FARMSTEAD PLANNING USING GEOGRAPHIC INFORMATION SYSTEM (GIS)

(FEDERAL UNIVERSITY OF TECHNOLOGY GIDAN KWANO CAMPUS AS CASE STUDY)

BY

ADEBAYO, SEGUN EMMANUEL

2001/13845EA

DEPARTMENT OF AGRICULTURAL ENGINEERING

SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

DECEMBER, 2005

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A PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B. ENG.) DEGREE IN AGRICULTURAL ENGINEERING FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGERIA.

DECEMBER, 2005

CERTIFICATION

This is to certify that this project work was carried out by Adebayo, Segun Emmanuel in the department of Agricultural Engineering, Federal University of Technology, Minna, Niger state.

....
Engr. Dr.B.A. Alabadan
Supervisor

23/12/05
....
Date

....
External Examiner

23/12/2005
....
Date

....
Engr. Dr. D. Adgidzi
Head of Department

30.12.05
....
Date.

DEDICATION

I dedicated this project to my Mum. May God prolong your days to eat the fruit of your labour.

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First and foremost I acknowledge the faithfulness of God Lord Almighty who hath shown Mercy unto me all through my course of study. Glorious Daddy I am grateful for seeing me through the thick and thin at it all. Thanks so much.

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ABSTRACT

Farmstead forms the nucleus of the farm operation where a wide range of farming activities takes place. It includes the dwellings, animal shelters, storage structures, equipment shed, workshop and other structures. For an optimum utilization of space, material, human and financial resources, effective efficient and prudent management, careful and accurate planning is necessary to achieve short and long term desired goals.

Functional planning is essential if this goal is to be realized. To realize these objectives in planning a farmstead, the Geographic Information System (G.I.S) is recommended for use in this modern digital world. It simplifies and enhances easier and faster work with better precision in terms of planning and monitoring.

The topographic, surfàce and subsurface soil classification maps and geological map of the study area were converted into a digital form which is readable by GIS software from where spatial and attribute database were created. The database were queried to get where best to place each of the farmstead which includes dwellings, animal shelters, storage structure, implement sheds, workshops and other structures.

The project was conducted to improve the methods of planning from the former analogue system to the most modern digital system. The world now has been computerized. The use of Geographic Information System is highly recommended to be used for planning of our day to day activities.

Regional and town planners, census or population experts, agricultural and educational researchers etc. the government at all levels should take the responsibilities of providing geo-referenced maps of their various areas with detailed geographical data which assist most people in different sectors to carry out researches and planning.

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CHAPTER ONE

1.0 INTRODUCTION.

1.1 What is Farmstead?

The farmstead forms the nucleus of the farm operation where a wide range of farming activities takes place. It normally includes the dwelling, animal shelters, storage structures, equipment shed, workshop and other structures. A carefully organized farmstead plan should provide an arrangement for buildings and facilities that allow adequate space for convenient and efficient operation of all activities, while at the same time protecting the environment from such undesirable effects as odors, dust, noise, Dies and heavy traffic.

A wide range of factors should be considered when planning the arrangement of buildings and services at the farmstead. Although, the immediate objective of these plans may be the inclusion of a new building in an existing farmstead, provision should be made for future expansion and replacement of buildings. In this way a poorly laid out farmstead can be improved over the long term (Noton, 1982).

1.2 Functional Planning

The majority of African farmers are small-holders who have limited resources and income and thus a low standard of living. The primary goal for most of these farmers is to produce food for the family together with some marketable surplus that can provide the income for such things as children's education and goods for personal consumption (Ruthernberg, 1980).

However, as urban populations increase, the demand for commercial crop production is turning many farmers to the goal of financial profit in operating their farm businesses. In any case, the farmer will want to make optimum use of his resources (land, labour, capital and fixed asset), in order to achieve the desired results (Dillon and Harder, 1980).

Functional planning is essential if this goal is to be realized. A good plan should provide an understanding of the situation and how it can be changed and thus assist the farmer to see his problems, to analyse them and to enable him to make soundly based decisions when choosing between alternative uses of his resources.

Clearly, a plan for an individual farm is influenced by a number of factors over which the farmer has no direct control e.g. as climate, soil fertility, government polices, stake at knowledge about agricultural techniques, and value of inputs and outputs. However, since many African small holders produce mainly for the farm household, they are only slightly affected by changes in policy and prices.

Nevertheless, national and regional rural development plans should be considered as they may provide the basis for plans for a community of farmers or an individual farm (Hardwood, 1979).

