UNIVERSITY OF NAIROBI

APPLICATION OF GPS AND GIS IN DAIRY LIVESTOCK MANAGEMENT:
CASE STUDY OF THE MT. KENYA REGION

By

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Master of Science in Geographic Information Systems

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Abstract

Dairy farming plays an important part in Kenya's economy. Any activities contributing to its improvement can only improve the livelihoods of its dependents. Proper record keeping is a prerequisite for improvement in management, breeding and ultimately in productivity of the sector.

Currently there is poor participation in dairy recording with only less than 1% of the eligible dairy herd being milk recorded at the national level.

This project documents a GIS based analytical tool to aid in decision making as pertains to locating the current participants in dairy registration and recording as well as offering tools to aid in service delivery.

The study was limited to farmers who had registered their animals by January 2007.
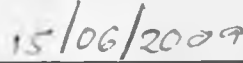
The project involved identifying stakeholders in dairy recording, carrying out a user needs assessment, data collection on herds, owners, and animals, geodatabase development and eventually a testing of the geodatabase to see its functionality.

It was found that stakeholders have spatial information needs. The geodatabase developed was found to be functional and fulfilled user needs. Farms with registered herds were found to be clustered around the divisional headquarters while most of the registered herds were found to be in Agro ecological zones UM2 and LHI. There was found to be poor follow up by farmers after initial registration of their animals.

It is recommended that farmers who have shown an interest in dairy recording be followed up so that uptake of recording is improved, main coordinators in the livestock recording adopt georeferencing by use of hand held GPS receivers, further improvement of the developed geodatabase to be more user friendly, and more facilitation in extension so that more farmers are reached.

Declaration

This project is my original work and has not been submitted for a degree award in any other University

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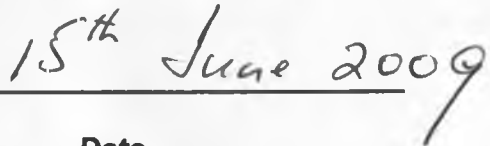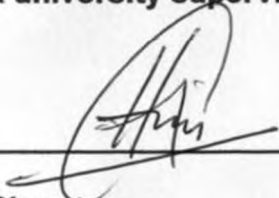
Signature   **Date**

David Muhindi Kariithi

The project report has been submitted for examination with my approval as a university supervisor

_____   ___15th June 2009___

Signature   **Date**

Prof G.C. Mulaku

Dedication

To my family

Acknowledgements

This report is the culmination of a process that could not have been possible without the support of many people.

Deepest gratitude to my supervisor Prof. G.C. Mulaku for his advice, challenge and support.

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To all those who assisted in data acquisition including staff at Kenya Livestock Breeders Organisation, Livestock Recording Centre and field extension officers in the study area for their unwavering support.

To ILRI from whom I was able to access important data sets from their website www.ilri.org.

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List of Abbreviations

- AEZ-Agro Ecological Zone
- AI- Artificial Insemination
- CAIS- Central Artificial Insemination Station
- DRSK-Dairy Recording Service of Kenya
- Div Hq-Divisional Headquarter
- FAO- Food and Agriculture Organization of the United Nations
- GB-Gigabyte
- GPS-Global Positioning Systems
- GIS-Geographic information Systems
- ICT-Information and Communication Technology
- ILRI- International Livestock Research Institute
- KARI-Kenya Agricultural Research Institute
- KLBO- Kenya Livestock Breeders Organization
- KNSDI-Kenya National Spatial Data Infrastructure.
- KSB- Kenya Stud Book
- LH1- Lower Highland 1
- LH2- Lower Highland 2
- LH3- Lower Highland 3
- LH5- Lower Highland 5
- LM3-Lower Midland 3
- LM4-Lower Midland 4
- LM5-Lower Midland 5
- LRC-Livestock Recording Centre
- MLD-Ministry of Livestock Development
- MOALDM- Ministry of Agriculture Livestock Development and Marketing
- RAM-Random Access Memory
- SNF-Solid Non Fat
- SQL-Structured Query Language
- UH0- Upper Highland 0
- UH1-Upper Highland 1
- UH2- Upper Highland 2
- UH3- Upper Highland 3
- UM1- Upper Midland 1
- UM2- Upper Midland 2
- UM3- Upper Midland 3
- UM3-4- Upper Midland 3-4
- UM4-Upper Midland 4

Chapter 1

INTRODUCTION

1.1 Overview

Dairy farming plays a leading role in the livelihood of many households. The Kenyan dairy sector is made up of more than 600,000 smallholder dairy farms scattered around the country. These farmers account for 56% of the total milk production and 70% of the total marketed milk in the country (Omore et al, 1999). Improvement in dairy can only be possible through conscious planning and monitoring of the trends in the industry. It is therefore important to have a functioning dairy recording system that shows how the country is fairing in terms of production and attaining of breeding goals.

With technology it is possible to more easily perform some of the activities that took a lot of time and physical resources. These include digitization and creation of databases, use of computers and internet to perform routine activities and information provision. This will go a long way towards making the country a knowledge based economy.

1.2 Statement of the Problem

From literature review it is evident that there is very low adoption of livestock recording in the country. Causes include lack of awareness, inadequate personnel, inadequate operational funds, inadequate data and analysis facilities and poor communication infrastructure.

Data management is mostly paper based (especially for recruitment and extension follow up), there is no physical address system and follow up of farmers is difficult.

1.3 Study Objectives

1. Evaluate the spatial distribution of Dairy recording farmers in the Central Kenya region and test the hypothesis that there is no spatial effect on the distribution of milk recording farmers.

2. To answer the question:

- Can GIS be used for management and decision support in aid of livestock recording?

The study was limited to the link between the number of adopters and administrative boundaries, AEZ, distance from various centers and individual

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animals information. All this geared to adding value to the existing livestock information management systems in use by adding the spatial dimension.

A final outcome of the project was expected to be a digital map showing the location of farmers who have adopted dairy recording in the study area. It also expected to come up with a prototype GIS that can be improved to serve livestock recording and breeding services sector.

1.4 Justification

The dairy industry in Kenya plays an important role in the lives of many people. From smallholder farmers to milk hawkers there are nearly 1 million households or businesses involved. Considering that there are 625,000 smallholder farmers, for whom dairy is a family business, it is likely that more than 2 million people are employed in the subsector in one form or another. Therefore, anything that affects the subsector affects a lot of people, especially small businesses and farmers. Increasing the growth in the subsector will lead to much greater overall growth.

Potential for development still exists as there is still low milk consumption per capita as well as there being a large potential market for milk in the African and the Middle East Regions.

Management of services being offered to farmers can benefit a lot by use of Information Communication Technology (ICT) tools for analysis and data management. Use of Geographical Information Systems (GIS) and GPS would go a long way in introducing the spatial dimension to the data and can result in better visualization of information, benchmarking and increased scope in data analysis.

1.5 Scope and limitation

The study area, in Central Kenya is characterized by small scale farmers whose entry in the livestock registration and recording is recent. Land sizes are small and farmers are scattered over a large area. Due to the nature of the records held at the KLBO offices in Nakuru it was not possible to have a complete record of all the farmers who have recorded their animals but rather considered all the farmers who had registered their animals up to January 2007.

Records are primarily in paper form in different files. Time was therefore spent perusing through the files in order to come up with a list of herds located in the study area. This was achieved by getting farmers whose postal addresses were given for towns in the study area.

Farmers, though required to sketch directions to their farms, did not do so and only 18 out of 220 farms (8.18%) whose application records were accessed had sketches to their farms.
Data collection from the field was done in the rainy season making accessibility to farms challenging.

There is limited staff at the organizations thus making fast retrieval of data challenging.

1.6 Significance of the study

The study set a basis for use of GIS tools in management of services in the livestock sector and specifically for dairy recording. Use of the technology can assist in planning, analysis and setting up goals and informing decision makers of the options to follow

1.7 Organization of the report

Chapter one gives an introduction to the study significance, the problem statement and expected outcomes of the research.

Chapter two discusses the study area in the context of the study.

Chapter three is basically on literature review and discuses findings from past literature on livestock recording (specifically dairy recording) and use of GIS for business in other enterprises that could offer an insight as to the potential of the technology.

Chapter four discusses the methodology used throughout the project. This is from identification of users; user needs assessment, data collection, data base conceptual design, database implementation and spatial analysis.

Chapter five discusses the results of the study as well as their analysis.

Chapter six discusses lessons learnt in conclusions and recommendations.

References and appendices follow thereafter.

Chapter 2

THE STUDY AREA

2.1 Kenyan Context

The principal dairy production areas in Kenya are in the highlands where most of the dairy herd is located. The country is divided into zones of which there are 6 including Mt.Kenya, Nairobi, Nakuru, Coast, Kitale and Maseno. Most of the activities in recording have been in the Rift valley and around Nairobi.
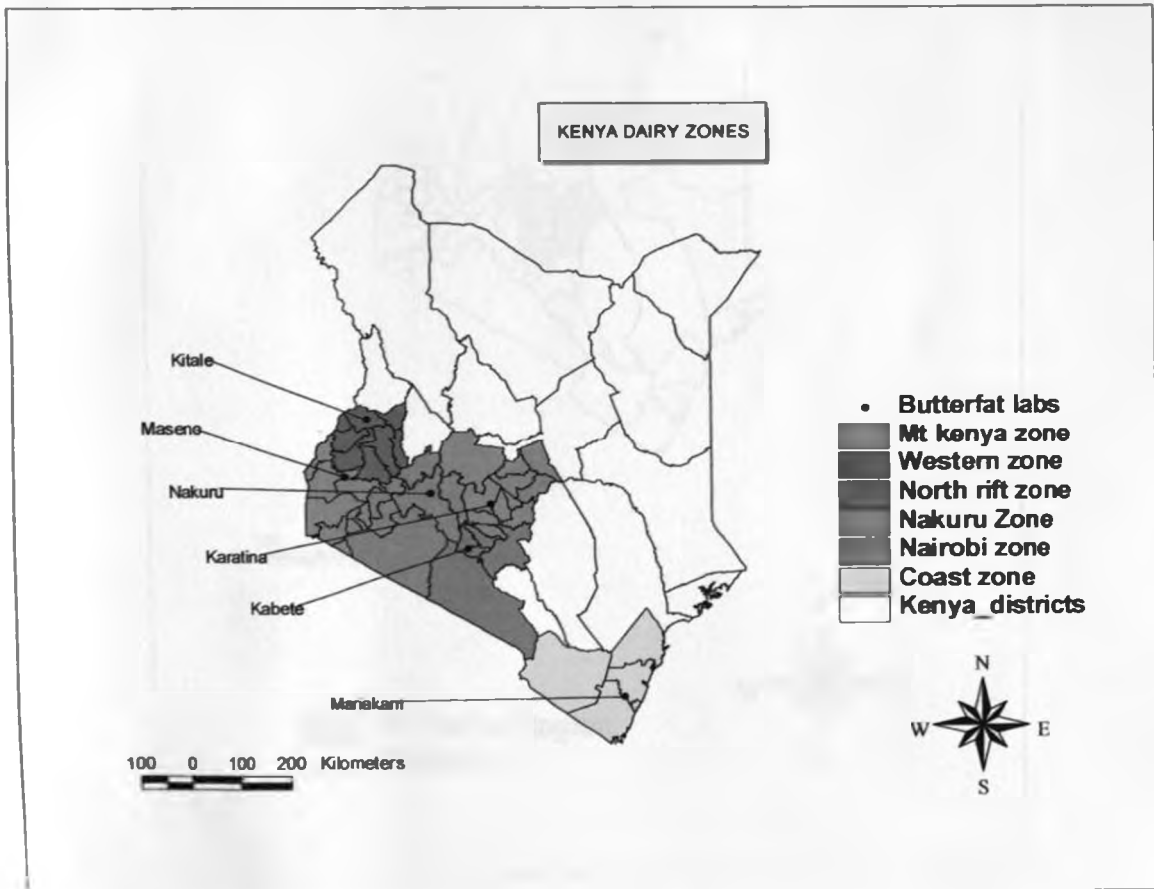
Fig 2.1: Map of Kenya showing the dairy zones served by milk testing labs

