by time, finances and access to some of the relevant literature during the study. Due to these constrains the research was conducted in only one district.

1.8 Justification of the study

Milk is an important product of high nutritional value and a source of regular income to many households in Kenya. The aim of the NDDP was to assist farmers increase milk through the zero grazing production system. Kirinyaga is one of the districts where the NDDP was implemented; the level of adoption of this production method was below that projected by the sponsors, the Kenya and Netherlands governments. This study's findings provide understanding of the factors that affected the

adoption of the zero grazing system in Kirinyaga. Those organizations and governments that plan to initiate similar projects will benefit from the findings, conclusions, and recommendations.

1.9 Definition of Terms

Adoption: The acceptance and continued use of the recommended practice.

Adoption rate: The number of farmers using the given technology as the percentage of the total number of survey farmers.

Agricultural Extension: A service that assists farmers through educational procedures in improving farm methods and techniques.

Communication: Process in which participants create and share information with one another in order to reach a mutual understanding.

Diffusion: Process by which an innovation is communicated through certain channels overtime among the members of a social system.

Discontinuance: A decision to reject an innovation after having previously adopted it.

Extension methods: Channels through which extension agents disseminate the message to the farmers.

Farmer's personal characteristics: Age, gender and level of education of a farmer

Farmer's situation characteristics: Feed availability, land size and labour availability to a farmer.

Feed: Forages concentrate, water and minerals that supply livestock with nutrients required for growth maintenance and production.

Innovation: A practice or idea that is perceived as being new by an individual.

Level of adoption: The number of people who have taken up the innovation.

Livestock unit: A mature animal weighing 300kgs and above.

Non – adoption: Non-practice of the zero grazing system.

Smallholder: Farmers with land size of less than 4.2 hectares used for the production crop, livestock or both.

Technology: Systematic application of specific knowledge for practical purposes.

Zero-grazing: Livestock management system where dairy cattle are managed exclusively under confinement in a constructed cattle shed (stall).

CHAPTER TWO

REVIEW OF LITERATURE

2.0 Introduction

This chapter reviews literature related to zero grazing dairy production system and factors related to the technology. It describes technology and its features, innovations factors, adopter categories and factors related to adoption of the technology.

Adoption is a sequential process of decision-making that involves the stages of awareness, interest, evaluation, trial and adoption (Rogers, 1989; Lionberger, 1996). Farmers do not adopt technologies immediately they are introduced to them but the decision to adopt takes time (Rogers, 1989). Farmers undergo an adoption process, which is a mental process through which an individual passes from first knowledge of innovation to forming an attitude towards the innovations, to a decision to adopt or reject, to implementation and use of the new ideas, and to confirmation of this decision (Rogers, 1995). For the purpose of this study, adoption was taken as initial decision to use the new practice (zero grazing) and the extent and intensity of the use of the technology at individual farm level.

2.1 Adoption process

A person undergoes the following five stages: 1) awareness stage which is the knowledge about a new idea or practice. A farmer may obtain the idea from neighbours, mass media, and/or extension agents; 2) interest stage in which the farmer becomes interested in the new practice and seeks information about the new idea or technology to determine its worth; 3) evaluation stage in which the farmer considers the effect of the new practice, weighs the advantages and disadvantages of the new practice in terms of the present and future prospects; 4) trial stage in which the farmer tries the new practice on a small scale and; 5) adoption stage on which convinced that the practice has been a success and it can add to his prosperity, he accepts it as his customary way of doing things. Farmers can sometimes reject or drop the practice but there is a continuous use of a technology if they are satisfied with its applicability under existing conditions on the farm.

2.2 The Adopter Categories

Any large group of farmers learning about a new practice will fall into five categories. In a society, the categories form a continuum and have their own characteristics. Farmers will adopt a technology at different times. There are farmers who adopt a technology immediately it is introduced while others take time before they adopt the technology. Others do not take up the technology at all. The five categories include: innovators who are usually the wealthy, well educated, widely travelled and venturesome and are more willing to take risks; early adopters who consists of people quick to assess the value of chance of success of any practice in the community, are younger, widely read and socially active; the early majority who are average people, highly respected in the society and will adopt a practice when they are convinced of its value; the late majority who are conservative, poor, and will adopt a practice only when generally accepted by a community; and the late adopters (laggards who are very conservative and older than average and will seldom take any risks (Fliegel 1989; Rogers, 1995).

2.3 Attributes of a technology that influence its adoption

The spread of any new technological innovation depends upon the characteristics of the innovation (Rogers, 1995). Farmers do not all accept a new idea at the same time, whatsoever desirable it might be. To have an entire population decide on some new course of action upon pronouncement of the new idea does not occur (Fliegel, 1962). Individual farmers are unique with a host of characteristics that may affect how information is received, processed and either used or not used in the production process. Farmers' inability to adopt innovation can stem from a variety of causes, but lack of resources, inability to qualify for credit, and poverty in general are some of the reasons in the developing countries.

These characteristics include: compatibility, complexity, triability, relative advantage and observability.

2.3.1 Compatibility

Compatibility refers to the degree to which an innovation is compatible with values existing in the area. For a technology to be acceptable it must be compatible with the social environment of the farmer. The technologies, which do not conform to farmers'

beliefs, needs and objectives are not easily accepted (Adams, 1984; Amudavi, 1993; Lionberger, 1996). Any technology meant for farmer's use must not conflict with their existing values, past experiences or farming conditions.

2.3.2 Complexity

Complexity refers to the degree to which an innovation is perceived as relatively difficult to understand and use. Easy and simple to understand innovations are easily accepted than complex ones (Waghmare, 1989). Simple technologies that are gender and user friendly are easily adopted by farmers than complex ones. The technology should be simple and easy to understand if it is to be adopted by farmers.

2.3.3 Triability

Triability refers to the degree to which an innovation can be tried or experimented on limited basis. Farmers are always risk averse and will want to try an innovation at a small-scale. Trying on a small-scale enables a farmer to reduce the uncertainty that usually accompany new innovations (Waghmare, 1989; Amudavi, 1993). Adams (1984) observed that farmers would like to try a technology on a small scale prior to wholesome adoption. The higher the triability the better the rate of adoption (Fliegel, 1989). Farmers may wish, for example, to try zero grazing with some cows in the zero grazing unit and leave out some under other systems to assess the performance.

2.3.4 Relative advantage

Relative advantage refers to the degree to which an innovation is perceived as being superior to the one it is going to replace. Technologies that produce quick results are rapidly adopted (Amudavi, 1993; Waghmare, 1989). Superiority may be in terms of economic gains (Hawkins and Van den Ban, 1992; and Batz, Peters and Janseen, 1999). Farmers will accept a technology that brings profit to farmers more easily than a practice that is not profitable.

2.3.5 Observability

Observability refers to the degree to which the results of an innovation are visible. An idea with visible results is easily adopted by farmers (Amudavi, 1993, Waghmare,

1989). Farmers adopt new ideas that have visible results more readily and thus farmers should see the need for the practice.

2.4 Smallholder dairy in Kenya

Development of small holder diary production system in Kenya highlands has been marked by declining farm size, upgrading of dairy breeds and an increasing reliance on purchased feeds both concentrates and forages (Staal, Delgado and Nicholson, 1997). In 1972 a small scale farming project under stall feeding was developed as a means of increasing farm productivity with the objectives of: boosting crop and livestock production; establishing of pastures and fodder trees; efficient use of crop residues; and utilization of locally available and conventional feed resources of dry season feeding. Kaliba, Featherstone and Norman (1997) in a study of the project to determine the factors influencing small holder farmers adoption of a stall feeding management system for improved dairy cattle, concluded that farm size, household labour and age influenced the degree of adoption of the technology. Households cultivating larger acreages did not participate in cattle stall-feeding because they had less need to look for alternative source of income. Female-headed households adopted the stall-feeding more than their male counterparts. The extension service had a significant impact on the adoption of stall-feeding technology and an increase in the frequency and number of extension seminars attended by the household head increased participation by 14.6% and 22.1%, respectively.

2.4.1 Selected zero grazing packages

2.4.1.1 Housing

The best way to fully utilize the genetic potential of dairy cows is to create an ideal environment, with the emphasis on cow comfort to optimize health and performance. All elements of planning a dairy housing system should be considered, with emphasis on logistics such as cattle movement to/from milking parlour, manure handling and storage, labour efficiency and, above all, the ease of management (African Farming and Food Processing, 1998). The emphasis should always be on having clean, dry and comfortable free stalls to provide animals with protection and comfort. Housing protects animals from extremes of temperature, humidity and wind speed and design factors can

affect food intake and production levels (Forbes, 1986). A proven housing system designed by the NDDP with eight components was developed. The benefits of the housing system was to increase comfort to the animal, reduce disease incidences, reduce fodder wastage, enable efficient manure collection and for improved cattle observation. A complete housing unit included cubicles/resting area, walking/feeding area, fodder chopping area, milking parlour, calf pen, store, feed/water troughs and manure pit.

2.4.1. 2 Fodder establishment and management

The major fodder has been Napier grass, there has also, been the use of herbaceous and tree legumes. The recommendation for pasture management under this package was specified acreage of Napier grass per animal, spacing of napier, weeding, manure/fertilizer application and cutting height of the napier. Different tree legumes and herbaceous legumes to improve the quality of fodder were also recommended. Napier grass has been the major livestock feed in Kirinyaga and was initially introduced as soil conservation measures in the steep areas. However, yields are low due to poor crop husbandry and low soil fertility.

2.4.1.3 Dairy cattle feeding

The availability of supply of pure water in sufficient quantity can often be a limiting factor in the dairy farming. Access to water by the animal is essential for efficient food conversion and maximum production of milk. Ideally, all stock should have free access to fresh clean drinking water at all times (Sainsbury and Sainsbury, 1988). The mineral requirements of animals are expressed in amounts per day. The species or breeds of animal and the intensity or rate of milk production affect the daily mineral requirements. In most circumstances, farm animals derive a high proportion of their mineral nutrients from the feeds and the forages they consume (Underwood, 1981). Inorganic compounds are used freely and increasingly to supplement the mineral supplied by feeds and forages. Sufficient quantity and quality fodder all the year round was encouraged by the NDDP. A dairy cattle requires enough fodder, concentrates, water and mineral. Feeding is a major constraint to livestock production. Availability of fodder throughout the year is a problem due to fluctuations in supply. Fodder conservation and utilization of crop residues is encouraged to cater for these fluctuations.