1.3 Farmstead Planning Factors

Good drainage, both surface and sub-surface, provide a dry farm courtyard and a stable foundation for buildings, A gentle slop across the site facilities drainage, but a pronounced slop may make it difficult to site larger structure without undertaking extensive earth-moving work. Adequate space should be provided to allow for maneuvering vehicles around the buildings and for future expansion of the farm operation.

Air movement is essential for cross ventilation, but excessive wind can damage buildings. Since wind will carry odours and noise, livestock buildings should be placed down wind from the family living area and neighbouring homes. Undesirable winds can be directed and reduced by hedges and trees or fences with open construction. Solar radiation may adversely affect the environment within buildings. An orientation close to an east-west axis is generally recommended on the tropics.

An adequate supply of clean water is essential on any farm. When planning buildings for an expanded livestock production, the volume of the water supply must be assessed. Where applicable, the supply pipe in a good building layout will be as short as possible. Similarly, the length of electric, gas and telephone lines should be kept to a minimum.

The safety of people and animals from fire and accident hazards should be part of the planning considerations. Children, especially, must be protected from the many dangers at a farmstead. It is often desirable to arrange for some privacy in the family living area by screening off the garden, outdoor meeting –resting places, verandah and play area.

Measures should be taking for security from theft and vandalism. This includes an arrangement of buildings so that the farm court and the access driveway can be observed at all times, especially from the house. A neat and attractive farmstead is desirable and much can be achieved towards this and, at low cost, if the appearance is considered in the planning end effective landscaping is utilized (Noton, 1982)

1.4 Geographic Information System (GIS)

A GIS is a computer system capable of capturing, storing, analyzing and displaying geographically referenced information; that is, data identified according to location. Practitioners also defined a GIS as including the procedures, operating personnel, and spatial data that go into the system.

GIS is a technology that manages, analyses, and disseminates geographic knowledge. It is a technology that is used to view and analyze data from a geographic perspective. The technology is a piece of an organization's overall information system framework.

The power of a GIS comes from the ability to relate different information in a spatial context and to reach a conclusion about this relationship. Most of the information we have about our world contains a location reference, placing that information at some point on the globe. When rainfall information is collected, it is important to know where the rainfall is located. This is done by using a location reference system, such as longitude and latitude, and perhaps elevation. Comparing the rainfall information with other information, such as the location of marshes across the landscape, may show that certain marshes receive little rainfall. This fact may indicate that these marshes are likely to dry, and this inference can help us make the most appropriate decisions about how humans should interact with the marsh. A GIS, therefore, can reveal important new information that leads to better decisionmaking.

A GIS can be used to emphasize the spatial relationships among the objects being mapped. While a computer aided mapping system may represent a road simply as a line, a GIS may also recognize that road as the boundary between wetland and urban development between two census statistical areas.

A GIS makes it possible to link, or integrate, information that is difficult to associate through any other means. Thus, a GIS can use combinations of mapped variables to build and analyze new variables. For examples, using GIS technology, it is possible to combine agricultural records with hydrography data to determine which streams will carry certain levels of fertilizer runoff. Agricultural records can indicate how much pesticide has been applied to a parcel of land. By locating these parcels and intersecting them with streams, the GIS can be used to predict the amount of nutrient in each stream. Then as steams coverage, the total loads can be calculated downstream where the stream enters a lake (Chorley, 1987).

1.5 Three Views of a GIS

A GIS is most often associated with maps. A map, however, is only one at three ways a GIS can be used to work with geographic information. These three ways are:-

1.5.1. The Database View: A GIS is a unique kind of database of the world – a geographic database. It is an "information system for Geography". Fundamentally, a GIS is based on a structured database that describes the world in geographic terms.

Data capture – putting the information into the system – involves identifying the objects on the map, their absolute location in the Earth's surface, and their spatial relationships.

How can a GIS use the information in a map? If the data to be used are not already in digital form, that is in a form the computer can recognize, various techniques can capture the information. Maps can be digitized by hand-tracing with a computer mouse on the screen or on digitizing tablets to collect the coordinates of features.

Satellite image data that have been interpreted by a computer to produce a land use map can be read into the GIS in raster format. Raster data files consist of a rows of uniform cells coded according to data values. An example is land cover classification. Raster files can be manipulated quickly by the computer, but they are often less detailed and may be less visually appealing than vector data files, which can approximate the appearance of more traditional hand-drafted maps. Vector digital data have been captured as points, lines (a series of point coordinates) or areas.