2.2 Mt Kenya region

The Mt. Kenya region is served by the Karatina mik testing lab. It consists of the Districts Nyeri, Murang'a, Maragua, Kirinyaga, Embu, larger Meru and Laikipia, a total area of 28340 Km².
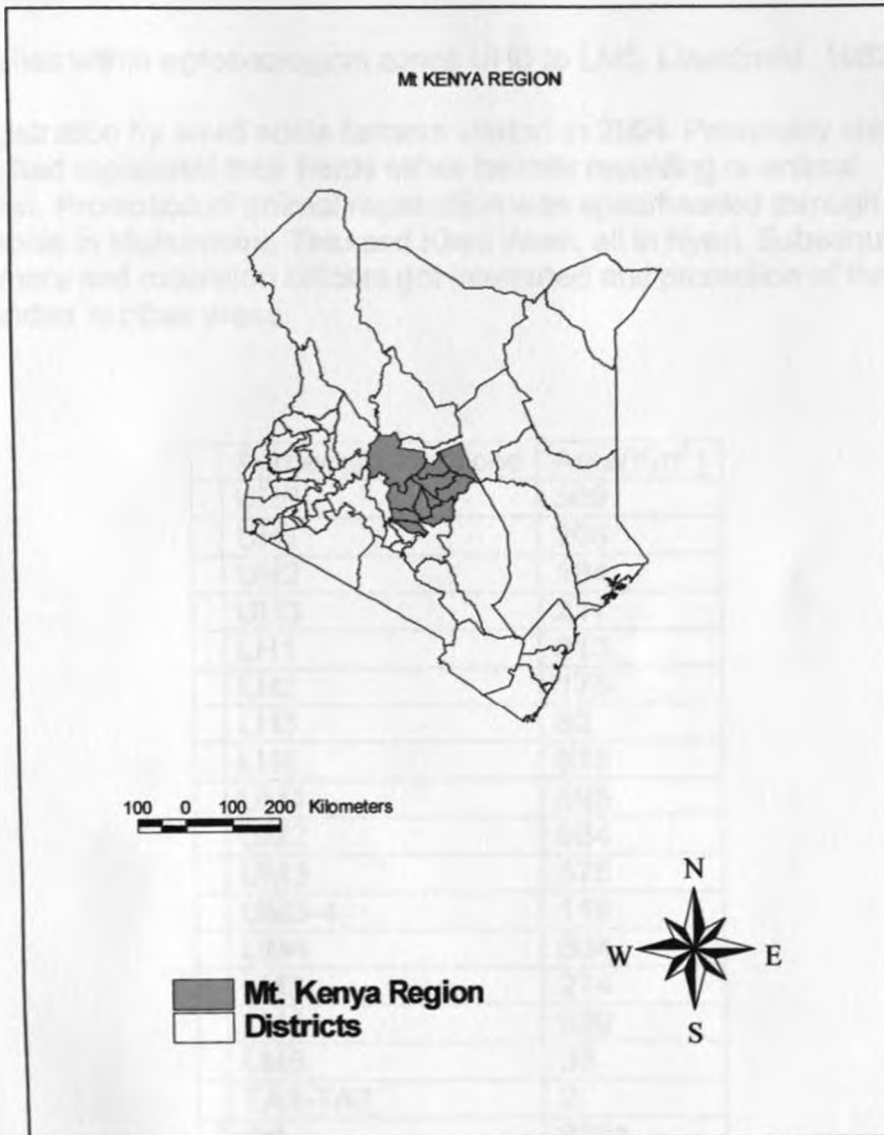
Fig2.2: Map showing the Mt. Kenya Region

2.3 Study region

The study area consisted of the districts Nyeri (Nyeri North and South), Kirinyaga and larger Murang'a (Maragua and Murang'a) 6301 Km ^{2} is available for dairying. It is located between longitudes 36.6 ^{0} and 37.49 ^{0} East and between latitude 0.02 ^{0} and 1.12 ^{0} South.

The area lies within agroecological zones UH0 to LM5, (Jaetzhold, 1982).

Mass registration by small scale farmers started in 2004. Previously only about 40 farms had registered their herds either for milk recording or animal registration. Promotion of animal registration was spearheaded through Farmer Field schools in Mukurweini, Tetu and Kieni West, all in Nyeri. Subsequently other farmers and extension officers got interested and promotion of the exercise was extended to other areas.

Agroecological Zone	Area(Km^2)
UH0	509
UH1	206
UH2	184
UH3	217
LH1	613
LH2	175
LH3	82
LH5	618
UM1	595
UM2	964
UM3	575
UM3-4	118
UM4	604
LM3	274
LM4	529
LM5	36
TA1-TA2	2
Total	6301

Table 2.1: The Agro Ecological Zones in the study area (Area internally generated in arc view)

AGROECOLOGICAL ZONES IN THE STUDY AREA
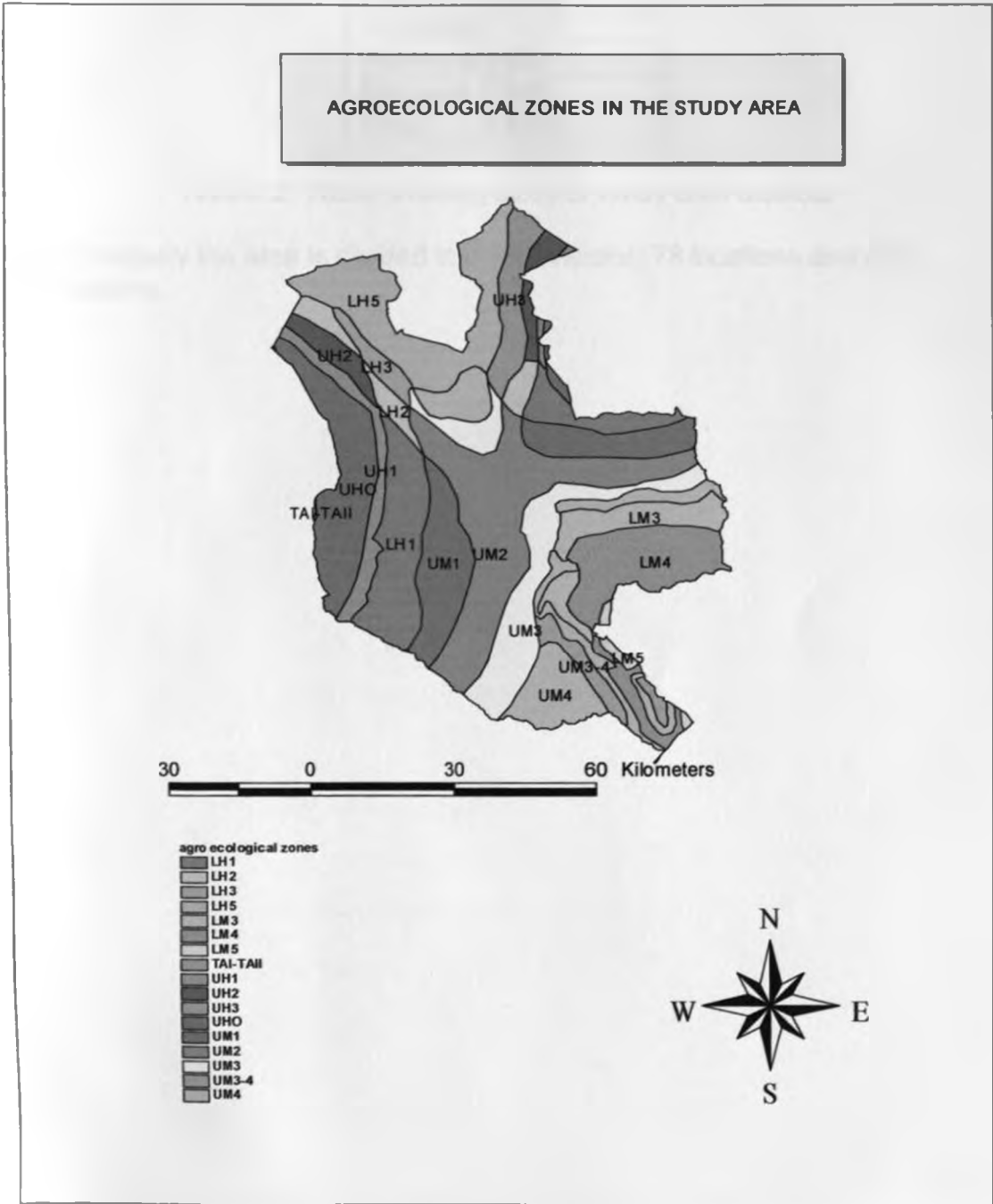
Figure 2.3: Map showing AgroEcological zones in the study Area (Non Protected Areas)

District	Area (Km^2)
Nyeri	3356
Kirinyaga	1478
Murang'a	930
Maragua	868
Total	6632

Table2.2: Table showing sizes of study area districts

Adminstratively the area is divided into 19 divisions, 78 locations and 400 Sublocations.

Figure2.4: Map showing the study area Districts and Divisional boundaries

Chapter 3.0

LITERATURE REVIEW

3.1 Livestock *records*

Keeping and efficient use of records is an important management practice for enhancing the biological efficiency and productivity of livestock. Important reasons for keeping livestock records include:

- Marketing(on-farm livestock and milk sales)
- Feeding, Housing planning
- Genetic Evaluation and improvement
- Health Management and Regulation
- Reproductive management
- Breed registry Program and Livestock Showing
- Research, Training and policy formulation.

At the farm level keeping of records would contribute significantly towards improved management skills, efficient breeding and feeding practices as well as profitable market returns.

At the national level records are needed for evaluation and selection purposes. The genetic gain resulting from selection of superior progenies is dependent on keeping accurate performance and pedigree records of both the progenies and their parents. Performance recording is a pre-requisite to effective decision making on breeding policy.

3.2 Dairy recording in Kenya

In Kenya only a few dairy herds are recorded.

"About 45% (1.35 million) of the commercial dairy herd, estimated at around 3 million, are cows. Based on a mean calving interval of about 456 days or 15 months, the average calving rate is around 80%. Thus, in a year about 1 080 600 cows should be in various stages of lactation and, therefore, recordable. Though less precise, these estimates show that the DRSK currently covers only 0.98% (less than 1%) of the country's dairy cows' population. In certain developed dairying countries like Israel over 50% of the cows are covered by the recording scheme. Thus, the main task of DRSK is now to develop a suitable recording system to enable it expand its services easily to cover most of the 1.1 million recordable cows, the majority of which are with the small scale farmers"(Trivedi, 1998)

A large breeding population is essential for the National Progeny Testing and Contract Mating Schemes for selection of breeding bulls and bull mothers respectively. These schemes depend on farmers who participate in the Milk recording and registration, both of which are based at Kenya Stud Book in Nakuru. In the year 2003 the total number of livestock registered with the Kenya stud book were 4889 with cattle accounting for 82% of the total. The total dairy milk-recorded cattle with the dairy recording services of Kenya were 17,200(Trivedi, 1988).

The breeding value of imported semen is well established unlike that of local semen. This way the farmers are assured of high quality semen. (Karanja, 2003)

In summary the animal genetics market in Kenya is shown to be characterised by:
- Low public financing and lack of proper co-ordination among the various players in the industry
- Declining number of AI inseminations and an increase in the use of natural service
- Under-capacity utilisation of available infrastructure for semen production at CAIS
- Thin AI market that is not conducive to private sector investments
- Skewed distribution of AI providers leading to exclusion of important dairy producing areas
- Dominance of socio-organisations in AI service provision
- Low levels of animal registration and recording
- Unsatisfactory involvement of farmers, breeders and other stakeholders in the management of institutions in the industry. (Karanja, 2003)

Several constraints limiting the operations of smallholder dairy recording have been identified, prioritized by researchers, extensionists and farmers. (Trivedi, 1998) These constraints are listed below in order of priority:

- Lack of awareness of the importance of records at farmer and extension level.
- Inadequate personnel.
- Inadequate operational funds.
- Inadequate data processing and analysis facilities.
- Poor communication infrastructure e.g. telephones.
- Inadequate transport for field work (recruitment and extension).
- Lack of proper identification methods of the animals.
- Inadequate information on feeding and management at the farm level.
- Inadequate labour at farm level - e.g. for feeding and recording.
- Inadequate market incentives for products and animals.
- Loss of records as a result of sale and transfers of farms and animals.
- High costs of recording

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Dairy recording in Kenya involves farmers registering their animals with the DRSK. On subsequent calving the farmer is expected to start recoding milk and sending production records on specified dates (14th of every month) and milk testing at one of the regional milk testing laboratories at least once every quarter. Previously the milk was only tested for butterfat. Currently machines can test for protein, SNF and density results of which are sent to DRSK for preparation of lactation certificates which are completed for every lactation period. Of importance is also the lifetime yield which is the cumulative milk yield for all of an animal's lactations. Up to 14 lactations are possible though the average is much less at around 3 to 6 lactations.