2.4.1.4 Calf rearing

Today's calf is tomorrows' cow. There is therefore need to raise the calf to maturity. Calf pens that greatly restrict the behavior of calves are not considered to be an adequate housing system. If the pens are to small they are small to prevent calves from lying in a comfortable position, then the welfare of calves suffer and the animal's growth rate and disease resistance is reduced. Mortality is lower in individual pens than group pens (Neindre Ple, 1993). Cattha, Sarwa, Abbas and Ali (1996) concluded that calves could successfully be weaned at six weeks of age if given abundant provision of palatable and nutritious starter ration without affecting the weight gain of the calves. During the project, the farmers were encouraged to house the calves in calf pens with slatted floors within the zero grazing units. The importance of milk and concentrate feeding and the correct time of weaning were also highlighted.

2.5 Factors that determine the adoption of a technology

There are a number of factors that determine diffusion and adoption of new technologies in general. These can be broadly classified as personal (age, gender, level of education), social (extension methods, frequency of visits by extension agents), and situational (feed availability, labour availability and land size). (Wilson and Gallup, 1955; Waghmare, 1989). Farmer's adoption of zero grazing technology may be determined by all these factors that include: -

2.5.1 Level of education

Education determines the rates of adoption of any new technology (Waghmare, 1989). A big percentage of the population in Kirinyaga district is literate and literacy plays an important role in enabling farmers' access information. Farmers with low education tend to be disadvantaged in utilizing information. Education increases managerial competence and therefore enhances ability to diagnose, access information, comprehend and respond to financial and production problems (Molnar, 1985). There is a positive relation between farmers level of education and adoption behavior in Kenya (Chitere, 1985). Misiko (1976) indicated that out of the total number of farmers who had

adopted the use of high yielding varieties of maize, 25% were illiterate, 65% had primary level education and 11% had secondary school education. However, farmers have always felt that schooling beyond primary school level is not needed; in any case it makes a person impractical (Lionberger 1996).

2.5.2 Age

Studies relating farmers' age to the adoption behavior reveal conflicting results with some showing relationships while others reflect no relationships. Amudavi (1993) found that there was no relationship between age and adoption.. Older farmers are less inclined to adopt new farm practices than young ones. Highest adoption of innovations is by those in the middle age bracket. Rogers (1993) argues that younger and more educated farmers are more inclined to adopt new practices. In Kirinyaga, both the old and young people practice dairy production.

2.5.2 Gender

Women usually manage most homes as men are out in towns seeking for jobs or working (Waghmare, 1989). They perform most of farming related activities but the male counterpart makes decisions. Women in the rural areas are responsible for half of the world's food production and produce about 60 percent of the food in the developing countries. In the sub Saharan Africa and the Caribbean, they produce up to 80% of basic foodstuff (FAO, 2002). Women in Africa have always played a central role in societies. Women account for over 50 % in the rapid economic development of any country at all levels (Were, 1985). In Kenya, women play a critical role in the development of the society (Masinde, 1987). Introduction of modern technology and cash crops in developing societies benefit men rather than women by creating productivity gap between them (Masinde, 1987). It is therefore not enough to talk about economic development without women, as they are the main actors in development activities in rural Kenya. The World Bank (1993) reported that there was no significant difference between the male-headed households and female-headed household in the adoption of technologies. Oywaya (1995), in a study carried out in Machakos district of Kenya, found significant gender difference in adoption rates of innovations. Women adopted new innovations more than men. Migration to urban areas has resulted in a rapid rise in the

number of rural families that have women as the household heads. These women are largely without effective decision-making powers. Yet, increasingly, female-headed households are faced with the task of producing food to feed an ever-growing population. Technology adoption decisions depend primarily on access to resources, rather than on gender although the gender of the household head may be important (Doss, 2001).

2.5.4 Farm size

Land size in Kirinyaga is small and a significant portion of this land is under cash crops. Farm size is significantly related to adoption of a new practice. Farmers with large size farms adopt new farm practices than the small holders (Amudavi, 1993). Kebende, Gunjal and Coffin (1990) in a study of adoption in Ethiopia found that farm size was the most significant factor affecting the adoption of agricultural technology. A survey in Kenya also isolated farm size as the most important variable affecting farmers' innovativeness (Rolling, 1990). Mbugua, (1996), cited land size as a factor influencing adoption of a particular technology.

2.5.5 Feed availability

Dairy development in the tropics is generally directed towards the smallholder sector. Major constraints on production are the scarcity and poor quality of on-farm feeds, prolonged drought, and the erratic supply and high cost of concentrates. Fodder is the main source of feeds for the dairy animals. Competition for available land between cash crops, food crops and fodder makes overproduction of fodder not possible even during the wet seasons (Said and Wanyoike 1987). Maize is a major food crop grown by almost all smallholder farmers and maize stover is, therefore, the most abundant arable crop residue (Methu, Owen, Abate, Mwangi and Tannar, 1996). Inadequate nutrition limit dairy cattle productivity (Rees, Nkonge and Wandera, 1997). *Pennisetum purpureum* (Napier grass var. Bana) grown with shrubby legumes, *Leucaena leucocephala* for example, can improve both the quality and quantity of food available throughout the year (Reynolds and Attah-Krah. 1989). Devendra (1990) observed that the use of legume supplements increased milk output, reduced production costs and was applicable for stall feeding. The NDDP initiated in 1980 promoted the zero grazing dairy production system. The project recommended Napier grass for dairy cattle feeding and

advised farmers to plant 0.4ha (1acre) of Napier grass per cow (Stotz 1983). Mureithi, Njunie, Muinga, Ali, Thorpe and Mwatata (1998) found out that smallholder dairy development in coastal lowland Kenya was mainly constrained by inadequate nutrition. The feed resources available in the small holder mixed farms were inadequate in quantity and quality and rarely meet the nutrient demand for lactating cows. Land sizes, allocation of land among different enterprises, labour allocation and capital availability were factors likely to affect adoption of planted forages. Mureithi also observed that planted forages contributed only 15% of available fodder in small holder dairy farms and each farmer planted an average of 0 071 hectares per cow which was far below what was recommended by the NDDP. Crop residues will have to play an important role as a feed source to overcome feed shortage, which is a constraint in the tropics. In Kirinyaga, Napier grass is the major source of fodder supplemented with concentrates, weeds, milling byproducts and crop residues. Due to limited land, most farmers depend on purchased fodder or pasture grown by the roadside.

2.5.6 Labour Availability

The relative cost of labour must be kept in mind when designing appropriate technology and other technical and input services. New technologies rely on machines which contrasts greatly with the limited amount of labour expended in the traditional production systems which is hired to implement the improved technology (Njoku, 1990). In Nepal where animals are raised under stall feeding system Shrestha and Evans (1984) found that the total amount of time required to raise an average 7.37 animals per household was 80.3, 208.0 and 106.3 days per annum for men, women and children respectively. This indicates that livestock rearing takes up to 7.5 hours per day when labour invested by men, women and children is considered together. Most labour for dairy production is family, but 60% of the households hire labour, with 20% retaining permanent labour throughout the year (Staals, Owango, Muriuki, Lukuyu, Musembi, Bwana, Muriuki, Gichungu, Omore, Kinyanjui, Njubi, Baltenweck and Thorpe, 1998b). Household labour is important in determining the degree to which the stall-feeding technology and associated management practices are adopted (Kaliba et al., 1997). Arriga (1999) concluded that milk production offers large benefits to the farming community,

and given that it was more profitable and well distributed, the large demand for labour gave work to 80% of men either full-time or part time. The labour requirement of zero grazing is high but rather equally spread during the year. Zero grazing is labour intensive and can constraint the adoption of technology. New technologies are classified as either labour intensive or labour saving. Labour intensive technologies are likely to impede small-scale farmers from adopting new innovations.

2.5.7 Extension Methods

Extension is considered a link between research station and farmers. Extension agents transmit new technologies to farmers and farmers' problem to the researcher. They also give technical advice to the farmers in a view of improving their productivity and income (Garforth, 1982). To facilitate transmission of technology, extension ensures that adequate knowledge about the technology is available to the farming community. Farmers who have been exposed to an intensive extension education adopted many agricultural innovations in contrast to neighbours who are not exposed to extension campaigns (Ascroft, Rolling, Kariuki, and Chege, 1993). Amudavi (1993) however, concluded that there was no relationship between extension contact and adoption of technologies.

Agricultural extension assists farmers through educational procedures to improve their farming methods and techniques. The Ministry of Agriculture and Livestock Development provides extension services in Kirinyaga. The extension agents are charged with the responsibility of transferring research findings and innovation from the research to the farmers through various methods. With the introduction of the National Dairy Development Project, some extension agents in livestock production were seconded to the project. They were trained on the packages developed by the Project to be adopted by farmers Information and knowledge is essential for improving agricultural productivity by farmers. Rural farmers are in great need of information, knowledge, and skills to improve decision-making, and increase productivity under market conditions. Appropriate technologies and information may exist, but they are often not accessible to farmers because of a lack of delivery system (FAO, 1998).

One of the primary barriers to the adoption of a new agricultural technology is lack of knowledge, and extension services. Extension services are an institution aimed at filling this gap its main function is to inform farmers of new innovations and techniques (World Bank, 2002). Extension services substantially improve technology adoption rates, awareness and productivity. Extension education motivates the level and intensity of adoption of specific technologies (Baidu, 1999). In Bangladesh, a study on the adoption of improved practice by potato farmers by Haque, Rashid and Rahman (1996) concluded that extension contact and attitudes towards improved practices are significantly related to the adoption of improved practices of a technology. Access to extension services was also found to significantly influence adoption of soil fertility management practices in Uganda (Ssegunya Semana, and Bekunda., 1999). According to Sharma (1997), the extent of extension contact was a significant determinant of adoption of land reclamation technology. The number of times that an extension workers contact farmers has a positive coefficient indicating that adoption level increases with an increase in the intensity of extension services (Njoku, 1990). The extension service had a significant impact on the probability of adopting the stall-feeding technology and increasing the frequency and number of extension service seminars attended by farmers increased the probability of participation in store feeding in Tanzania. (Kaliba et al., 1997).