Ideally a farmer should register his or her animals with the KSB upon which the animals should be milk recorded on calving.

There is need to breed local bulls as the cost of importing bulls or semen is high, there is a rapid increase in semen demand which can not be met by importation and possible presence of genetic-environmental interaction.

Factors favouring a breeding programme include a viable dairy industry, established institutions, existing communication networks and the need for efficient and adequate production (KARI, 2003).

3.3 Dairy recording in developed countries

It is from the developed countries that developing countries adopted livestock recording. When it comes to dairy animals, the major dairy breeds originated from Europe. It is only from recording that the breeders in Europe were able to select and refine the animal genetics to come up with animals conformed for dairy production. In the developed countries namely Europe, Americas, Australia and New Zealand there is an active recording that has been around for over 100 years. The herd sizes are large with an average of 30 to 100 for various countries in Europe, 100 for US, 350 for New Zealand and 350 for Australia. (Wikipedia, 2008)

In these countries it is mostly the breed societies that are very active in matters concerning their breed. They have inspectors, with some having very strict policies on joining, having different memberships like junior member, senior member etc.

The farmers in those countries are commercially oriented and dominate world dairy farming and trade in dairy products. (Wikipedia, 2008)

There is advanced information technology infrastructure and use of automation in management all the way from feeding to record keeping.

There is a high degree of adoption of recording with a very high percentage of animals being tested.

Information on individual animals and herds is increasingly being made available to the public through breeders' websites.

3.4 Dairy recording in developing countries

Compared to the developed world, dairy recording is only in inception stages in most of the developing countries. Most of the animals in these countries are kept at a small scale and mostly for subsistence purposes with only the surplus being available for sale. Like in Kenya there is poor penetration of technology.

Usually the herds are sedentary and limited due to small size. There is a general lack of qualified recorders and the educational level of farmers is limited compared to the developed world. (FAO, 1986)

For any recording scheme (especially so in developing countries), the system must be simple and involve little paper work for the farmer ie should not require major alterations in a farmers usual routine. Traits should be economically important and resulting products being either marketable or consumed by the producer. Their number should be kept as low as possible. The system should be efficient in terms of time and cost and records should make it possible to identify the best and poorest animals at farm level as well as genetic differences between populations at national levels. (FAO, 1982)

3.5 GIS potential for managing services

Management is all about making conscious, desired changes to the world. It is about achieving desired ends through people and with the use of tools such as GIS- and irrespective of the sector.

A GIS makes use of spatial and attribute data by integrating the two in a powerful manner. Attribute data are represented by populations, income/poverty levels, milk production, sales, etc. while geographic data is represented as points, lines and polygons representing for example towns, roads and land use respectively. GIS provides the ability to query this spatial data along with its non-spatial properties.

The use of GIS as mainstream analytical tool is gaining importance. GIS has been documented to help in targeting of resources, identifying where the biggest problems exist, modeling different interventions for different areas and zones etc. (Smith et al, 2007)

An animal's phenotypic value is as a result of the interaction of the environment and its genetics. To be able then to estimate a true breeding value(which should

be a factor of genetics) it is therefore important to correct for effects of the environment. In case of a cow such factors include season of calving, feeding (usually characterized by the season and the agro ecological zone), temperatures etc. GIS can be of use in georeferencing different environmental regimes leading to better computations and weighting.

Access to reliable data across an enterprise means valuable intelligence for strategic decision-making.

Use of information is the key to any organisation today. Significance of GIS in data management and decision making is enormous. This technology holds potential for improving productivity, credibility and profitability of any organisation. GIS can be customised to meet user specific requirements..

A range of generic uses of spatial data that span many sectors can be identified Most prominent of these are:
• market and infrastructure planning
    o   building infrastructure and providing services where it is needed the most, by incorporating supply and demand side spatial variables
• asset management
    o   managing existing infrastructure, identifying faults and sites needing attention quickly, and allowing for the site to be found quickly and the problem addressed faster
• appreciating spatial trends
    o   spatial trends and issues that may not be apparent when data is presented in a tabular from are often clearly apparent in maps
    o   any data that has a recognisable spatial dimension can be mapped and analysed in GIS, often shedding new light on problems and allowing for improved decision making and policy decisions. (anzilic, 2008)

Business GIS is a concept by which corporations begin to use spatial information to manage their business. Since 70-80% of any data has geographical dimension, it becomes important to use GIS for analysing them spatially.

3.6 GIS in livestock management

The Government of Kenya, in the small holder dairy project identifies spatial analysis of dairy systems for improved targeting of technology and investment as one of the key area in research /development activities. (Muriuki et al, 2003)

GIS and spatial analysis can play a functional role in supporting various areas of livestock recording service management. These include mapping of existing farmers, identifying areas of high potential and low penetration, classifying different systems according to different parameters, assist in planning, budgeting, staff deployment and location of services, evaluation of extension projects etc.

Extension Service administrators have used GIS as a budget and staffing tool. GIS maps have been used to show elected officials and state legislators where in their respective districts Extension Service programs have been implemented, demonstrating the accomplishments and importance of the Extension Service in these locations. Determination of county staffing needs has been streamlined by using GIS technology. State leaders defined and weighted the criteria important to program implementation and used GIS to objectively prioritize the results for decision makers. (Estrada et al, 1997)

GIS has been used for defining census units for livestock census. Instances include development of a spatial model taking into account daily livestock movements in Burkina Faso and Mali. (FAO, 2003)

METHODOLOGY

4.1 External modeling

This is the determination of a finite set of potential users of the database as well as their information needs. With their information needs data that is supposed to satisfy those needs can be identified.
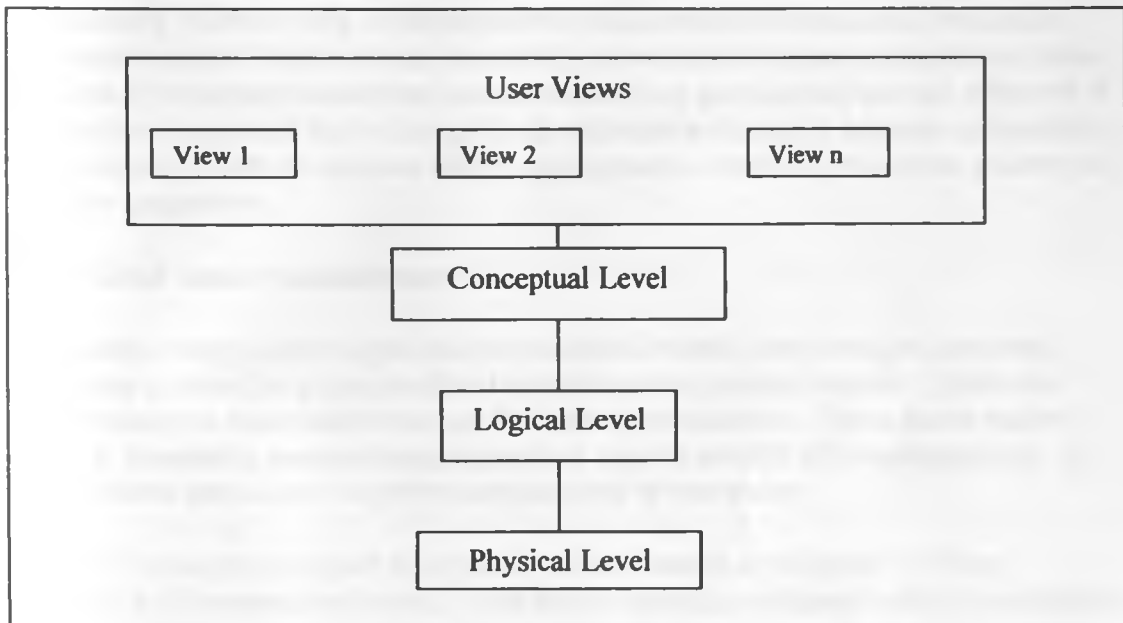
Figure 4.1 Levels of abstraction in a DBMS

Abstraction in this project was at the conceptual and user views levels.

4.2 Identification of users/Stakeholders

Institutionally, there are a number of players in Kenya who contribute significantly to production and use of livestock records including:

- Livestock farmers and breeders
- Central Artificial Insemination Station (CAIS) at Kabete
- Kenya National Artificial Insemination Services (KNAIS)
- Private AI service providers.
- Livestock Recording Center (LRC) at Naivasha
- Research and Training Institutions
- Livestock Marketing Institutions (milk processors, slaughter Houses etc)
- Kenya Stud Book(KSB) in Nakuru
- Dairy Recording Services of Kenya (former Kenya Milk records) in Nakuru

- Ministry of Livestock

KSB and DRSK under KLBO conduct dairy registration and milk recording.

This is done with input from the Livestock Recording Centre (LRC) of the MOLD that is responsible for contract mating, progeny testing and ultimately breeding value prediction. The dairy cattle breeding stock at Central Artificial Insemination Station (CAIS) are presently confined to four breeds (Friesian, Ayrshire, Guernsey and Jersey).

Traditionally, farmers rely on their memory capacities to remember important information about their animals, especially ancestral lines and production levels. Systems of livestock identification and measuring productivity are all different. It is therefore important that standardized methods be used to enable comparison of production levels of animals within and between herds in the same country or between countries

4.3 User needs assessment

The methodology used to get user information needs was through personal interviews guided by a predesigned questionnaire (see appendix 1) that was administered to representatives of the main stakeholders. These were mainly farmers, breeders, researchers, extension agents and KLBO management. 12 respondents were used to get a sample view of the users.

Information needs included location of farms, details of animals, contact addresses of owners and farms, farm owner details, pedigree details, production details of animals and in case of small scale farmers details of groups to which they are members.

The KLBO emphasized on individual animal and herd records. Spatial location of farms was cited as important in aiding field staff and inspectors access the herds.

The LRC which is charged with the recording interest was on individual animal records, location of the herds (for followup) environmental zonation and group details especially for small scale farmers who are better handled in groups. Likewise researchers required the same information on the production systems and animal performance.

Extension agents were interested in knowing the location of herds so that in their normal extension work they would be able to have specific extension packages for such farmers. They were interested in getting owner and group details.

Semen providers' interest was in knowing how their semen/bulls were performing and this could only be possible by knowing where the bulls are being used as well as the performance of the progeny. At the same time getting a profile of

where their bulls were being used is important for marketing and promotional purposes.

Data and information on individual animals and herds is only released to the farmer. Release of such information to a third party has to be by approval of the KLBO Board.

4.4 Conceptual Data Modeling

The database was implemented using an Object Relational geodatabase model. The non spatial data was arranged in a relational model and eventually using the location coordinates it was possible to create an event theme using the X,Y coordinates to create geographical features. These features include points to represent location of farms and location of groups' offices/meeting points for farmer groups. The geographical features created could then be related to other features such as polygons, other points, and lines from other sources. Spatial queries, Overlay and intersection were done on the farm point features so as to get its administrative location (Sublocation, location, division, district), and environmental location (AEZ), relation to other points(such as points representing villages), towns etc. It was possible, using line features to know distances between two points such as from one farm to the next or from a town to a farm etc.

 A relationship of the entities, their tables and fields are described here below. The Attribute data set was set up in tables in a relational database. This was done by inputing data into database tables that were later linked or related so that a user could get information by using SQL. The tables built were for the following entities.

1. Group
2. Owner
3. Farm
4. Animal
5. Sire
6. Dam

Group
OBJECTID
GROUP_ID:Int
GROUPNAME:Str
LAT:Single
LONG:Single
POBOX:Int
TOWN:Str
CODE:Str
TELEPHONE:Str
FAX:Str
EMAIL:Str
POWER:Boolean

Table 4.1: The GROUP entity

A Group is made up of members (in this case owners). OBJECTID is a system generated field in arccatalogue, GROUP ID is an integer and the primary key, GROUPNAME gives the group name. LATandLONG provide for coordinates of the groups offices or meeting point. POBOX, TOWN,CODE,TELEPHONE,FAX and EMAIL are all fields for Address while POWER is a field to record whether group has access to electricity in case member farmers would require to have milk testing done on site.

A Group is important in mobilization, training and collective action for smallholder farmers

Owner
OBJECTID
OWNERID:Int
NAME:Str
GENDER:Str
GROUPID:Int

Table 4.2: The OWNER entity

An Owner owns a farm and can be a member of a Group. OBJECT ID is system generated, OWNERID is the primary key, NAME is the name of the farmer/owner, and GENDER is either male or female while GROUPID is the foreign key to relate to Group. In this study an owner was only allocated to one group although there are cases where a farmer can be a member more than one group.

An owner is related to a farm, and an owner can own more than one farm.

Farm
OBJECTID
SHAPE
FARMID:Int
HERDPREF:Str
OWNERID:Int
POBOX:Int
TOWN:Str
CODE:Str
TELEPHONE:Str
PREFIXLET:Str
DRSKNO:Int
LAT:Single
LONG:Single
SUBLOC:Str
AEZONE:Str
DISTRICT:Str
DIVISION:Str
LOCATION:Str
VILLAGE_NA:Str

Table4.3: The FARM entity

The farm is the main focus as a spatial entity. OBJECTID is system generated (Arccatalogue), SHAPE is system generated (point), FARMID the primary key, HERDPREF (HERD PREFIX) is a unique identity for a farm (with a dairy herd/animal(s)), it is unique and can not be a name of a place. POBOX, TOWN, CODE, TELEPHONE are all addresses, PREFIXLETTER is a letter code issued by KSB as a Prefix for pedigree animals in a herd, LAT/LONG are the coordinates of a point in the farm, DRSKNO (DRSK Number) is a number issued to farms/Herds that have registered for milk recording, AEZONE is the Agroecological zone in which the farm is located, While DISTRICT, DIVISION, LOCATION AND SUBLOCATION are admistrative areas within which the farm is located. VILLAGE represents the nearest village to the farm (ILRI, 2008) Farm is owned by an owner, OWNERID is the foreign Key to relate to Owner. A farm contains one or more animals

Animal
OBJECTID
ANIMALID:Int
ANIMALNAME:Str
REGIST_NO:Str
ID_NO:Int
FARMID:Int
SEX:Str
BREED:Str
COLOURMARK:Str
GRADE:Str
DATEOFBIRTH:Date
SIREID:Str
DAMID:Str
DATEOFREGIST:Darte
SALESTATUS:Boolean
SALEPRICE:Num
LAC1CALVING:Date
LAC1DRY:Date
LAC1YIELD:Num
LAC1BF:Num
LAC1PROT:Num
LAC1SNF:Num
LAC2CALVING:Date
LAC2DRY:Date
LAC2YIELD:Num
LAC2BF:Num
LAC2PROT:Num
LAC2SNF:Num
LAC3CALVING:Date
LAC3DRY:Date
LAC3BF:Num
LAC3SNF:Num
LIFEYIELD:Num
LIFEBF:Num
LIFEPROT:Num
LIFESNF:Num
EBV:Num
ETA:Num

Table4.4: The ANIMAL entity

Animal is the main focus of livestock/Dairy recording. OBJECTID is system generated, ANIMALID is the primary key,REGIST NO is a registration number/identity issued by the KSB, IDNO is a number/identity given by the farmer, FARMID is a foreign key to relate Animal to Farm, SEX is either Male or Female, COLOURMARK describes the colour/markings of the animal, DATEOFBIRTH the date on which the animal was born, SIREID is the name of the sire/father of the animal(This provides the foreign key to relate with Sires), DAMID(the foreign key to relate to dam)/mother of the animal. LactnCALVING, LACnDRY represent the date of calving and the date of drying (Stoppage of milking) respectively for lactation n respectively. This database goes up to lactation3 though it is possible for an animal to have up to 15 lactations. LacnYield, LacnBF,LacnPROT,LacnSNF represent Milk yield(in Kg), Butter fat, Protein and Solid non fat respectively for lactation n in this case as a percentage though it can also be expressed in Kg. LIFEYIELD, LIVEBF, LIVEPROT,LIVESNF represent the lifetime milk, butter fat, protein and Solid non fat yield for an animal. EBV is the Estimated Breeding Value it is expressed as a number and represents the breeding value for a certain trait (taking the example of milk production) Breeding Value is positive if the animals milk yield is above average when compared to its contemporaries and negative when lower that the average) pedigree records are also taken into account in coming up with a breeding value. For bulls it is best estimated using progeny/daughter records while for cows, while progeny performance is taken into account, it can be estimated using individual production records. ETA is the Estimated Transmission Ability of a Breeding Value and is expressed as a percentage. Standardization of milk yield and other yield parameters is done with assistance of Livestock Management System software that is able to among other things standardize the lactation period to 305 days as well as compute EBV and ETA given an animal's performance and its pedigree.

Sire
OBJECTID
ID:Int
SIRE_SID:Str
DAM ID:STR
ANIMAL_ID:Int
SIRE_PID:Str
EBV:Num
ETA:Num

Table 4.5: The SIRE entity

Sire, the paternal parent of the animal is one of the pedigree/parental records the other being the dam(mother), an animals genetic value is got from both its sire and dam on a 50:50 basis. OBJECTID is system generated, ID is the number of the sire on the table, SIRE SID is the primary key and Provides unique identification of the sire, DAMID is the dam of the sire SIRE PID is the sire of the sire (The paternal Grandsire of the animal) while ANIMAL ID is the animal ID in the animal entity table in case the sire is registered locally with the KSB.

Dam
OBJECTID
ID:Int
DAM_S_ID:Str
ANIMALID:Int
SIRE_ID:Str
DAM PID:Str
EBV:Num
ETA:Num

Table4.6: The DAM entity

The dam details the maternal pedigree/parentage. OBJECTID IS system generated, ID is the number of the dam in the records ANIMALID is the animal Id if registered with the KSB, SIREID is the sire of the dam (maternal grandsire of the animal), DAMPID is the dam of the dam(maternal grand dam of the animal)
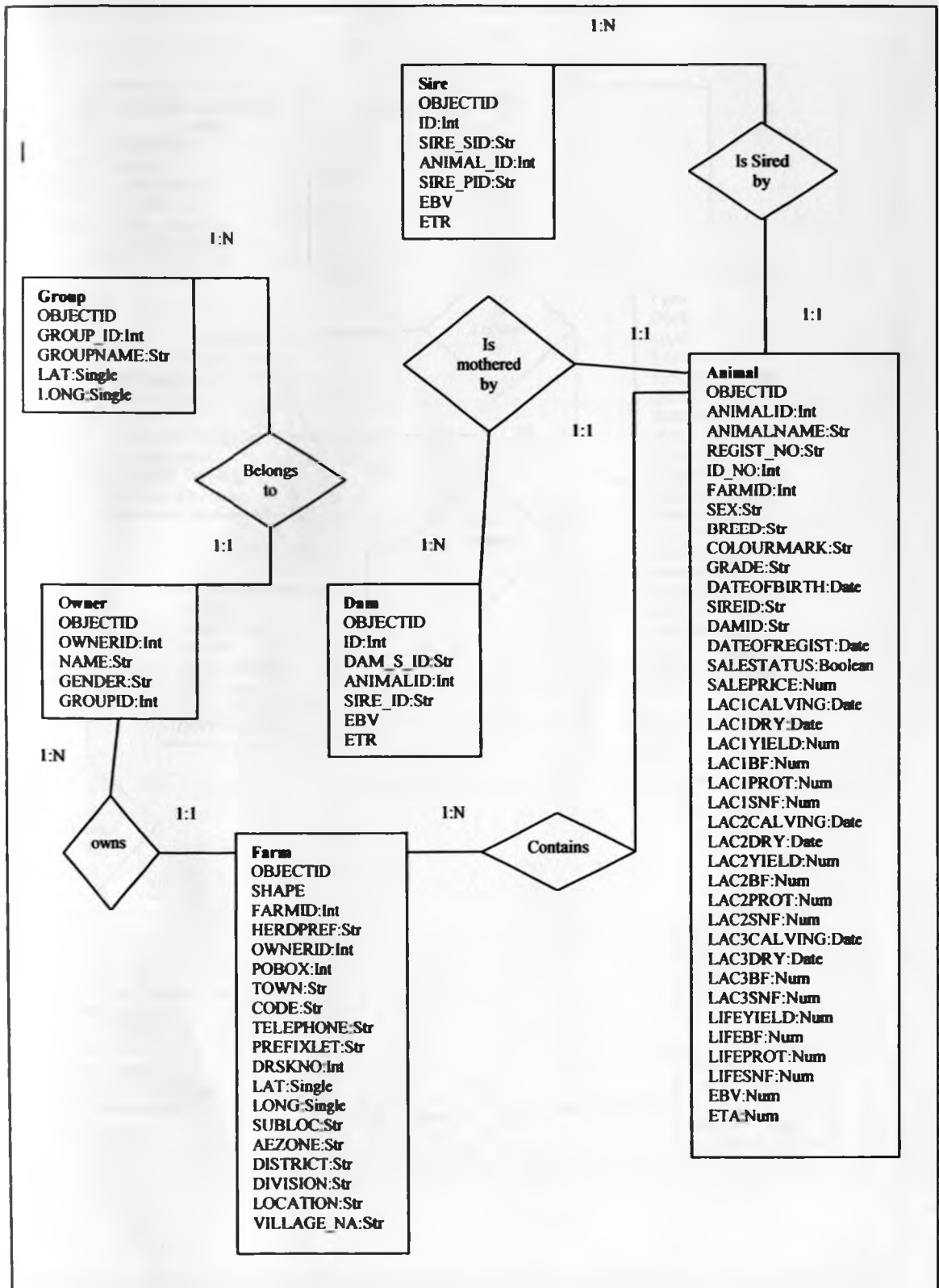
Figure4.2: E-R Diagram showing conceptual design of non spatial entities

1:N

is located in

1:1

1:N

Is Located in

AGROECOLOGICAL ZONE
OBJECTID
SHAPE
AEZONE:Str
COUNT:Int
SUM_ARE:Num
SHAPELENGTH:Num

Sublocation
OBJECTID
SHAPE
SUBLOCATION:Str
AREA:Num
PERIMETER:Num
LOCATION:Num

1:1

Is Located in

1:1

Location
OBJECTID
SHAPE
LOCATION:Str
AREA:Num
PERIMETER:Num
DIVISION:Str

1:1

Farm
OBJECTID
SHAPE
FARMID:Int
HERDPREFIX:Str
OWNERID:Int
POBOX:Int
TOWN:Str
CODE:Str
TELEPHONE:Str
PREFIXLET:Str
DRSKNO:Int
LAT:Single
LONG:Single
SUBLOC:Str
AEZONE:Str
DISTRICT:Str
DIVISION:Str
LOCATION:Str
VILLAGE_NA:Str

1:1

is located near

1:N

Village
OBJECTID
SHAPE
NAME:Str

is located in

1:N

1:1

Division
OBJECTID
SHAPE
AREA:Num
PERIMETER:Num
DIVISION:Str
Disrict:Str

1:1

is located in

1:N

District
OBJECTID
SHAPE
DISTRICT:Str

1:N

Figure 4.3: Diagram showing feature relationships

4.5 Data collection

Data collection involved getting data from three main sources:The farm, KLBO/LRC and spatial data for basic layers in the study area(which was extracted from ILRI shapefiles of different themes)

Information about the animals is reposited at the KLBO Nakuru office. These were mainly in hard copy and involved sorting and eventual entry into the database.

Farm location and group data were obtained from the field by use of GPS hand held receivers (Garmin etrex Legend). Accuracy ranged from 5metres to 25 metres (as indicated by instrument) which was adequate for the purpose of the study as it was unlikely to change farm parameters including administrative location or the Agroecological zone.

Additional materials included a computer (1 GB RAM, 1.66 Duo processor) and software in ArcGIS and ArcView 3.2.

4.6 Data base implementation

The database was designed in ArcGis and exported for implementation in an Arcview3.2 project where the tables were linked as is appropriate. Arcview offered an interphase for making complicated SQL queries compared to ArcGis though ArcGiS offered better geodatabase tools in Arcmap/Arccatalogue for managing the data.

4.7 Data base query

The created database was queried to determine whether it could meet the expressed user needs. Querying was done using feature themes as well as by using SQL. Selected queries were as follows

Query 1: Select divisions with farms that have registered animals.

Query 2: Select farms whose owners are members of group 3.

Query 3: Highlight farms whose owners are members of group 3.

Query 4: Select animals which are available for sale.

Query 5: Highlight farms that have animals for sale.

Query 6: Select animals with a lactation 1 yield of above 5000Kg.