2.5.8 Technology

There is considerable potential for increased productivity in the dairy sector through development of appropriate and affordable livestock technologies (Omiti and Muma, 2000). The complexity of new technology, financial cost, farmers belief and opinion towards the technology, farmers level of motivation, farmers' attitude towards risk and change are some of the factors influencing the adoption of agricultural technologies by farmers (Guerin, 1994). Technology is a combination of all the management practices for producing a particular enterprise, and technologies appropriate to farmer circumstances are easily adopted (Kaimowitz, 1990). A technology is relevant to farmers if it responds to their needs. Variables that determine the adoption of a technology include its profitability, social acceptability, and its importance to producers system of production. Improved technologies must address the issues and constraints

faced by the farming community (American Society of Agronomy, 1990). Ouedraogo, Mando and Zombre (2001), in a study of the impact of compost in improving crop production and soil properties, found that lack of equipment, and adequate organic materials for making compost and intensive labour requirement for making the compost were major constraints for the adoption of compost technology.

2.5.9 Cost

A study by FAO (1992) indicated that cost is a major constraint to technology utilization. Cost and other economic variables overwhelmingly determine the adoption and utilization of a technology (World Bank, 1992). The common reason for the partial adoption or discontinuation of improved practices of livestock technology by villagers in West Bengal, India, was the high cost (Das, 1997). On a study on the adoption of improved technologies in India it was concluded that the adoption was low among farmers due to the high cost and capital scarcity (Dayanatha, 2001).

2.6 CONCEPTUAL FRAMEWORK

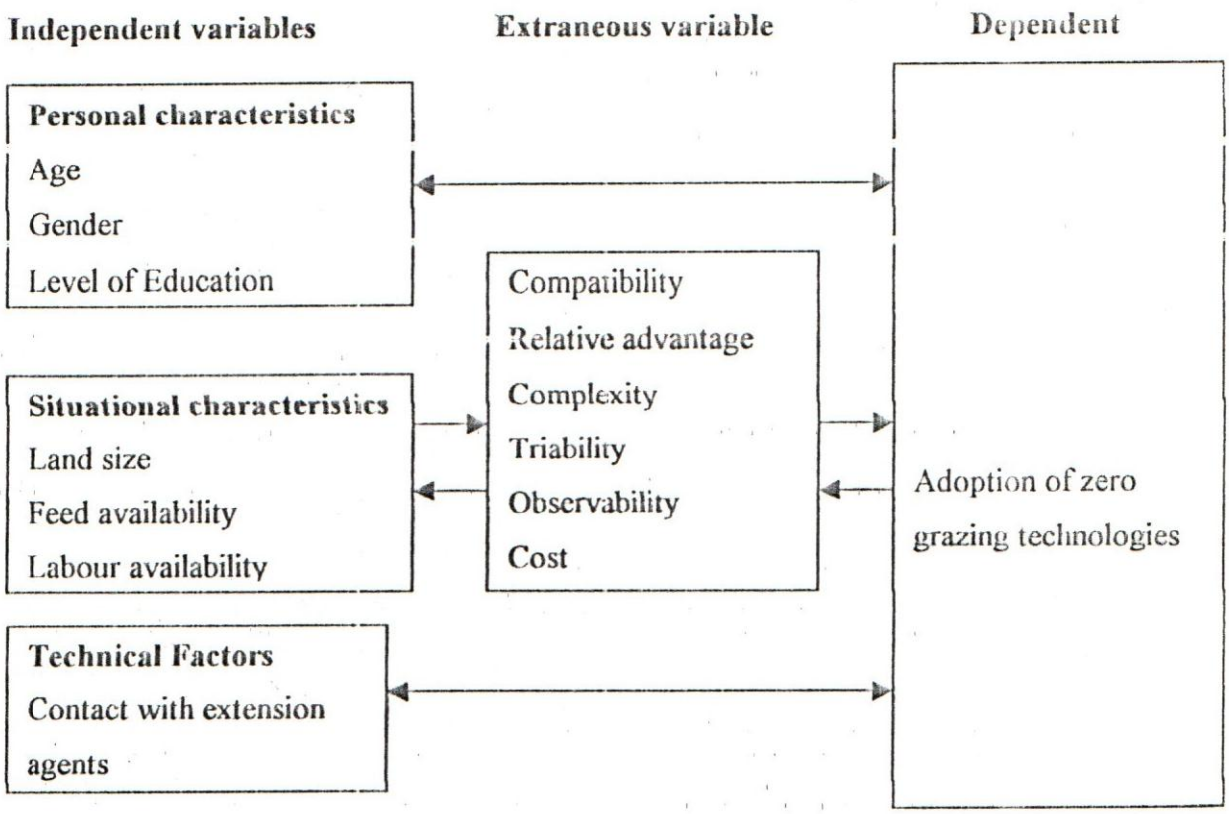

Fig 1. Conceptual Framework Model Identifying factors influencing the adoption of zero grazing system by farmers

Independent variables

These are operationalized as personal, situational and technical variables that influence farmers to adopt or reject a new technology.

Dependent variable

This is the innovation or technology to be adopted by the farmers and the degree to which the farmer applies the practice.

Extraneous variable

These are variables that are not known but will affect the results of the study.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This chapter deals with the research design, the location of the study, population of the study, sampling and sampling procedure, instrumentation, data collection procedure and data analysis procedure.

3.1 Research Design

The design for the study was ex-post facto design. In the study the effects of naturally occurring influence of independent variables, the farmers' personal characteristics, farmers' situational characteristics and extension contact on dependent variable, adoption of zero grazing practice were examined. Four objectives were used to guide the study and from these, four hypotheses were developed. The dependent variable was the adoption of zero grazing technology. There were eight independent variables namely 1) farm size, 2) level of education, 3) gender, 4) age, 5) availability of feeds, 6) availability of labour 7) contact with extension 8) extension method.

3.2 Location of the study

The study was conducted in Kirinyaga District, which is one of the seven districts in Central Province. The district has four divisions, 22 locations and 80 sub-locations with an average farm size of 1.2 hectares. The district covers an area of 1437 square kilometers and lies between latitudes 01^{o} – 0^{o} 40^{o} South and longitudes 37^{o} – 38^{o} East. The topography is characterized by the low lying areas of Mwea, which lie between 1480, and 2000 meters and the high areas of Gichugu and Ndia which lie between 2000 and 4800 meters and the high areas of Gichugu, Ndia and mount Kenya which lie between (4800-6800) meters. The District receives a bimodal type of rains, which average between 800 to 2100mm per year, with long rains being experienced between the months of March and May and the short rains between October and November. Temperatures ranges between 14.5^{O} C and 22^{O} C. Agro-ecological zones of Low highlands (LH), Upper Midlands 1(UM1), Upper Midlands (UM2), Upper Midlands 3

(UM3) and Lower Midlands 3 (LM3) are found in the District. Rich fertile clay soils are found in the upper regions of Gichugu and Ndia while the black cotton soils are found in the low lying areas of Mwea. The major agricultural enterprises are tea and dairy farming in the upper parts of Gichugu and Ndia, coffee and dairy in the medium parts of the two divisions, and rice and horticulture in the lower parts of Mwea. Subsistence crops include maize, bananas, beans, and sweet potatoes.

3.3 Population of the study

The population of the study comprised of interested dairy farmers in Kirinyaga district. There were a total of 1687 dairy farmers.

3.4 Sampling procedures and samples

Proportionate stratified random sampling procedure was used to get the sample in the study. The dairy farmers in the District fall in to three categories. Those who adopted zero grazing were 253, those who discontinued were 15 and those who did not adopt were 1419. Farmers were then randomly selected from each stratum except the discontinuance, where the whole number was used. Simple random sampling was employed to form a study sample and random numbers used to generate the required numbers. The sample size of one hundred and eighty (180) farmers for the three divisions was used during the study. This size was determined using Fischers formula in Mugenda and Mugenda (1999) as follows.

$n = \quad Z^2pq \ / d^2$

Where

n = desired sample size

Z = Standard normal deviate

P = Proportion in target population estimated to have characteristics being measured

q = 1 – p

d = Level of statistical significant set.

N = Population size

$$nf = \frac{n}{1+n/N}$$

Estimate of population size

(a) Estimate of adopters – N = 253

$$n = \frac{(1.96)^2 (0.5)(0.5)}{(0.05)^2} = 384$$

$$\frac{384}{1+\frac{384}{253}} = 152$$

$$\frac{49}{100} \times 152 = 74$$

Estimate for non- adopters – N =1419

$$Nf = \frac{384}{1 + \frac{384}{1419}} = 302$$

$$0.3 \times 302 = 91$$

Discontinuance =15

Total sample = 74 + 91 + 15 = 180

Table 1. Sample size according to category

Category	Number	Percent (N=180)
Adopters	74	41.1
Non adopters	88	48.9
Discontinuance	18	10.0
Total	**180**	**100.0**

The sampling unit was the individual dairy farmers, achieved from the sampling frame of the study. There were one thousand, six hundred and eighty seven interested farmers in Kirinyaga district.

3.5 Instrumentation

The instrument for this study was a structured questionnaire, which was administered to the selected farmers in the area supplemented by observation and farm visits. The questionnaire was development based on the objectives of the study. It was reviewed and validated by peers and agricultural extension experts from the Departments of Agricultural Education and Extension and Animal Science of Egerton University. All useful comments were used to improve the questionnaire. Piloting was done using thirty farmers in Tetu division of Nyeri district. Piloting was carried out in this district because it has similar conditions to Kirinyaga, was one of the project district and also to avoid contamination. Results from the piloting indicated a reliability coefficient of .825 which was above the .70 threshold (Selltiz, Wrightsman and Cook, (1976).

3.5.2 Data Collection Procedures

Permission to conduct research in Kirinyaga district was sought from the District Agriculture and Livestock Extension Officer (DALEO). A research permit was also obtained from the Ministry of Education Science and Technology. One livestock production officer in each division was recruited to accompany the researcher during the data collection exercise. This was necessary because they were conversant with both the research area and the farmers. The researcher with the assistance of personnel from the District Agriculture and Livestock Extension Officer (DALEO) administered the structured questionnaire to the farmers or their representatives in their homes. Farm visits and observations supplemented the questionnaire to assess the levels of adoption of the various recommended packages.

3.5.3 Data Analysis Procedures

Frequencies and percentages were used to give a summary of both the dependent and independent variables. Chi-square and Pearson's correlation was used to test hypothesis with levels of significance set at .05. The statistical package for social sciences (SPSS) version 9 for windows was used during the analysis.

Table 2. Summary of Statistical Procedures

Objective/ Hypothesis	Independent Variable	Dependent Variable	Statistics
Hypothesis 1 There is no significant relationship between farmer's personal characteristics and adoption of zero grazing technology.	Gender, age, level of education	Adoption of zero grazing technology Housing Feeding Calf rearing Fodder establishment and management-	Correlation (Pearson r) Frequencies and Percentages Chi-square
Hypothesis 2 There is no significance relationship between farmers situation characteristics and adoption of zero grazing technology.	- Labour availability - Feed availability - Land size	Adoption of zero-grazing technology Housing Feeding Fodder establishment and management Calf rearing	Correlation (Pearson r)
Hypothesis 3 There is no significance relationship between common extension methods and frequency of contact in adoption of zero grazing.	Contact with Extension Agents	Adoption of zero grazing Housing Feeding Calf rearing Fodder establishment and management	Frequencies and percentages (Pearson r)
Hypothesis 4 There is no significance difference in farmers' personal characteristics among the categories	Age, gender and level of education.	Adoption of zero grazing	Chi-square Correlation

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Introduction

This chapter presents the results of the study. The purpose of the study was to Asses the impact of selected factors affecting adoption of zero grazing dairy production system in Kirinyaga District. In presenting the results and discussion of the study, the following four objectives were taken into consideration.

1. To determine the rate of adoption, reasons for adoption and non-adoption of the zero grazing technology.
2. To determine the relationship between farmers' personal characteristics and adoption of zero grazing in Kirinyaga district.
3. To determine the relationship between farmers' situational characteristics and adoption of zero grazing.
4. To determine the relationship between farmers' contact with extension agents and adoption of zero grazing.
5. To determine and evaluate the levels of adoption of selected zero grazing packages by smallholder farmers in Kirinyaga district.

Several factors influence farmers' adoption of zero grazing technology. The factors considered in this study include: age, gender, level of education land size, feed availability, labour availability, extension methods and frequency of contact with extension agents. These characteristics formed the independent variable while adoption of zero grazing technology formed the dependent variable.

4.1 Conceptualization of adoption

Adoption is the degree to which a new technology is used in long-run equilibrium when farmers have complete information about the technology and its potential. Therefore, adoption at the farm level indicates farmers' decisions to use a new technology in the production process. Adoption at the farm level often is quantified using a binary variable (adoption of zero grazing = 1, non-adoption = 2, discontinuance = 3).

The farmer's decision for or against adoption of science-based production technology is a mental process consisting of several stages.

4.2 Rates of technology adoption

The adoption rate was defined as the number of farmers using the technology as a percentage of the total number of survey farmers. From the analysis, results indicated that 41% of the respondents adopted the zero grazing technology 49% did not adopt while 10% adopted the technology and then discontinued.

4.2.1 Reasons for adoption

Dairy development has mainly been directed towards satisfying the rapidly increasing demand for milk. The required intensification of animal production has often been enhanced by farmer's ability to purchase the required inputs. Table 3 shows the distribution of respondents by reasons for adoption of the technology. In the table, the data revealed that 48.6% of the respondents adopted zero grazing for efficient utilization of fodder and comfort of the animal, 43.2% adopted the system as there was reduced grazing time for herding, 5.4% adopted the system because of limited land for grazing while 1.4% indicated manure production as a reason for adoption. The reason for farmer's response giving efficient utilization and comfort of the animal, as the major reason for adoption may be that, the animals did not trample or foul the fodder with dung. In addition, the animal wholly utilized fodder chopped into small sizes. Animals when confined in the unit were clean and protected against adverse climatic condition. Respondents also indicated that when animals were confined they were able to attend to other farm activities, as no time was required to herd the animals. It was expected that limited land would be a major reason but only 5.4% of the respondents indicated it as a reason for adopting the technology. This could be due to the fact that some of the farmers with small land sizes used it more efficiently and intensively.

Table 3. Percent Distribution of Respondents by reasons for adoption

Reasons for adoption	Percent (N =74)
Comfort and efficient utilization of pasture	48.6
Reduced grazing time	43.2
Limited land	5.4
Manure production	1.4
Others	1.4
Total	100.0

4.2.2 Reasons for non-adoption

Many factors hinder the adoption of a technology. These include the socio-economic factors, attributes of a technology, cost of the technology and farmers' attitudes towards the technology among others. Respondent's reasons for not adopting the technology are shown in the Table 4.

The data indicated that 83% of the respondents did not adopt the technology because they lacked capital, 11.4% gave the reason for non-adoption as high labour requirement while 5.6% indicated availability of grazing land as the reason for non-adoption. The technology is capital intensive in terms of constructing the unit, purchase of farm inputs, equipment and fodder establishment. The high cost was beyond the reach of most smallholder farmers without other sources of income. Most farmers depend on farming as the source of income and during this project period, most agricultural enterprises such as coffee where farmers could access some credit were not performing well.

Table 4. Percent Distribution of Respondents by Reason of Non-adoption

Reasons for not adopting	Percent (N=88)
Lack of capital	83.0
Labour intensive	11.4
Enough grazing land	5.6
Total	100.0

4.2.3 Reason for Discontinuation

Discontinuation is the decision to reject an innovation after having previously adopted it. The reason to reject the idea could be to adopt the better idea that supersedes it or rejection as a result of dissatisfaction with its performance. Such dissatisfaction may come about because the innovation is inappropriate for the individual and does not result in an adequate level of perceived relative advantage of alternative practice (Rogers, 1995). High discontinuance is usually characterized by less formal education, low socio-economic status and less change agent contact. In this study the data revealed that 44.4% of the respondents discontinued the practice due to lack of milk market, 33.3% due to low milk prices, 16.7% due to lack of labour and 5.6% due to feed shortage as indicated in Table 5. Before the liberalization of the milk market in 1992, Kenya Cooperative Creameries (K.C.C) was the main outlet of the milk. After liberalization, the K.C.C collapsed and farmers had no stable market for their milk. Due to this marketing problem, most farmers abandoned dairy farming. The only milk outlet was the mushrooming private processors and hawkers who dictated the prices of the milk. However, the situation is expected to change with the recent government's intervention of buying back the K.C.C. plants and making them operational.

Table 5. Percent Distribution of Respondents by Reasons for Discontinuation

Reason for discontinuing.	Percent (N=18)
Feed shortage	5.6
Lack of labour	16.7
Low milk prices	33.3
Lack of milk market	44.4
Total	100.0

4.3 Farmers personal characteristics

The objective was to determine the relationship between farmer's personal characteristics (age, gender and level of education) and adoption of zero grazing. The

objective is important because various factors may affect the adoption, which are not necessarily the personal characteristics of the respondents. Data was collected using the structure questionnaires s whereby the respondent gave their age in years, their gender and the highest level of education attained. The data was analyzed using both descriptive and inferential statistics.

4.3.1 Age

The age of the farmer determines the degree to which they adopt innovations. Table 6 shows the distribution of respondents in terms of age. From the analysis, results indicated that majority of the respondent (55%) were more than 50 years of age as shown in the Table. The farmer's ages ranged between 24 to 76 years with an average of 52 years. Majority of the respondents in the study area were the older generation. The adoption of zero grazing technology is therefore expected to be low, usually the highest adoption of a technology is found within the young and educated (Rogers, 1989). The high percent of the respondents were aged between 51 and 60 years. At this age most people are preparing to retire or have retired and have the capital required to start an enterprise. To keep themselves busy, they had to be occupied in the farm. Most turn to dairy farming as it has a regular income compared to other enterprises. The low percent of the younger farmers adopting the technology would be that at this age, they have just left school, are single and, not capable of making their own decision but depend on their parents or seniors. Majority of them migrate to the urban areas searching for white-collar job for they do not take farming as a business or a source of income. After all they have less financial commitments. In addition, due to lack of collateral, they cannot access credit for livestock development. Land allocated to them is not permanent as such they hesitate to invest heavily as they are not sure of the future on that land.

Table 6. Percent Distribution of Respondents' Age by category

Age in years	Adopters (N=74)	Non adopters (N-88)	Discontinuance (N=18)
21-30	1.4	3.7	-
31-40	9.5	25.0	-
41-50	23.0	29.5	33.3
51-60	37.8	33.0	50.0
61-70	21.6	8.0	11.1
71-80	6.8	1.0	5.6
Total	**100.0**	**100.0**	**100.0**

4.3.2 Gender

Women perform most activities related to farming, while decisions are made by men. The data revealed that 78.8% of the respondents were male and 27.2% were female as indicated in Table 7. Women form almost a quarter of respondent of the sample study and this is consistent with many other studies where women have been represented as participants in new projects. Zero grazing is labour intensive and involves heavy manual work. Cleaning of the unit, slurry disposal and chopping fodder is hard task appropriate for men and not gender friendly to women. Most homes are usually managed by women as men are out in towns seeking for jobs or working (Waghmare, 1989) women also produce 80% of the foodstuff in the sub-Sahara Africa and the Caribbean's (FAO, 2002). Oywaya, (1995) in a study in Machakos found that women adopted new innovations than men. Women are usually involved in household activities, food crop farming and tea picking while men take care of the livestock.

Table 7. Percent Distribution of Respondents' Gender by category

Gender	Adopters (N=74)	Non adopters (N-88)	Discontinuance (N=18)
Male	70.3	73.9	77.8
Female	29.7	26.1	22.2
Total	100.0	100.0	100.0

4.3.3 Level of education

Education determines the rate of adoption of a technology (Waghmare, 1989). The data showed that 36.7% of the respondents had received primary school education 29.4% had received secondary education 9.4% had received post secondary education, 18.3 had gone to tertiary colleges 4.4% had University education and 1.7% had no formal education as shown in Table 8. Since more than 60% of respondent had received education beyond secondary level. Most of the respondents were expected to have adopted the zero grazing technology as education increases managerial competence, enhances ability to diagnose, comprehend and respond to financial and production problems (Molnar, 1985). Farmers with higher levels of education have the ability to allocate resources in their farms effectively and efficiently than those with low or have none. Most of the educated farmers ventured into horticultural farming as it was more paying while others did not take farming as business. Zero grazing is not a new system in Kirinyaga district. Farmers have been confining their animals in enclosures and feeding them in the same spot with the aim of manure production. They have developed a positive attitude towards the system due to limiting land and therefore level of education did not influence their adoption of the system. However, they were limited by capital to construct the zero grazing units according to the design of the NDDP.