Query 7: Highlight farms with animals with lactation 1 milk yield of above 5000kg.

Query 8: Select animals whose sires are known.

Query 9: Select farms in Nyeri, located in Agro ecological zone UM2.

4.7 Spatial analysis

This involved getting the distances by road from divisional headquarters to respective farms within the division and from divisional headquarters to some evenly picked points throughout the divisions with registered herds. This was accomplished by using a road network layer and a point's layer and by running an arcview script: Network_Distance.ave source www.arcscripts.esri.com. The two sets of data obtained were then subjected to the t test to test if there was any statistically significant difference at (P< 0.025) between the farms and the control points.

The Hypotheses to be tested were: $H_0 : \overline{X}_{farms} = \overline{X}_{control points}$
$$H_1 : \overline{X}_{farms} \neq \overline{X}_{control points}$$

Where:

$\overline{X}_{farms}$ = Mean distance from Divisional headquarters to farms.
$\overline{X}_{control points}$ = Mean distance from Divisional headquarters to control points

To evaluate the distribution of farms across Agroecological zones, the expected number of farms in any zone proportional to the area under the respective Agroecological zone. The difference between the expected and the actual number of farms was tested using the student-test to determine whether farms distribution was significantly different at (P< 0.5) from the expected distribution, other factors remaining constant.

The Hypothesis to be tested were : $H_0 : \overline{\overline{X}}_D = 0$
$$: H_1 : \overline{\overline{X}}_D \neq 0$$

Where $\overline{\overline{X}}_D$ is the mean of differences between the actual farm distribution and the expected considering Agroecological zones.

CONTROL POINTS DISTRIBUTION

20   0   20   40   Kilometers

• controlpoints
Othaya
Municipality
Mukurweini
Mathira
Kigumo
Kieni west
Kieni east
Kangema
Kandara
Gichugu

N
W   E
S
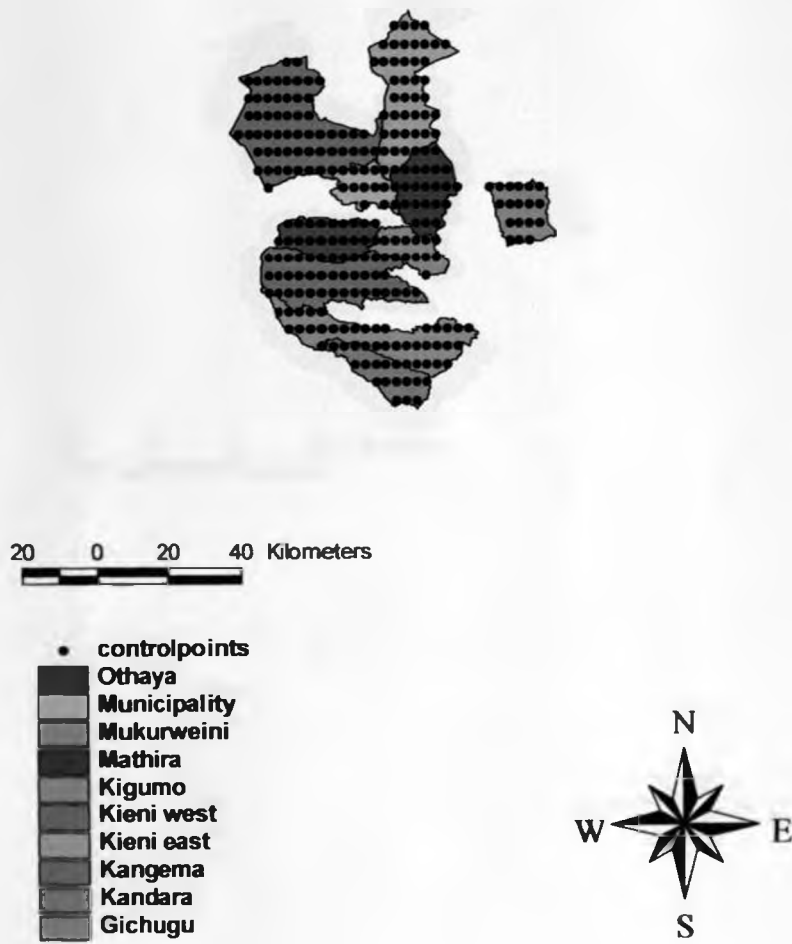
Fig4.4: Distribution of Control Points

DIVISIONS WITH FARMS

20   0   20   40   Kilometers

• Farms
Othaya
Municipality
Mukurweini
Mathira
Kicumo
Kieni west
Kieni east
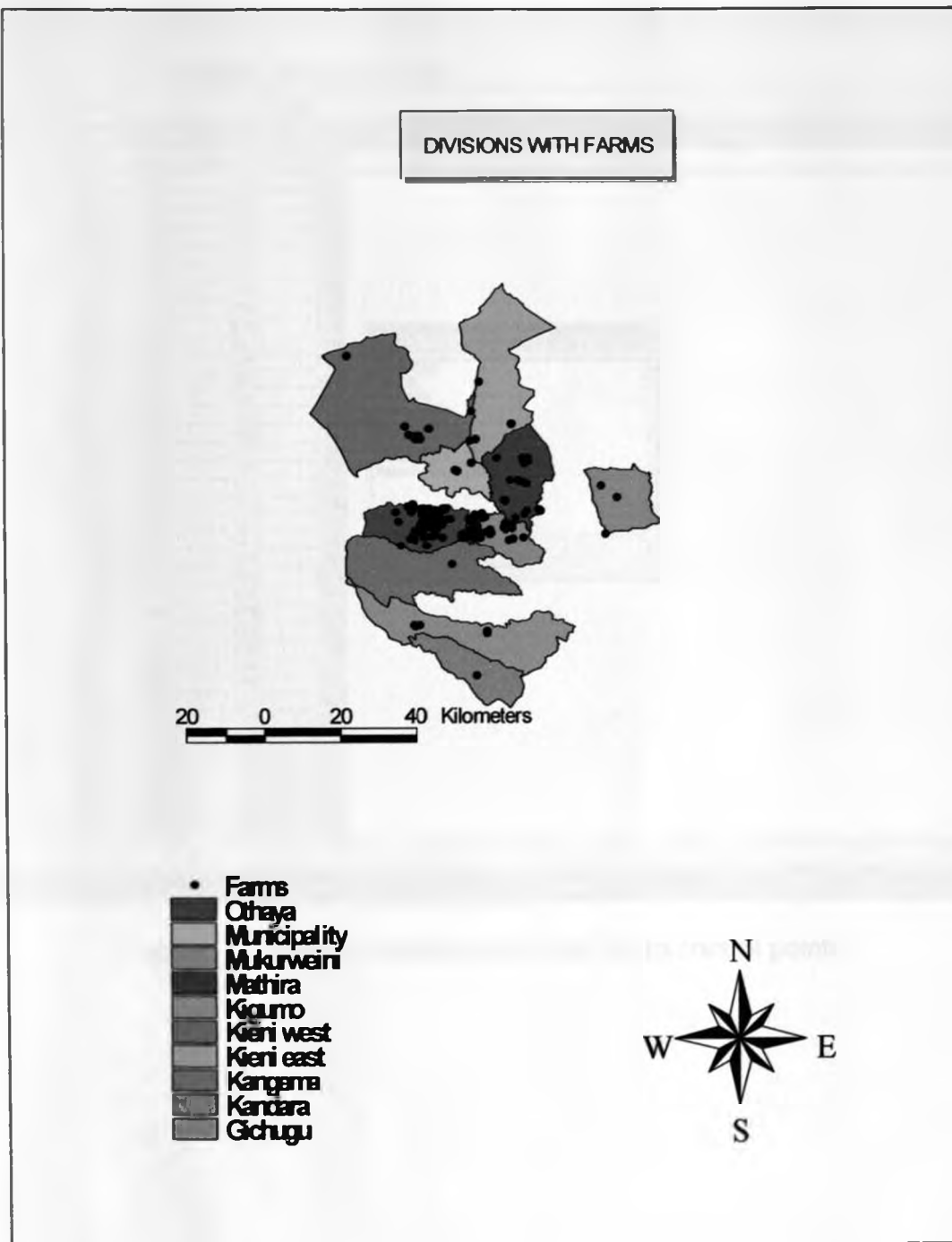Kangema
Kandara
Gichugu

N
W   E
S

Figure4.5: Distribution of farms

Table4.7: Distance Statistics from Div Hq to control points

Shape	Fam_id	Herd_prefi	Owner_id	P_o_box	Town	Code	Telephone	Email	Fax	Prefix_let	Drnk_no	Date_appli	Date_rec	Lat	Long	Tirenbi	Distance	DistDivHq
Point	4	KANJURI FARM	4	5	Mugunda		0722-254918					22/1/03		-0.152838	36.709132	2.07	0.427	42.700
Point	5	LIVE FARM	5	1	Endarasha		0722-359562					18/2/03		-0.315571	36.846993	1.69	0.080	8.000
Point	9	NYAMATI FARM	9	26	Mweiga									-0.339518	36.876481	1.66	0.034	3.400
Point	10	KIMUWA FARM	10	58	mweiga									-0.339084	36.875295	1.66	0.035	3.500
Point	11	NDEGWA FARM	11	58	mweiga									-0.341449	36.876624	1.66	0.031	3.100
Point	12	MATHARE-INI	12	23	mweiga		0721-9127207							-0.339582	36.874051	1.66	0.036	3.600
Point	13	NDIMA FARM	13	58	Mweiga									-0.342680	36.870292	1.66	0.041	4.100
Point	19	MARINI FARM	19	46	Mweiga		0722-645285					21/8/04		-0.338400	36.881309	1.66	0.029	2.900
Point	20	PARK FACE D.F	20	228	Mweiga		0721-983219					21/6/04		-0.339420	36.870645	1.66	0.040	4.000
Point	21	MOKIMA INVESTMENT	21	228	Mweiga		0721-798414										0.038	3.800
Point	22	CORNER BAYA	22	26	Mweiga												0.029	2.900
Point	23	MUGA	23	8	Mweiga		0721-550670										0.029	2.900
Point	24	MUKURWE	24	140	Mweiga		0721-613945										0.029	2.900
Point	25	KAIRINI	25	8	Mweiga												0.037	3.700
Point	27	LIVISA	27	162	Mweiga												0.034	3.400
Point	28	MUIRI	28	108	Mweiga		0721-473923										0.029	2.900
Point	29	RUKU-INI DAIRY CATTLE	29	67	Mweiga		0721-638822										0.029	2.900
Point	126	MUGANYONI	126	475	Nyeri	10100	0722-869185										0.194	19.400
Point	135	SEMA	135	26	Mweiga		0721-638822										0.054	5.400
Point	230	AMBONI DAIRY FARM	230	595	Nyeri												0.032	3.200
Point	231	MWEGA ESTATE	231	453	Nyeri												0.007	0.700
Point	98	MAZIWA	98	2409	Nyeri		0720-428333										0.280	28.000
Point	117	JAMAMU	117	475	Nyeri	10101											0.386	38.600
Point	119	KIBUBUNG1	119	475	Nyeri	10101	0726-284410										0.385	38.500
Point	120	KIRIHINYA	120	85	Naromoru		0720-225232					23/8/06		-0.310671	37.097041	1.46	0.385	38.500
Point	124	TAGWA	124	475	Nyeri	10100	0721-835969					30/8/06		-0.309521	37.100106	1.46	0.385	38.500
Point	214	JOJAN	214	142	Kiganjo		0722-818957					21/9/06		-0.345831	37.012270	1.46	0.292	29.200
Point	228	KINWARA FARM	228	383	Naromoru					148					-0.210351	37.021081	1.66	0.134	13.400
Point	100	WHIPPO	100	211	Karatina		0722-605261					31/8/05	5/9/2005	-0.528683	37.106888	1.26	0.064	6.400
Point	101	THAMBU FARM	101	99	Karatina		0733-221805					1/9/2005	5/9/2005	-0.513546	37.166020	1.12	0.062	6.200
Point	102	RIKABA FARM	102	99	Karatina		0727-711947					1/9/2005	5/9/2005	-0.513893	37.168032	1.12	0.064	6.400
Point	103	NGATA	103	1239	Karatina		0722-699888					31/8/05	5/9/2005	-0.390196	37.125728	1.30	0.103	10.300
Point	104	KARIA	104	1239	Karatina							31/8/05	5/9/2005	-0.388617	37.139213	1.32	0.113	11.300
Point	105	BUIWA	105	1239	Karatina							31/8/05	5/9/2005	-0.402862	37.130816	1.29	0.085	8.500
Point	106	MAGUU	106	1432	Karatina							31/8/05	5/9/2005	-0.351208	37.131028	1.30	0.105	10.500
Point	107	NGANYI FARM	107	1292	Karatina		0724-460334					31/8/05	5/9/2005	-0.392339	37.129412	1.30	0.103	10.300
Point	108	PATMAR	108	315	Karatina							31/8/05	5/9/2005	-0.488462	37.078968	1.26	0.059	5.900

Statistics for DistDivHq field

Sum: 1535.300
Count: 203
Mean: 7.563
Maximum: 42.700
Minimum: 0.600
Range: 42.100
Variance: 41.433
Standard Deviation: 6.437

0 of 203 selected

Table4.8: Distance Statistics from Divisional Hq to Farms

Chapter 5

RESULTS AND ANALYSIS

5.1 Results

Data was collected from 237 farms/ herds of which 203 were georeferenced. 6 groups, 237 owners, 70 animals, 9 sires and 7 dams. From the animals captured there were no available production records. Production records used in the database were simulated for demonstration purposes.