Table 8. Percent Distribution of Respondents by Level of Education by category

Level of education	Adopters (N=74)	Non adopters (N-88)	Discontinuance (N=18)
None	1.4	1.1	5.6
Primary	31.1	39.8	44.4
Secondary	27.0	31.8	27.8
Post secondary	9.5	10.2	5.6
Tertiary colleges	25.7	14.8	5.6
University	5.4	2.3	11.1
Total	**100.0**	**100.0**	**100.0**

4.3.4 Farmer's situational characteristics

The objective was to determine the relationship between farmer's situational characteristics (farm size, feed availability and labour availability) and adoption of zero grazing. The objective is important as it indicate how the three variables constraints the adoption of zero grazing. Farmers were asked to state the size of their farms in a acres, the source of fodder and the extent which they planted are purchased fodder, the crop residues fed, the concentrates and the fodder legumes they used. On labour, farmers were asked the number of hours spent on the zero grazing for the various activities, or grazing the animals by the family, permanent labour, casual labour, or a combination of the various sources. Data was presented by descriptive and inferential statistics.

4.3.4.1 Farm size

Majority of the respondents (90%) had their farm size 2 hectares or below. Their farm sizes were between 0.1 ha and 2.0 ha. Farm size has been isolated as the most important variable affecting farmers' innovativeness (Rolling, 1990). Table 9 shows the distribution of the respondents by acreage of land owned. Farmers with large farms adapt new practices more than smallholders (Amudavi, 1993). Farm size is the most significant factors affecting the adoption of agriculture technology (Kebende, Gunjal, and Coffin, 1990). With small land fragments farmers have to find alternative ways of feeding the livestock. These small land sizes are allocated all the other resources including cash

crops, food crops and home compound. There is need therefore to intensify the productivity of the available land and utilize it efficiently.

Table 9. Percent Distribution of Respondents' Farm Size by Category

Farm size (acres)	Adopters (N=74)	Non adopters (N-88)	Discontinuance (N=18)
0-2	36.5	51.1	27.8
3-5	48.6	44.3	55.6
6-8	9.5	3.4	5.6
Over 9	5.4	1.1	11.1
Total	**100.0**	**100.0**	**100.0**

4.3.4.2 Feed availability

Feed scarcity constraints dairy farming leading to low productivity. Farmers have to look for alternative means of feeding their livestock, as smallholder dairy production depend virtually on feed availability. Results from the data revealed that 67.2% of the farmers used fodder from their own farms and purchased from neighbours. 31% of the farmers planted their own fodder 1.1% planted in their farms and on the roadside while 0.6% bought fodder from neighbours and competition for available land between cash crops, fodder crops and food crops makes over production of fodder not possible (Said and Wanyoike, 1987).

Analyzed data revealed that only 43% of the farmers planted fodder legumes and 18% inter-planted herbaceous legumes with the fodder. Legumes supplements increases milk output and reduces production costs (Devendra, 1990) The farmers also fed their animals with crop residues with 61.1% feeding maize stovers and banana pseudostem, 30% used rice straws in addition to stovers and pseudostem while 8.9% fed their animals on bean haulms. Only 41.1% supplemented the feeding with dairy meal, 44.4% did not use any concentrates while 14.8% did not use any concentrate while 14.8% used rice bran, pollard or maize germ. Results also show that 88.9% gave minerals, however, only 41.8% fed their animals with adequate amounts. Most farmers made waters readily available to their animals (74.7%) 11.2% watered their animals 3 times a day 9% twice a

day and 5.1% once a day as shown in Table 10. The high dependency on purchased feed is as a result of limited land for fodder production can cannot expanded due to existence of cash crop and food crops. However, these constraints can be overcome by utilization of crop residues and milling by-products such as rice straw and rice bran respectively that are cheap and readily available in the farms and rice mills in the region. Maize stover is the most abundant crop residue used by farmers (Methu, Owen, Abate, Mwangi and Tanner, 1996). Fodder crops such as Leucaena can improve the quality of feeds (Raynolds and Attah-Krah, 1989). Other available feed resources are bean haulms from the horticulture industry and maize stover. All these can be stored and utilized to offset the dry season scarcity. Conservation of fodder in form of silage is less practiced, as farmers are only able to produce sufficient for utilization and in some cases hardly produce enough to suffice. Concentrate feeding is less practiced for they are expensive and only fed to the animals at milking time.

Feeds are normally the binding constraint on smallholder production and project designed to assist this sector should always incorporate a well thought out feed or forage component.

Table 10. Percent Distribution of Respondent by Source of Fodder

Sources of fodder	Adopters (N=74)	Non adopters (N-88)	Discontinuance (N=18)
Own land	29.7	7.3	38.9
Own land/purchase	51.4	58.0	44.4
Own land/ roadside	16.2	12.5	16.7
Purchase	2.8	2.3	-
Total	**100.0**	**100.0**	**100.0**

Table 11. Percent distribution of farmers by type feeds fed to the animals

Type of feeds	%
Fodder legumes	43.0
Herbaceous legumes	18.0
Maize Stover/banana pseudo stem	61.1
Rice straw	30.0
Bean haulms	8.90
Dairy meal	41.1
Rice bran/pollard/maize germ	14.8
Mineral salts	88.9
Water (readily available	74.7

4.3.4.3 Availability of Labour

Many technologies are labour intensive and contrasts with labour involved in traditional production systems, and many small holder must hire labour to implement the improved technology (Njoku, 1990). Zero grazing is labour intensive and involves various activities within the unit and on the farm. The study sought to determine the source of labour for the zero grazing system by the respondents. Table 12 shows the source of labour used in the farm.

The data revealed that source of labour for most of the farmers was mainly a combination of family and hired labour. However, labour by the family accounted for 40%, 18.9% was family/permanent hired, 12.2% family/casual labour, 9.4 was permanent labour and 8.9% was casual labour as indicated in Table 10. 60% of the respondents employed hired labour and this factor was likely to influence the adoption of zero grazing technology. In Nepal, Shrestha and Evans (1984) found that the total time required to raise an average 7.37 animals in a stall feeding system was 80.3 to 208.0 and 106.3 days per annum for men, women and children respectively. In Kirinyaga, a total of 7.09 hours were spent in the zero grazing with a mean of 3 animals compared to 4.39 and 4.17 hours with a mean of 2.2 and 2.7 for non-adopters and discontinuance respectively. With 40% of the labour being supplied by the family who include the children, the situation is likely to change with the introduction of free primary education as most of these children have

enrolled in school. In dairy production, most labour is provided by the family, 60% is hired labour with 20% retaining permanent labour throughout the year (Staal *et al*, 1998b). Labour can be reduced by the introduction of mechanical equipments such as motorized chaff cutters that could reduce the time taken to chop the fodder. However, this calls for rural electrification to enable farmers purchase these equipment. The system is labour intensive and a lot of time is spent on milk marketing, fetching fodder, fodder chopping, cleaning the unit, slurry disposal, weeding the fodder, feeding the cows and calves.

Table 12. Percent Distribution of Respondents Labour Source by category and mean hours spent for livestock activities.

Labour source	Adopters (N=74)	Non adopters (N-88)	Discontinuance (N=18)
Casual	9.5	4.5	27.3
Permanent hired	14.9	1.1	22.2
Family	13.6	62.5	22.2
Family/ permanent	37.8	6.8	-
Family/ casual	10.8	13.6	27.8
Family/permanent/casual	13.5	11.3	-
Total	**100.0**	**100.0**	**100.0**
Mean hours	7.09	4.39	4.17

4.3.5 Contact with Extension Agents.

The objective was to determine the relationship between farmers contact with extension agents and adoption of zero grazing. The objective was to determine the relationship between farmers contact with extension agents and adoption of zero grazing. Various methods used by extension agents are necessary to enhance access to information about new innovations. Farmers were asked the number of times they were visited by extension agents at their farms, how frequently they visited agricultural offices and the extension methods they were exposed to on livestock production information. Data was presented in percentages for the descriptive and a correlation coefficient for the

inferential statistics. Extension services assist farmers improve their farming methods and techniques through educational procedures. Farmers were asked to state the numbers of times they received extension messages related to dairy production within the project period. The number of times that an extension agent contacts a farmer indicates that adoption level increases with an increase in the intensity of extension services (Njoku, 1990).

The data revealed that 60% of the respondents had never received any extension messages, 10.6% were visited once, 16% were visited after 4 month 10% were visited on weekly basis as indicated in Table 13. Given that the frequency of contact with extension agents is quite low in the study area, it is unlikely that the frequency of extension contact would have an influence on the rate of adoption on the zero grazing technology. Appropriate technologies and information may exist, but they are often not accessible to farmers because of a lack of delivery system (FAO, 1998). The primary barrier to the adoption of new agricultural innovations is lack of extension services and extension service is an institution aimed at filling this gap by informing farmers of new innovations and techniques (World Bank, 2002). Learning is a continuous process and there is need therefore to intensify extension services to keep farmers informed of new innovations and practices. Frequent contact between farmers and extension agents is therefore necessary and should be enhanced to at least once a fortnight. However, this could be an expensive exercise as it calls for an increase in the number of extension agents.

To be effective in dissemination of information, extension agents use various methods to reach the farmers. Increasing the frequency and number of services, and seminars attended by farmers increase the probability of adopting the stall-feeding technology in Tanzania (Kaliba *et al.*, 1997). Farm visits though expensive are the most ideal methods of reaching farmers. Extension agents and farmers are able to identify problems at the farm level and find solutions to these problems. Field days, demonstrations and agricultural shows though cheap reach more farmers at a time are not effective as most farmers are not able to practice what they see or learn as they cannot afford some of the inputs required. Within extension services, livestock usually take second to crop production. The skills required for animal husbandry are different from those associated with crop and the use of multi-disciplinary extension cannot provide

sufficient knowledge and skills needed to be effective. Technology may be available but the extension agents lack the capability to interpret when and where the interventions are appropriate due to lack of appropriate technical messages. Majority of extension agents have had little exposure to livestock production and in-service training should be provided for to equip them with skills necessary to fulfill the duties effectively.

Table 13. Percent Distribution of Respondents by Contact with Extension Agents

Frequency of visit by extension agents	Adopters (N=74)	Non adopters (N-88)	Discontinuance (N=18)
Weekly	32.4	36.4	22.2
Monthly	16.2	8.0	11.1
Never	23.0	28.4	22.2
2-3 months	5.4	15.9	11.1
4-5 months	10.8	9.1	5.6
Half yearly	3.5	-	11.2
Yearly	6.8	2.3	16.7
Total	**100.0**	**100.0**	**100.0**

4.3.6 Farmers' personal characteristics among the categories

The aim of this objective was to determine whether the various categories of farmers differed in age, gender and level of education. The results of the analysis indicated that the percentages of respondents above 50 years of age was 62.2% for the adopters, 42.1% for the non adopters and 66.7% for the discontinuance. The mean ages for adopters, non-adopters and the discontinuances were 55.36 years, 49.39 years and 56.00 years respectively with a total mean of 52.28 years. The highest adoption of a technology is found within the young and educated (Rogers, 1983). This being the case, adoption is expected to be low as most of the farmers were over 50 years of age.

On gender, the percentage of men and women was 70.3%, 73.9% and 77.8% for men and 29.7%, 26.1% and 22.8% for women respectively for adopters, non-adopters and discontinuance. Men control most of the resources and for this reason the number of

women is low though they are the people who perform most of the day-to-day activities in agriculture.

Level of education among the groups varied with 67.5% of adopters, 59.1% of non-adopters and 50% of discontinuance having attained secondary school education and above. Farmers with higher level of education are expected to adopt new technologies as they have the ability to allocate resources in their farms effectively and efficiently.

Table 14. Percent Distribution of Respondents Personal Characteristics according to Category

Age	Adopters (N=74)	Non-adopters (N=88)	Discontinuance (N=19)
<50 years	33.8	57.9	33.3
>51 years	66.2	42.1	66.7
Total	**100.0**	**100.0**	**100.0**
Gender			
Male	70.3	73.9	77.8
Female	29.7	26.1	22.8
Total	**100.0**	**100.0**	**100.0**
Level of Education			
None	1.4	1.1	5.6
Primary Level	31.1	39.8	44.4
Secondary and above	67.5	59.1	50.0
Total	**100.0**	**100.0**	**100.0**

4.4 Adoption levels of zero grazing packages

The objectives sought to determine and evaluate the adoption levels of some selected zero grazing packages by farmers in Kirinyaga district. Evaluation of the levels of adoption was by asking the farmers whether they practiced the recommended packages and this was supplemented by observation. A farmer is considered to have adopted a technology if he/she use it to any extent on his farm. In this study the adoption level is defined as the number of recommended packages practiced. The objective sought to

determine and describe the degree to which the farmers practiced the recommended packages. The selected packages were dairy cattle, housing, fodder establishment and management, dairy cattle feeding and calf rearing among others.

4.4.1 Dairy Cattle Housing

Housing protects animals from extremes of temperature and creates an ideal environment with an emphasis on comfort and cleanliness. A well designed zero grazing units with eight compartments were recommended by the National Dairy Development Project. The components included. Cubicles, feeding/walking area, milking parlour, calf pen, feed/water troughs, store, manure pit and fodder chopping area.

Data revealed that only 41.9% of the farmers had a complete zero grazing unit with all the components, 20.3% had seven components, 16.2% had six components, 17.6% had five components, 4.0% had only four components as shown in Table 15. Most farmers did not incorporate manure pit and the fodder chopping area within the unit. They felt that fodder-chopping area was not necessary because they could not afford a chaff-cutter and chopped their fodder directly into the trough using a machete. This resulted to high wastage, as the chopped pieces were too big. As for the manure pit, most farmers felt that the slurry had to completely decompose before use in the farms. Other components that farmers felt were not necessary included the store and the milking parlour. The zero grazing unit was popular as most of the farmers tried to construct a complete housing unit. However, the cost of construction was beyond their reach. This was mainly because their source of income that was dairy and coffee had collapsed. There is hope that the situation will change with the government's commitment to revive the agricultural sector, which is the backbone of the country's economy.

Table 15. Frequency and Percent Distribution of Respondents levels of Adoption of Housing components of the zero grazing units

No of components	Percent (N=74)
8	41.9
7	20.3
6	16.2
5	17.6
4	4.0
3	0
2	0
1	0
0	0
Total	**100**

4.4.2 Dairy Cattle feeding

The National Dairy Development Project promoted zero grazing dairy production system where animals are fed in confinement. The project recommended Napier for dairy cattle dairy feeding and advised farmers plant 0.4 ha of Napier grass per cow. In 1987 the project encouraged the plating of fodder trees to bridge the protein gap and identified. *Leucaena*, *Calliandra* and *Sesbania* as suitable species. *Desmodium* was also recommended to be grown as a mixture with Napier grass. Adequate amounts of high quality minerals, free access to water and supplementary feeding of concentrates (dairy meal) were encouraged. Feeding of crop residue was emphasized to cater for the feed shortage.

Data showed that only 8.1% of farmers planted 0.4 ha of Napier per livestock unit as recommended. 64.9% of the farmers in addition to sourcing fodder for their own land depended on purchase from neighours and only 29.7% of the farmers sourced fodder from their own land. 54.1% of the farmers had planted fodder trees, 32.4% had planted herbaceous legumes. 40.5% of the farmers fed their cattle with dairy meal, 52.7% did not. 82.4% of the farmers fed minerals adequately while 90.5% had the animals with free

access to water as shown in Table 16. The low adoption of Napier hecterage was limited land due competition with other crops. The high adoption of access to water was that most farms had piped water. Farmers knew the importance of mineral supplementation for increased fertility and this lead to high adoption while concentrate feeding was slow due to high cost of the feed and low milk prices.

Table 16. Percent Distribution of Respondents by Adoption of recommended feed

Feed	Percent
Napier grass	8.1
Fodder trees	54.1
Herbaceous legumes	32.4
Dairy meal	40.5
Minerals	82.4
Water	90.5

4.4.3 Adoption of fodder management package

The number of farmers who implemented the fodder management package varied extensively from one practice to the other. These practices development by the researchers are aimed at achieving a sustained increase in fodder production.

About 70.3% of the farmers spaced the Napier according to the recommendations, 60.8% weeded their Napier after every cutting. Only 10.8% of the farmers returned all the manure to the Napier grass, 40.5% applied the recommended N.P.K 20:10:10 fertilizer and 10.8% applied recommended rate while 24.3% applied the recommended CAN fertilizer. Only 6.4% of the farmers harvested their fodder at the recommended height as shown in Table 17. Most respondent harvested their Napier at a height more than 120 cm. Reason given were that due to fodder scarcity the overgrown Napier had higher productivity per unit area and the animals would consume it longer. This led to low milk production as the nutritive value of the fodder increased with age. Most of the manure was used in coffee, bananas and planting subsistence crops with only a little left for manure Napier. This resulted to low productivity due to low soil fertility. Chemical fertilizers were not often used due to their high cost and the farmers could not afford to

purchase them. The fertilizer applied was what remained after fertilizing coffee, tea and after planting the subsistence crops.

Table 17. Percent Distribution of Respondents by Adoption of Fodder Management Practices

Practice	Percent (N=74)
Napier spacing	70.3
Napier weeding	60.8
Manure application	10.8
NPK application	40.5
CAN application	24.3
Cutting height	6.4
Rate of NPK application	10.8

4.4.4 Adoption of Calf rearing package

There is need to raise the calf to maturity. This will reduce the cost of purchasing the replacement stock and the calf is also a source of income when sold. The National Dairy Development Project recommended individual calf pens with a slated floor. This was aimed at reducing calf mortality that was high in most farms. Other recommendations included bucket feeding, milk feeding, concentrate feeding and age at weaning.

The data indicate that 73.0% of the respondent adopted the slatted floor pen for the calves while the rest 27% housed their calves elsewhere in the kitchen and other separate pens. 63.5% fed the recommended amount of milk per day 13.5% fed concentrates in correct amounts 56.8% weaned their calves at the recommended age of 16 months and 90.5% farmers had adopted bucket feeding as shown in Table 18. The high adoption of housing can be attributed to the fact that farmers were aware of its importance and the role played in reducing disease incidences and death. The high adoption of bucket feeding was attributed to the fact that the farmers were able to regulate the amount of milk fed to the calves. The low adoption of concentrate feeding was attributed to the high cost and farmers had alternative substitutes such as sweet

potato vines and other young succulent fodders. Most farmers wean their calves at earlier age of 12 weeks and below and this was due to the fact that they earned money from the milk saved.

Table 18. Percent Distribution of Respondents by Adoption of Calf rearing package

Practice	Percent (N=74)
Slatted flow pen	73.0
Milk per calf per day	63.5
Concentrate per calf/day	13.5
Age at weaning	56.8
Milk feeding method	90.5

4.4 Testing of Hypothesis

The following hypotheses were tested to find out whether there were statistically significant relationships between the independent variables and the dependent variable.

1. There is no significant relationship between farmer's personal characteristics and adoption of zero grazing
2. There is no significant relationship between farmer's situational characteristics and adoption of zero grazing.
3. There is no relationship between farmers contact with extension agents and adoption of zero grazing
4. There are no significant differences in personal characteristics among the various categories of farmers.

4.5.1 Adoption of zero grazing in relation to farmer's personal characteristics.

The null hypothesis under test (H_{01}) was that there is no significant relationship between farmers' personal characteristics and adoption of zero grazing. The hypothesis of no relationship between farmers personal characteristics and adoption of zero grazing was accepted except for the age which was found to be significant ($r=.233$ and $p=.002$ which is less than 0.05). This means that adoption of zero grazing is influenced by the adopter's age. This can be explained by the fact that farmers in the study area had been

exposed to dairy production practices for a long time and hence had formed a positive attitude towards zero grazing though constrained by the design developed by NDDP. Waghmare (1989) and Amudavi (1993) found no relationship between age and adoption of a technology. On gender, this can be attributed to the fact that most homes are usually managed by women who are also involved in household and other farm activities as men are usually out seeking for jobs or working in urban areas (Waghmare, 1989). This is consistent with the findings of Amudavi (1993) and World Bank (1992) who found no relationship between adoption and gender, but contradicts Oywaya (1995) who found significant differences between male and female-headed households in Machakos district. In addition, both men and women are responsible for decision-making as far as dairy production is concerned.