Querying of the database was done by theme and SQL in an arcview 3.2 project. The database could be queried in a GIS environment where spatial relationships include intersect , overlay,point in polygon etc.

The created geodatabase was found to be functional and can fulfil user needs.

There was found to be a significant correlation between the farms and distance from divisional Headquarters by road when compared with some control points that had been picked from the divisions that had farms with registered animals. Farmers nearer the divisional headquarters are more likely to adopt registration than those farther away.

10 out of 16 divisions in the study area had farmers with registered herd. Most of the farms were located in Nyeri.

Across Agroecological zones most of the farms were found in Agroecological zones LH1 and UM2.

There is poor followup and farmers do not progress beyond the initial registration of their animals.
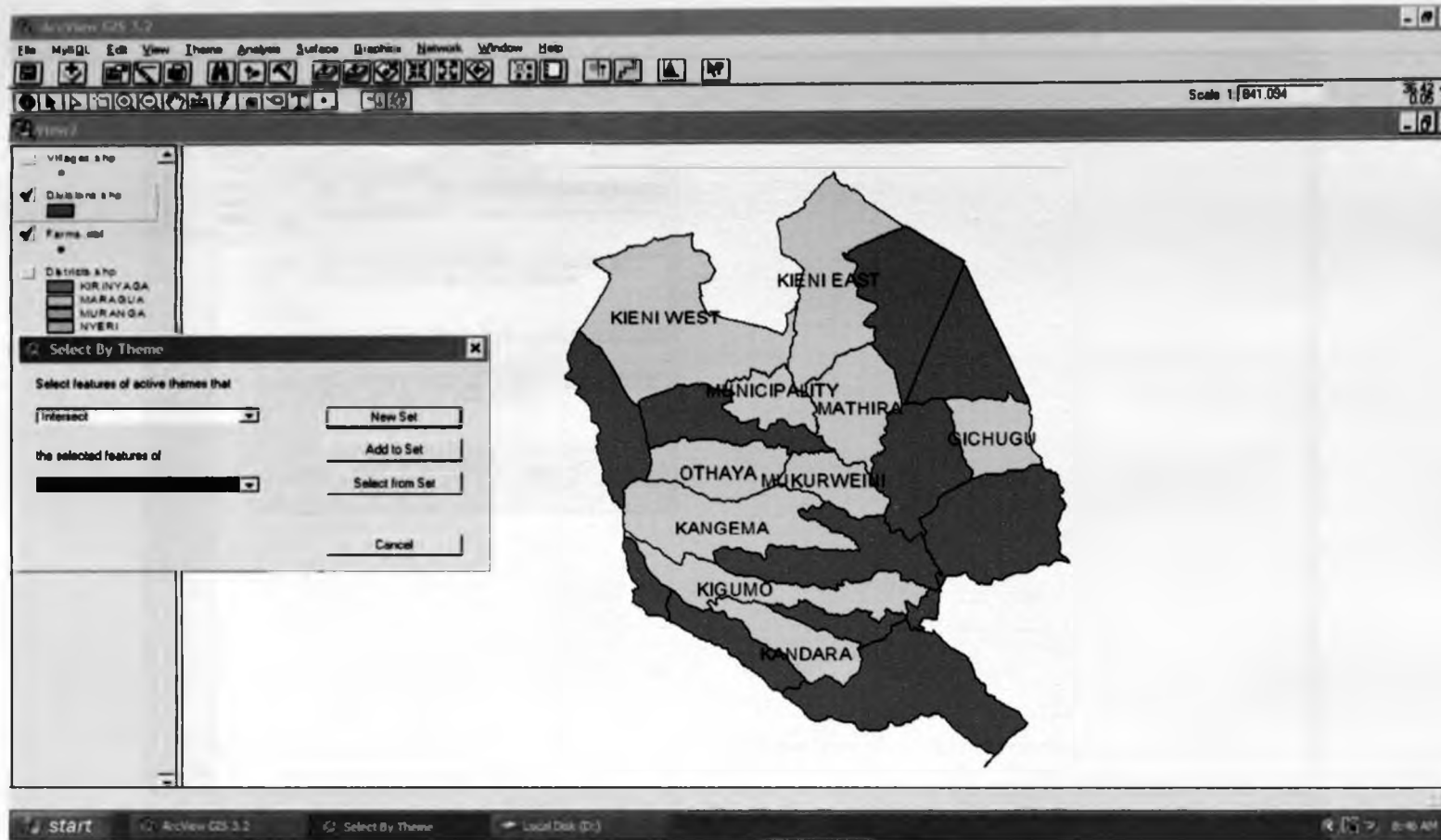
5.1.1 Query demonstration

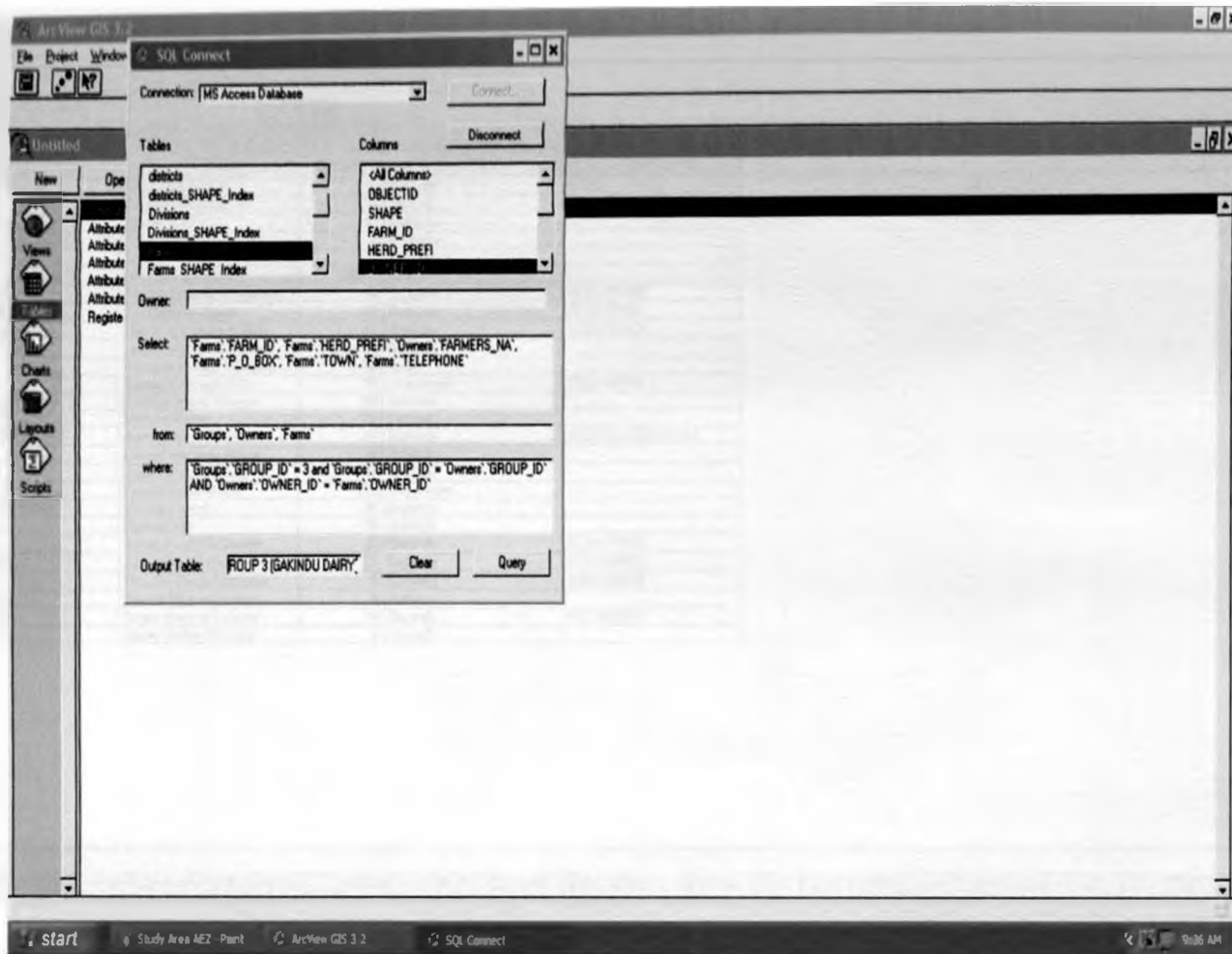Figure 5.1:Query 1:Select features of active theme(Divisions) that intersect the selected features of farms

Figure 5.2: Query 2:SQL query: Select farms whose owners are members of group3 (Gakindu dairy)

FARMS WHOSE OWNERS ARE MEMBERS OF GROUP 3 (GAKINDU DAIRY)

FARM ID	HERD PREFI	FARMERS NA	P.O. BOX	TOWN	TELEPHONE
70	MEKANGUI FARM	Masha RK Kaburi	50	Gakindu	60367
71	WAMALA	Paul Kiugi Muchiri	56	Gakindu	0722-266163
73	CHANRA FARM	Charles Karomo	57	Gakindu	
74	RUKURI	Ngunjiri Njue	1	Gakindu	
75	NGUTITI	Gichohi Nguthi	87	Gakindu	
76	GURA	Amos Waru Kariuki	28448	Nairobi	
77	KAMUNGE	Stanley Mwangi W Kariuki	62	Gakindu	0722-505442
78	JAMAGEOVI	Jane Njeri Wahome	63	Gakindu	0723-408431
79	KAGUTUINI	Dishon Wambugu Kariuki	82	Gakindu	0720-727848
80	WATHU FARM	Wilson Wanjau Wambugu	60	Gakindu	
81	KAHEHO	Boniface Murage Wanyika	64	Nyeri	
82	KAWASA	Samuel Kanyago Muta	78	Mukurweini	0722-443788
83	GATEGWA FARM	Duncan Maina Ndonga	92	Gakindu	
84	BY CHOICE	Michael Maina	21	Gakindu	
85	GOOD HOPE	Bernard Wanjohi Muguku	39	Gakindu	2032210/0722-925337
86	DOCHI	Donald Machaira Maina	39	Gakindu	
87	KAMAIRA	Joseph Ndungo Mirati	34	Gakindu	
88	WAIGUMU	Francis Muya Waya	158	Mukurweini	
89	HAKARAGE FARM	George Karega	39	Gakindu	
91	KIAGIRI	Richard Kiai	39	Gakindu	
92	UKOLE	James Muchiri Wamwea	35	Gakindu	0734-769562
93	SATHOMU	Samuel Mugo Kiragu	31	Gakindu	0720-268796
94	DALAS	Douglas Chege Machana	5	Gakindu	0722-539290
95	GATHURILI	Francis Nuguna Irungu	5	Gakindu	
96	JAMLILIAN	James Mwangi Ngechu	74	Gakindu	0721-922576
97	ESTALINA	Joyce Muthoni Wangui	4	Gakindu	

Table5.1:Query 2: Farms whose owners are members of Group 3 (Gakindu Dairy)

34

Figure 5.3: Query 3: Map highliting farms whose owners are members of group 3(Gakindu dairy)