Table 19. Chi-square Tests for Gender

	Gender		
Category	**Male**	**Female**	**Total**
Adopter	70.3	29.7	100
Non adopter	73.9	26.1	100
Discontinuance	77.8	22.2	100

Chi square values = 0.541; Significance = 0.733

It has been noted that farmers with high levels of education adopt more improved farm practices faster than the less educated (Chitere, 1985; Waghmare, 1989; World Bank, 1992; Amudavi, 1993). This can be explained by the fact that farmers with low education tend to be disadvantaged in utilizing information. Education increases managerial competence, and enhances the ability to comprehend and respond to financial and production problems (Molnar, 1985; Misiko 1976). However, adoption can occur without being influenced by adopters' level of education, especially when the individual has a positive attitude towards an innovation.

4.5.4 Relation of farmers situational characteristics and adoption of zero grazing

Farm size is positively associated with adoption of new innovations. Many technological advances require large farm sizes (Waghmare, 1989). The null hypothesis under test (H2), was there is no significant relationship between farmers situational characteristics and adoption of zero grazing. The no significant relationship between adoption and farmers situational characteristics was rejected except for labour availability. Kebende (1990) found a significant relationship between farm size and adoption of ox-plough in Ethiopia. The general tendency is to have higher adoption with increase of land size. Owners of small farms do not have economic resources and cannot afford to take risks involved in trying a new idea. They wait until it has been successfully used on the farms of their wealthier neigbours before adopting it (Rogers, 1983) However, in Tanzania Kaliba *et al* (1997) found out that stall feeding was particularly attractive to those households with fewer resources. Amudavi (1993) found no relationship between adoption and farm size and this contradicts Misiko (1976) who concluded that there is a relationship between farm size and adoption. This can also be attributed to the fact farmers without land are able to keep animals and depend on purchase of fodder, renting land, roadside cultivation as well as forest grass. Land size can determine whether to adopt a given technology or not because size is not a direct cause of adoption Land is correlated to other factors such as credit, access to farm inputs and wealth.

Inadequate nutrition limit dairy cattle productivity (Rees *et al*, 1997). This highly significant relationship could be attributed to the fact that most farmers do not have adequate feed needed by the animals for both maintenance and production, throughout the year. The amount of fodder (Napier) planted per animal per year is 0.08 ha which is far below the recommended 0.4 ha. It was also observed that most farmers purchased fodder from neighbours which was neither enough and was costly. None of the farmers conserved fodder as they hardly had enough for utilization.

Technologies can either be labour intensive or labour saving. Labour saving technologies are adopted faster than those that are labour demanding. Zero grazing is

labour intensive as it involves many activities within the whole process. This includes fodder harvesting and collection, fodder chopping, feeding of the dairy cattle and the calves, washing the unit and utensils, slurry disposal, milking and milk marketing. This does vary much with the traditional method as the added labour is for washing the unit and slurry disposal. From the results of the analysis, the average number of animals kept in the zero grazing was 2.6 taking 7.09 hours per day compared to an average of 2.2 animals kept under the traditional system which took 4.4 hours per day.

Table 20. Correlation of Adoption and Farmers' Situational characteristics.

	Farm size	Feed availability
Adoption	.147	.632

Significant at .05 ($p<.05$)

Table 21. ONE WAY ANOVA -- Number of hours

Source of variation	df	Sum of Squares	Mean square	F value.	F probability
Between groups	2	313.333	156.666	21.904	.000
Within groups	170	1215.919	7.152		
Total	**172**	**1529.251**			

$P < 0.05$

Table 22. Post Hoc Tests (Tukey HSD) for Number of hours

Mean	Categories	Adopter	Non adopter	Discontinuance
7.0925	Adopter	-	2.6930	2.9194
4.3994	Non adopter	2.6930*	-	.2263
4.1731	Discontinuance	2.9194*	.2263	-

* Significant

4.5.8 Relation of adoption and extension contact

The aim of this objective was to test whether there was a significant relationship between farmers contact with extension agents and adoption of zero grazing.

One of the primary barriers to the adoption of a new technology is lack of knowledge and extension services. Extension is an institution aimed at filling this gap (World Bank, 2002). The null hypothesis under test (H_{03}) was that there is no significant relationship between farmers contact with extension agents and adoption of zero grazing. Results obtained accept the hypothesis that there is no significant relationship between adoption and contact with extension agents. The no significant relationship between extension contact and adoption in the study area could he due to the high awareness levels of the innovation. This implies the farmers knew about the innovation. Consequently, the role of the extension agents as regards zero grazing was not important. Zero grazing is not a new phenomenon in the study area and the only difference was in the design recommended by NDDP. Misiko (1976) concluded that there was significant and positive relationship between extension contact and adoption. Amudavi (1993) however found that there was no relationship between extension contact and adoption. The high number indicated that extension agents had never visited them and the implication here is that farmers are left without the active stewardship of extension agents. This is an indication that technological benefits requiring active participation by extension agents remain unknown to the farmers and may have led to the low adoption of the zero grazing.

4.5.9 Farmers Personal Characteristics among the categories

The hypothesis (H_{04}) was that there is no significance difference in farmers' personal characteristics among the various categories. Results from the analysis show that there was no significance difference in gender in the Chi-square value (0.514 and significance of 0.733 and level of education in the Chi-square value of 10.937 and significance of 0.632). However, there was a significant difference in age which was found to be significant ($r=.233$ and $p=.002$ which is less than 0.05).

4.5.9 Evaluation of adoption of four selected zero grazing packages by small holder farmers

The selected technologies under investigation were feeding, housing, fodder establishment and management, and calf rearing.

Data showed that aggregate adoption level was 44% as shown in Table 23. Less than half of the respondents had at least adopted one or more of the four technologies under study. Adoption of cattle feeding was 43% which was only 10.8% of the aggregate adoption of the four technologies. Reasons that could be advanced for adoption of this technology were increased milk, improved herd fertility and healthy animals. Adoption of fodder establishment and management was 32% which was equivalent to 10.5% of the aggregate adoption. Respondents gave reasons for adoption of this technology as easy access to cheap fodder and maintenance of soil fertility. Adoption of housing was 42% which was equivalent to 8% of the aggregate adoption of the four technologies. Reasons for the adoption were comfort and cleanliness of the animal, efficient utilization of fodder, manure production, increased milk yields and pest and disease control. Adoption of calf rearing was 59% which was equivalent to 14.8% of the aggregate adoption. Reasons given for the adoption were reduced mortality rate, reduced disease incidences and strong healthy calves.

Table 23. Aggregate Adoption Levels of Four Selected Zero grazing Packages

	Adopted		Not Adopted		Aggregate
Technologies practiced	**No**	**Percent**	**No**	**Percent**	**Percent**
Dairy cattle feeding	32	43	40	57	10.8
Dairy cattle housing	31	42	43	58	10.5
Fodder establishment and management	23	32	51	68	8
Calf rearing	44	59	30	40	14.8
Total	**130**	**176**	**164**	**223**	**44**

Aggregate = 44%

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter outlines the summaries, conclusion and recommendation related to the study.

5.1 Summary

To increase agricultural growth in Kenya, there is need to increase land productivity through intensive method. Smallholder farmers are important target in the effort to increase dairy production. Partial adoption and non-adoption of innovations by small-scale farmers have led to low productivity. To increase agricultural production, the issue of partial and non-adoption of innovations must be addressed. Various factors influence adoption of innovation, those of interest in this study was personal characteristics (Age, gender and level of education); Situation characteristics (Farm size, feed availability and labour availability); frequency of extension contact. The study was designed to determine and evaluate some selected factors that effected adoption of zero grazing dairy production system by smallholder farmers in Kirinyaga district. The information obtained is expected to assist policy makers, livestock production researchers, extension agents and farmers in their efforts to improve dairy production in the district. The objectives of the study were:

1. To determine the relationship between farmer's personal characteristics (age, gender, level of education) and adoption of zero grazing in Kirinyaga district.
2. To determine the relationship between farmers' situational characteristics (feed availability, labour availability, land size) and adoption of zero grazing.
3. To determine the relationship between common extension methods and frequency of contact with extension agents and adoption of zero grazing system in Kirinyaga district.
4. To determine and evaluate the levels of adoption of the selected zero grazing packages by smallholder farmers in Kirinyaga district.

The research was a descriptive survey and data was collected using a structured questionnaire. Descriptive statistics was used to summarize data and inferential statistics was used to test the hypotheses.

5.2 Conclusion

The results indicate that farmers in the study area adopted some innovations and neglected others. Some farmers adopted zero grazing but not fully thus the level of adoption of the zero grazing dairy technology was low given that the practice had been in existence for more than nine years. This has resulted in low productivity per livestock unit. Consequently, there is need to address the issues related to adoption of zero grazing technology in the district.

It is can be concluded that the lack of capital, lack of feeds, high labour requirements and less extension contact have resulted in non and partial adoption of innovations. The low contact with extension agents therefore, needs to be addressed by policy makers. Researchers and extension agents have to look for ways of developing appropriate and gender friendly technology that are suitable for smallholder farmers. Farmers should also be encouraged to plant high yielding fodders that will ensure sufficient supply of feeds that is a major constraint to dairy production.

5.3 Recommendation

1. Similar study should be carried out in other project districts to confirm whether the trends are the same.
2. A cost benefit analysis should be carried out to establish affordability and sustainability of the system.
3. Farmers should be encouraged to form milk-marketing groups or cooperative societies to enable them have a bargaining power and also pool their milk to reduce the cost.
4. Policies that ensure availability of affordable credit to small-scale dairy farmers should be put in place.
5. Researchers, extension agents need to seek ways of developing cheaper and suitable technologies for dairy development while at the same time incorporating farmers as partners in developing those technologies. In addition, the researchers should come up with cheaper methods of livestock feeding. There is also need to coordinate the activities of the researchers and extension agents in order to stimulate and develop relevant technologies and disseminate extension messages

consistently. The potential of the zero-grazing technology to increase agricultural productivity should be encouraged through research and extension activities that seek to better the integration of crop and livestock production.