File Edit Table Field Window Help

0 of   5 selected

DETAILS OF ANIMALS FOR SALE

ANIMAL NAM	REGISTRATI	BREED	GRADE	SALE PRICE	HERD_PREFI	DISTRICT
JANUARY	F/11756	Friesian	Foundation	70000.0000	MUTAHI FARM	NYERI
M-28	F/1149	Friesian	Foundation	65000.0000	MUTAHI FARM	NYERI
TARZAN	F/12161	Friesian	Foundation	40000.0000	JAMLILIAN	NYERI
WENDI	F/11805	Friesian	Foundation	60000.0000	KAMABURI FARM	MURANGA
KAMINI	F/12199	Friesian	Foundation	50000.0000	KAIWAI	NYERI

start   Farms owned by mem...   ArcView GIS 3.2   SQL Connect   9:58 AM

Table5.2:Query 4: animals which are available for sale
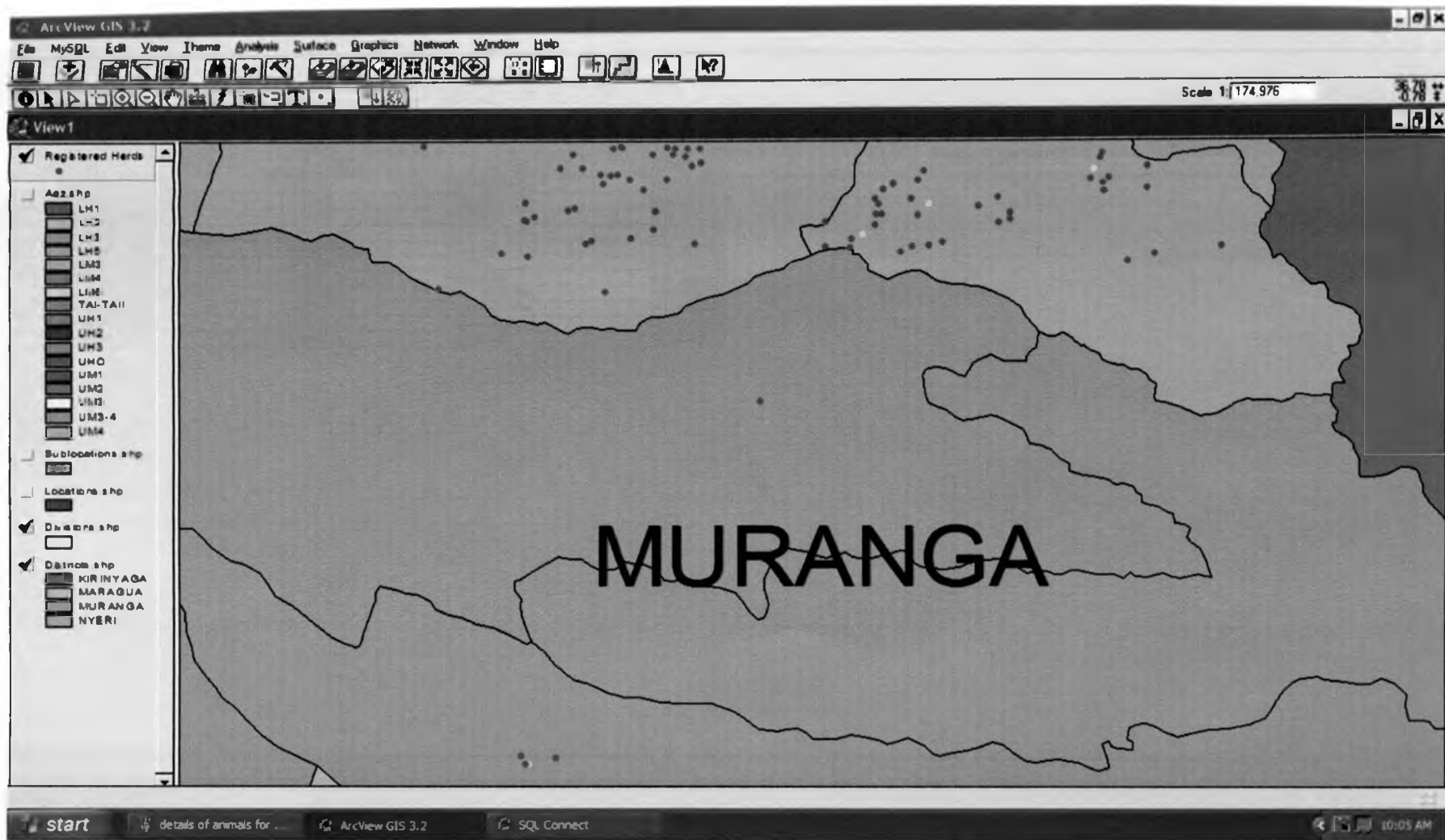
Figure5.4:Query 5: Farms with Animals for sale. (in yellow)

ANIMALS WITH YIELDS ABOVE 5000

ANIMAL_ID	ANIMAL_NAM	REGISTRATI	HERD_PREFI	LACTYIELD
15.000000	MWANZO	F/11810	GITAMA FARM	5527.000000
21.000000	GACHAU	F/12200	KAIWA	5646.000000
24.000000	MBIONI	F/12197	RUKURI	5574.000000
29.000000	JANE	A/4191 LXVI	CHANRA FARM	5453.000000
30.000000	MAXI	A/4898 LXVIII	CHANRA FARM	5706.000000
31.000000	KANINI	F/12159	GURA	5632.000000
44.000000	KANINI	I/7072	KAMAIRA	5681.000000
52.000000	MWITURIA	F/12176	WATHU FARM	5463.000000
53.000000	MENI	F/12177	WATHU FARM	5713.000000
58.000000	NDARI	I/7076	JAMAGEOVI	5311.000000
59.000000	TURI	F/870	KIRIGUINI	5523.000000

Table 5.3 Query 6: animals with lactation 1 yield above 5000kg

38
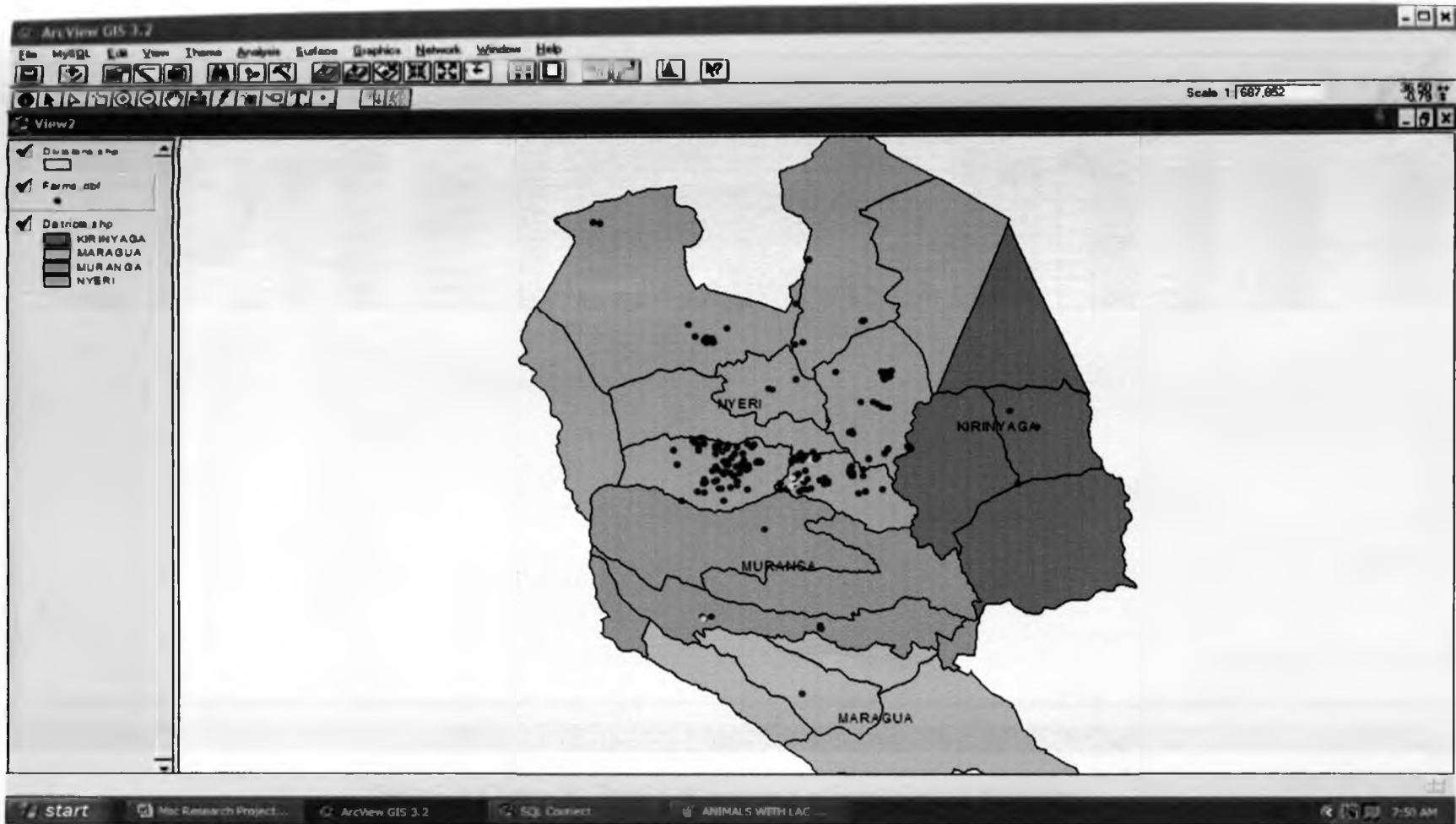
Figure 5.5: Query 7: Farms with animals producing above 5000Kg in lactation 1(Highlighted in yellow)

DETAILS OF ANIMALS WHOSE SIRES ARE KNOWN

ANIMAL	NAME	REGISTRATNO	MM	SEX	BREED	GRADE	COLOUR	DATE OF A	SIRE ID	DAM ID	DATE OF AI	S	SALE PRICE	LACTYIELD	LACTPI	LACTFP	LACTSA
13	TARZAN	F/12161	01	96	F	Friesian	Foundation	B/W	2004-05-05	MARLOW	MUIRU	2005-06-17	1	40000 0000	3360	4 500000	3 200000	7.0
14	WENDI	F/11805	01	59	F	Friesian	Foundation	B/W	2000-10-12	1	F/12160	2004-10-27	1	60000 0000	4339	5 700000	3 100000	7.0
15	MWANZO	F/11810	01	60	F	Friesian	Foundation	B/W	2004-08-21	2		2004-10-27	0	0 0000	5527	4 900000	4 100000	8.0
25	TURI	I/7069	04	74	F	Friesian	Intermediate	B/W	2004-12-09	GICHEHA RIVER RANCH MO	MENI F/12198	2005-06-17	0	0 0000	3743	3 300000	3 700000	8.0
27	MADAM	I/7069	02	73	F	Friesian	Intermediate	B/W	2002-09-02	SASAMUA HUMPHREY LIX 1	MUIRU F/12194	2005-06-17	0	0 0000	3334	3 400000	4 200000	7.0
28	RAHA	I/7070	04	73	F	Friesian	Intermediate	B/W	2005-01-18	GICHEHA RIVER RANCH MO	MUIRU F/12194	2005-06-17	0	0 0000	2429	5 500000	4 300000	7.0
29	JANE	A/4191 LXVI	03	73	F	Friesian	Appendix	B/W	2004-09-30	ADC NAMANDALA SEAWAY		2005-06-17	0	0 0000	5453	5 800000	4 300000	7.0
30	MAXI	A/4898 LXVIII		73	F	Friesian	Appendix	B/W	2006-01-13	EKE SIAWAY 15540 LXI	MADAM I/7069	2007-02-07	0	0 0000	5706	4 500000	3 700000	8.0
44	KANINI	I/7072	04	87	F	Friesian	Intermediate	B/W	2004-08-28	KAPSOEN KEBENEI 148TH L	CHARITY F/12191	2005-06-17	0	0 0000	5681	5 300000	3 400000	6.0
46	TURI	I/7087	02	75	F	Friesian	Intermediate	B/W		MARIRU EMORY KABURU L	STORIA F/12198	2005-06-17	0	0 0000	4371	5 600000	4 400000	8.0
58	NDARI	I/7076	02	78	F	Friesian	Intermediate	B/W	2005-06-10	RAY MAGIC ANOLD ET LX 1	PARCH F/12175	2005-06-17	0	0 0000	5311	4 900000	3 200000	8.0

Table5.4 Query 8: Details of animals whose sires are known

FARMS IN NYERI IN AEZONE UM2

FARM ID	HERD_PREFI	P.O.BOX	TOWN
31	BEWA FARM	13	Mukurweini
34	MUTAHI FARM	232	Mukurweini
35	DENKA FARM	22	Mukurweini
36	JOLOI FARM	302	Mukurweini
37		19	Mukurweini
38	KAWA FARM	45	Mukurweini
39	KAWA FARM	45	Mukurweini
40	LEISURE FARM	155	Mukurweini
41	OAPHEN FARM	19	Mukurweini
42	ZEJO FARM	19	Mukurweini
43	SKY FARM	56	Mukurweini
44	WAGI FARM	13	Mukurweini
45	CHAGE FARM	13	Mukurweini
46	HIGHWAY FARM	49	Mukurweini
47	GLEPA FARM	45	Mukurweini
48	HUNGURA FARM	19	Mukurweini
50	BAJARY FARM	24	Mukurweini
53	NDEWA FARM	0	Mukurweini
64	BETHANICK	24	Gakindu
65	NIA ZUA	40	Gakindu
66	KIRIGUINI	66	Gakindu
67	NYAMUGANGU FARM	48	Mukurweini
68	JOMATHE FARM	51	Gakindu
69	GAWABE	393	Mukurweini
70	MEKANGU FARM	50	Gakindu
71	WAMALA	96	Gakindu
72	KAWAI	50	Gakindu
73	CHANRA FARM	57	Gakindu
74	RUKURI	1	Gakindu
75	NGUTITI	57	Gakindu
76	GURA	28448	Nairobi
77	KAMUNGE	62	Gakindu
78	JAMAGEOVI	63	Gakindu
79	KAGUTUINI	62	Gakindu
80	WATHU FARM	60	Gakindu
81	KAHEHO	64	Nyeri
82	KAWASA	78	Mukurweini

Table5.5 Query 9: Farms in Nyeri which are in AEZ UM2

5.1.2 Spatial analysis results

	Farms	Control
Count(n)	203	268
Mean($\bar{X}$)	7.563	22.276
Minimum	0.600	0.400
Maximum	42.700	78.500
Range(Maximum-Minimum)	42.100	78.100
Variance(δ^2)	41.433	377.348
Standard Deviation(δ)	6.437	19.425
Sum	1535.30	5970.000

Table 5.6 Table showing a summary of statistics of farm distance from divisional Hq to farms and to control points

The difference is statistically significant at $t_{0.025, \infty}$ Where t_{cal} = 10.3666 while $t_{0.025, \infty}$= 2.2414

	LH1	LH3	LH5	UH1	UH3	UM1	UM2	UM4	OTHERS	TOTAL
Expected (E)	20	3	20	7	7	19	31	19	77	203
Actual (A)	65	10	12	2	4	24	80	6	0	203
I(E-A)I	45	7	8	5	3	5	49	13	77	212

Table 5.7 Table showing the expected number of farms proportionate to the area under each AEZ compared to the actual

The total of differences = 212
The Mean of differences = 23.555556
Standard Deviation = 26.69789838
Degrees of freedom (df) = n-1 = 8
Testing at 95% Confidence Interval t_{cal}= 2.647 while $t_{0.5,8}$ = 2.306
Meaning that there is a significant difference between the expected distribution of herds to the actual realized. Most of the herds, holding other factors constant, are disproportionately located in Agro Ecological Zones LH1 and UM2.

Farmers do not appear to be keen on follow-up so that they can further register their progeny as well as milk testing as none of the small scale farmers registered between 2004 and 2007 January has followed up.

5.2 Analysis of results

Through querying, the database is functional and fulfills user needs. It is possible to query the database both for spatial and non spatial information. The database can be queried in SQL, by theme or by attribute table.

Query 1: Selects Divisions with registered herds demonstrates querying by theme. This would be important in selecting administrative areas at different levels within which farms with certain characteristics are found. The search can be refined further to link or join two or more attribute tables.

Queries 2 and 3: Selects farms whose owners are members of Group 3. This would be important in case one wants to meet the farmers in a group, evaluate a group's animals and farm distribution among others. Such information would fulfill expressed needs of extension staff and other stakeholders with interest in groups.

Queries 4 and 5: Select animals available for sale and highlights in a view where the animals are located. This can be refined to include only specific animals with certain attributes for instance age, number of lactations etc. This information would be useful to direct buyers of animals and in establishing an inventory of animals available for sale.

Queries 6 and 7: Select animals with lactation 1 yield above 5000Kg. This is important for selection. Selection can be refined to include other constraints eg age, Butter fat yield, from certain regions etc. This is important for researchers, bull dams' selection, marketing etc.

Query 8: Select animals whose sires are known. A variant of this could select animals whose sires are from a certain semen provider.

Query 9: Select farms in Nyeri and in Agro Ecological zone UM2. This query can be useful in selecting farms falling in a certain environmental zone.

Since the database will be multi-user and updating is likely to be done from different users (eg,farmers updating on such issues as animals for sale, sale status and the KLBO updating on receiving information from their inspectors, while the LRC updates on milk records), the best option will be a distributed database where users can have security protocol to enable them have access to modifying their records.

Concentration of farms near divisional headquarters can be explained by the fact that it is at the divisional headquarters where extension staff are located. It would

therefore be easier for staff to visit farms near their station as well as having farmers likely to visit the Extension staff.

Different Agro Ecological zones have different potential for dairy production. Other factors include availability of a competing alternative livelihood crop in the area. It is therefore expected that farmers in areas where dairy potentially does well will be likely to adopt technologies and messages that would improve their productivity. Another factor to consider is the population density in an area. In areas where there is a high concentration of farmers there is likely to be more farmers adopting messages especially when they are mobilized in groups.

Chapter 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The objectives of the project were to:

- Evaluate the spatial distribution of Dairy recording farmers in the Mt. Kenya region and test the hypothesis that there is no spatial effect on their distribution
- To answer the question:
  - o Can GIS be used for management and decision support in aid of livestock recording?

A final outcome of the project was expected to be a prototype GIS that can be further improved to serve the dairy breeding and recording sector.

Revisiting the stated objectives, the project achieved it's purpose and can be used as a basis to develop a finer GIS for the sector.

Potential users had their needs satisfied. The developed geodatabase can fulfill spatial and non spatial information needs.

There is a spatial effect on the distribution of farmers whose cause can be determined using GIS. These would be for instance accessibility to extension staff, environmental factors, accessibility to markets and socio-economic factors among others. GIS as a tool is able to show where there are spatial trends causes of which can be researched.

A functional geodatabase of the study region is a result of the study project and can be taken up to cover other regions.

GIS can be used to assist in the management of dairy recording, herd registration and performance testing. It has the capability of integrating datasets that are georeferenced to a common point, provides a tool for visualization (geovisualization) as well as offering capability of spatial analysis using different themes.

6.2 Recommendations

It is recommended that players in dairy registration and recording adopt georeferencing. This can be ably done using hand held GPS whose price is expected to be affordable as well as investing in GIS.

From the study it is apparent that farmers far away from the divisional Headquarters are less likely to be reached. Appropriate extension methods need to be employed so as to reach all areas.

There is need to follow up on farmers who have shown interest by registering their animals so that they make the other steps of registering their offspring as well as milk recording.

The database can be developed further now that there is a working prototype that can make it easier for stakeholders grasp the issues and what mapping can offer.

Since most of the potential users have limited ICT capability so there is need to simplify the interphase with the database as to make it simpler to query such by using interactive maps. A user friendly Graphical User Interphase needs to be developed where persons with limited geospatial software skills can effectively use the database.

In database design there is need to come up with concepts where in a relational database a relationship of many to many is possible like in the case of a farmer belonging to more that one group.

Provision of basic datasets needs to be stepped up and the various data owners come up with updated datasets at various degrees of accuracies and coverage. For instance analysis of the datasets available can only be carried out at a large scale. For instance the road layer does not contain farm roads. KNSDI should be active in making spatial data sharing/provision a priority from the data owners.

Researchers can carry out studies to understand how the environment affects production. GIS opens an opportunity in that environmental data (e.g. prevailing weather conditions of temperature, humidity, rainfall, cloud cover) can be correlated with animal production data. It is possible to access even historical data for such studies. This will enable better standardization and correction for the effects of environmental influence on breeding value.

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APPENDIX 1

APPLICATION OF GPS AND GIS IN DAIRY RECORDING MANAGEMENT.

USER NEEDS ASSESSMENT QUESTIONNAIRE

SECTION I:

What is your role in Dairy breeding and recording?

SECTION II:

For Livestock Recording center (LRC), Researchers, Kenya Breeders Organization (KBO), Kenya Stud Book (KSB), Dairy Recording Service of Kenya (DRSK)

What general improvement can be made to improve the current status of dairy recording and breeding in Kenya?

What is your view on information and data and its role in running a successful dairy recording/ breeding scheme?

What information needs to be added to the existing official recording?

How is information in the official recorded herds currently stored? (Digital, Map, Hard copy, other)

Who are the main users of Official records?

What is your policy in dissemination of performance records? Is there any active dissemination eg through pamphlets, internet, advertising etc?

What impact can ICT have on information access, storage and dissemination?

What is the current reach of officially recorded herds? Is it satisfactory? What strategies can be put in place to net more farmers and herds?

How do you gauge the potential of a farmer successfully joining the official dairy recording scheme? Are there any geographical/ regional peculiarities? What are the factors?

How are dairy records management and data collection process shared between the different stakeholders? What problems are encountered? What aspects should be centralized? What aspects should be decentralized and what should be the basis of decentralization?

Of the information, what data would you want to be for public consumption and which should be private, confidential?

SECTION III:

Farmers

Have you ever sought information related to dairy performance? If so, at what level? Individual animal, Herd, Breed, Zone etc. Where did you source for the information? How accessible were the information?

In selling breeding stock, who do you inform and what media do you use?

What general improvement can be made to improve the current status of dairy recording and breeding in Kenya?

What is your view on information and data and its role in running a successful dairy recording/ breeding scheme?

What information needs to be added to the existing official recording?

SECTION IV:

Semen providers.

Where do you target your market?

What are the characteristics of areas with a high potential to use your services?

Do you use the services of any locally based Dairy Recording or Livestock registration service provider? If yes, which one? What are the information needs? Are there information needs that you would recommend for the organizations to provide? If yes, what are they?

SECTION V

Extension agents

What general improvement can be made to improve the current status of dairy recording and breeding in Kenya?

What information needs that you would require in order to serve farmers doing dairy recording?

APPENDIX 2

DATA CAPTURE FORMS

FARM DETAILS

1. Farm ID_____

2. Farm Name/ Herd prefix_____

3. District_____

4. Address_____

5. Telephone_____

6. Email_____

7. Owners ID_____

8. Group Membership _____

9. KSB Membership_____Date Joined_____

10. DRSK Membership_____Date Joined_____

11. Herd size_____

12. Coordinates

   Lattitude_____Longitude_____

13. Breeds

_____

OWNER DETAILS

1. Owner ID_____

2. Owner Name_____

3. Owners Address_____

4. Telephone_____

5. Email_____

6. Membership to Group(Yes/No) if Yes , Group's

   Name_____

ANIMAL DETAILS

1. Animal ID_____

2. Animal Name_____

3. Animal Registration No_____

4. Sex _____

5. Breed_____

6. Grade_____

7. Date of Birth_____

8. Identification Method_____

9. Colour/Markings_____

10. Sire_____Volume_____Number_____

    Paternal Grand Sire_____Paternal Grand Dam_____

11. Dam_____Volume_____Number_____

    Maternal Grand Sire_____Maternal Grand Dam_____

12. Date Registered_____

13. Breeder_____

14. Inspector_____

15. Transfer: Owner_____Date_____

16. EBV_____

17. ETA_____

18. Reliability_____

19. If for Sale (YES/NO)_____Sale Price.Ksh_____

LACTATION DETAILS

No	CalvingDate (dd.mm.yy)	DryDate (dd.mm.yy)	Milk Yield (Kg)	BF(%)	Protein(%)	SNF(%)
1						
2						
3						
4						
5						
6						
7						
8						

FARMERS GROUP DETAILS

1. Farmers Group ID_____

2. Name_____

3. Address_____

4. Email_____

5. Telephone_____

6. Coordinates

   Lattitude_____Longitude_____

7. Access to electricity (YES/NO)