6. The knowledge gap between the farmer and extension agents should be bridged through education. Various extension approaches such as farmer-to-farmer contact via farmer field day should be encouraged to stimulate and nurture adoption process.
7. There is need to ensure milk-marketing channels are available and efficient. For viability of the dairy industry, milk-marketing channels need to be efficient. Ways of improving the services of the Kenya Cooperative Creameries need to be identified and implemented. There is need also to look at the organized marketing channels owned by private process to supplement the efforts of Kenya Cooperative Creameries. Increased profitability of milk may the lead to enhanced adoption of zero grazing technology. In summary, it is also important to note that adoption could be higher if the provision of extension services is matched with the provision of appropriate research recommendation and development of agricultural related infrastructure such as access to credit.

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APPENDIX 1

QUESTIONNAIRE ON EVALUATION OF SELECTED FACTORS AFFECTING THE ADOPTION OF ZERO GRAZING DAIRY PRODUCTION SYSTEM BY SMALLHOLDER FARMERS IN KIRINYAGA DISTRICT, KENYA: A CASE OF NDDP 1987 – 1995

Name of farmer.....Code.....

Division.....

1. Age .....years

2. Gender 1. = Male 2. = Female

3. Education Level

1. =None	( )	4. Post secondary	( )
2. = Primary	( )	5. Tertiary college	( )
3. = Secondary	( )	6. University	( )

4. Farm size .....Ha

5. Category 1 = Adopter ( )
2 = Non adopter ( )
3 = Discontinuance ( )

6. Number of animals owned.....

6b. What dairy production system do you practice?

1 = Extensive system ( )
2 = Semi-zero system ( )
3 = Tethering ( )
4 = Zero grazing ( )

7. Why do you practice this system named above? (6b)

1. = Readily available grazing land ( )
2. = Lack of labour ( )
3. = High cost of input ( )
4. = Lack of capital to start zero grazing ( )
5. = Others (specify).....

7b. Why did you adopt the zero-grazing system?

1 . = Protect animals from adverse climatic conditions ( )
2. = Comfort and cleanliness ( )

3. = Manure production ( )

4. = Limited land for grazing ( )

5. = Efficient utilization of fodder ( )

6. = Reduced grazing time ( )

7. = Others (specify) ( )

8. How many animals did you keep in zero-grazing unit .....number

9. When did you start the zero grazing practice?.....

10. Are you still practicing zero grazing?

1. =Yes ( )

2. = No ( )

11. If you practiced zero-grazing why did you discontinue the practice? (Tick all that apply)

1. = Feed shortage ( )

2. = High cost of feeds ( )

3. = Lack of labour ( )

4. = Low milk prices ( )

5. = Lack of milk market ( )

6. = High transport cost ( )

7. = Others (specify).....

FEED AVAILABILITY

12. Which was the source of fodder for your cattle? (Please tick all that apply).

1. = Own land ( )

2. = Rented land ( )

3. = Forest grass ( )

4. = Roadside cultivation ( )

5. = Purchase ( )

5. = Others (specify).....

13. How much fodder did you plant?.....

14. Which fodder crops did you plant?

1= Napier grass

2= Pasture grasses

3= Sweet potato vines

4 = Maize fodder

5 = Others (specify) .....

15. When do you experience fodder shortage?

1 = Rainy season

2 = Dry season

3 = Always

4 Never

16. What crop residues did you feed livestock?

1. = Maize stover ( )

2. = Banana pseudostem ( )

3. = Straws ( )

4. = Haulms ( )

5. = Farm weeds ( )

6. = Others (Specify).....

17. Which commercial feeds were you feeding the animals?

1.= Dairy meal ( )

2.= Pollard ( )

3. = Pymarc ( )

4. = Maize germ ( )

5.= Bran ( )

1. = Others (specify).....

2. = None ( )

18. How did you cater for fodder shortages?

1. = Purchase from neighbours ( )

2. = Conserved fodder ( )

3. = Commercial feeds ( )

4. = Crop residues ( )

5. = Others (Specify).....

19. What did you do with excess fodder?

1 = Conserve ( )

2. = Sell to neighbours ( )

3. = Make compost ( )

4. = None available for conservation ( )

5. = Others (Specify).....

EXTENSION CONTACT.

20. How often did extension agents visits you?

1. = Weekly ( )
2. = Monthly ( )
3. = Never ( )
4. = 2-3 months ( )
5. = 4-5 months ( )
6. = Others specify..... ( )

21. What were your sources of information on livestock production? (a mark for every source known).

1 = Extension agents ( )
2 = Mass media (Radio/TV) ( )
3 = Neighbours ( )
4 = Public barazas ( )
5 = Journals ( )
6 = Public meetings ( )
7 = Others (specify).....

22. Which was the source of information of zero grazing

1 = Public baraza ( )
2 = Extension staff ( )
3 = Agricultural shows ( )
4 = Mass media (TV/Radio ( )
5 = Field days ( )
6 = Neighbours ( )
7 = Others (specify).....

23. Which of the following did you attended in the last 12 months (tick all that apply) (a mark for every extension method attended)

1. = Demonstrations ( )
2. = Farmers' seminars ( )
3. = Agricultural field days ( )
4. = Agricultural shows ( )
5. = Farmers' workshops ( )
6. = Residential training in FTC ( )
7. = Farmers tour ( )

24. How often did you visit agricultural extension offices to seek information on dairy production?

1 = Very frequent ( )
2 = Frequent ( )
3 = Often ( )
4 = Rarely ( )
5 = Very rarely ( )

LABOUR AVAILABILITY

25. Which was the source of labour for dairy production?

1. Casual labour ( )
2. Permanent hired labour ( )
3. Family labour ( )
4. Others (specify)_____

26. How much time is spent by each of the following in dairy production per day?

ACTIVITY	TIME IN HOURS					
	Husband	Wife	Children	Perm. Lab	Casual	Total
1. Weeding fodder						
2. Collecting fodder						
3. Chopping + feeding forage						
4. Milking						
5. Milk marketing						
6. Slurry disposal						
7. Cleaning shed						
8. Fetching water						
9. Spraying/dipping						
10. Obtaining vet. Services						
Total						

EVALUATION OF THE EXTENT OF ADOPTION OF SELECTED ZERO GRAZING TECHNOLOGIES.

1) Calf Rearing (indices ranges from 1-4 with 4 being the recommended practice).

27. What kind of calf pen did you have?

4 = Slatted floor within the zero-grazing unit ( )
3 = Earthen floor ( )
2 = Concrete floor ( )
1 = Housed elsewhere ( )

28. How were you feeding your calves with milk?

1 = Suckling ( )

2 = Bucket feeding ( )

29. How much milk was given to the calves per day? ..... kgs

4 = 4 kgs ( )

3 = 3 kgs ( )

2 = 2 kgs ( )

1 = 1kg ( )

30. How much concentrates did you feed the calf per day?

4 = 700g ( )

3 = 500g ( )

2 = 300g ( )

1 = 100g ( )

0 = None ( )

31. At what age did you wean the calves?

4. = 16 weeks ( )

3. = 12 weeks ( )

2. = 8 weeks ( )

1. = 4 weeks ( )

2) Fodder Establishment and Management

32. What was the spacing of Napier in your farm?

4 = 90 x 60 cm ( )

3 = 90 x 30 cm ( )

2 = 60 x 60 cm ( )

1 = 60 x 30 cm ( )

0 = 100 x 30 cm ( )

33. How often did you weed the Napier?

4. = after every cutting ( )

3. = 3 times a year ( )

2 = 2 times a year ( )

1. = Once a year ( )

0. = Others (specify) .....

34. At what height did you harvest the Napier?

4. = 60cm ( )

3. = 90cm ( )
2. = 100cm ( )
1. = 120cm ( )
0. = 150cm ( )

35. How much manure were you returning to the Napier from the zero-grazing unit?

4. = All the manure ( )
3.= Most ( )
2. = Half ( )
1. = A little ( )
0. = None ( )

36. How much of the compound fertilizer 20:10:10 did you apply per acre of Napier per year?

4. = 200kg ( )
3 .= 150kg ( )
2. = 100kg ( )
1. = 50kg ( )
0. = None ( )

36b. How much CAN did you apply per acre per year?

4. = 100kg ( )
3. = 75kg ( )
2. = 50kg ( )
1. = 25kg ( )
0. = None ( )

3) Dairy Cattle Housing

37) Which of the following component did you construct according to the recommendations of NDDP design (one mark for every component constructed)

1 = Cubicles
2 = Feeding/walking area
3 = Feed/water trough
4 = Milking parlour
5 = Calf pen
6 = Store
7 = Manure pit
8 = Fodder chopping area

4) Dairy Cattle Feeding (indices range form 1-4)

38. How much Napier did you plant per cow?

4 = 0.4 ha

3 = 0.3 ha

2 = 0.2 ha

1 = 0.1 ha and below

39. How much minerals did you supply per cow/ day?

4. = 100g/day ( )

3. = 75g/day ( )

2. = 50g/day ( )

1. = 25g/day ( )

0 = None ( )

40. What is the frequency of watering the animals?

4 = Water readily accessible ( )

3 = 3 times a day ( )

2 = 2 times a day ( )

1 = Once a day ( )

41. Which fodder trees did you plant? (1 mark for every type of fodder tree planted)

1. = Calliadra ( )

2. = Sesbania ( )

3. = Leucaena ( )

4. = None ( )

42. Which herbaceous legumes had you incorporated in the fodder? (a mark for every type)

1. = Desmodium ( )

2. = Vetch ( )

3. = Stylo ( )

4. = None ( )

43. How much dairy meal were you feeding per cow/day?

1. = 4kg

2. = 3kg

3. = 2 kg

4. = 1kg

5. = none

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16th July, 2003

Shadrack Muchemi Ndegwa
Egerton University
P.O. BOX 536
NJORO

Dear Sir

RE: RESEARCH AUTHORISATION

Following your application for authority to conduct research on 'An evaluation of factors affecting the Adoption of Zero -Grazing Dairy Production in Kirinyaga' A case of NDDP, I am pleased to inform you that you have been authorised to conduct research in Kirinyaga District for a period ending 30th August, 2003.

You are advised to report to the District Commissioner and the District Education Officer Kirinyaga District before embarking on your research project.

You are further expected to avail two copies of your research report to this Office upon completion of your research project.

Yours faithfully

A. G. KAARIA
FOR: PERMANENT SECRETARY/EDUCATION

CC
The District Commissioner
Kirinyaga

The District Education Officer
Kirinyaga