Data restructuring can be performed by a GIS to convert data between different formats. For examples, a GIS can be used to convert a satellite image map to vector structure by generating lines around all cells with the same classification, while determining the spatial relationships of the cell, such as adjacency or inclusion.

It is impossible to collect data over every square meter of the Earth's surface. Therefore, samples must be taken at discrete locations. A GIS can be used to depict two – and three dimensional characteristics of the Earth surface, subsurface, and atmosphere from points where samples have been collected (Burrough, 1986).

1.5.2 The Map View: A GIS is a set of intelligent maps and other views that shows features and feature relationship on the earth's surface. Maps of the underlying geographic information can be constructed and used as windows into the database to support queries, analysis, and editing of the information. This is called geo-visualization.

1.5.3 The Model View: A GIS is a set of information transformation tools that derive new geographic datasets from existing datasets. These geo-processing functions take information from existing datasets, apply analytic functions, and write results into new derived datasets.

Together, these three views are critical parts of an intelligent GIS and are used at varying levels in all GIS applications (Burrough,1986).

1.6 Aim and Objectives

The aim of this project is to plan a simple case study farm at the Federal University of Technology, Gidan Kwano site in Minna using Geographic Information System (GIS).

The objectives of the study are:

to convert the data gathered into digital form, and

to use the digitized data to plan the farmstead of the study are using zone planning.

1.7 Justification

Well-designed Geographic Information System has the capability of providing:

(i) Quick and easy access to large volumes of data;

(ii) The ability to select detail by area or theme, to link or merge one data-set with another, to analyse spatial characteristics of data; to search for particular characteristics or features in one area, to update data quickly and cheaply; to model data and assess alternatives; and

(iii) New and flexible forms of output – such as maps, graphs, address lists and summary statistic-tailored to meet particular needs.

The use of computers and computerized information systems has suddenly encompassed all disciplines and is becoming increasingly unavoidable. One of such systems has been variously described as geographical information science spatial information system or geo-informatics (Ayeni, 2001).

A geographic information system, (GIS) can be defined as a set of tools or system used for capturing, storing, updating, analysing, manipulating and displaying spatial data reference to the earth (Burroughs, 1980).

GIS is much more than mapping software. Maps are only one of three views of a GIS. When deployed with a clear strategy, GIS is a technology that can change an organization fundamentally and positively.

Most computer technology is designed to increase a decision – maker's access to relevant data. GIS goes beyond mining data to give you the tools to interpret that data; allowing one to see relationships, patterns, or trends intuitively that are not possible to see with traditional charts, graphs and spreadsheets.

More than that, a GIS lets you model scenarios to test various hypotheses and see outcomes visually to find the outcome that meets the needs of all the stakeholders.

The application of GIS is unlimited. It has been used to solve problems as diverse as where to place self-service coin counting machines, how to improve the yield of crops in a traditional Tuscan vineyard, or how to manage on entire city enterprise.

GIS can provide you with powerful information- not just how things are, but how they will be in the future based on changes one apply. GIS is, therefore, about modeling and mapping the world for better decision making (Ayeni, 1998).

Finally, the recent relocation of School of Agriculture and Agricultural Technology to Gidan Kwano, there is therefore a need to have a functional farmstead, and this can be easily plan using geographical information system.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Use of GIS in Planning

Basically, the sources of spatial data include analogue and digital maps, census and survey data, aerial photograph, remotely sensed images, and data from Global Positioning Systems (GPS) (Burrough, 1986).

GIS can be viewed as tools of investigation; therefore it can be used by variety of scholars from wide range of fields of disciplines. It may be used for variety of purposes, interdisciplinary and multi-disciplinary researches, investigations and planning. Academic disciplines such as geography, geology, petroleum, civil and agricultural engineering are making use of this technology. The potential users of GIS are nearly limitless. The types and users of GIS are growing at an amazing pace (Ayeni, 1998).

Agricultural Engineers may employ GIS as a spatial decision support system for surface and groundwater modeling, precision farming irrigation and drainage, water resource planning and development, image processing of food and agricultural wastes, crop weather forecasting and environmental impact assessment of projects e.g. irrigation, dams, and rural road development.

Once begin, is continuing part of farm management, adjustment and additions to our plan will reflect changes in your life and your farming operations.

Planning involves setting goals, evaluating farm and family needs mapping existing facilities, and making decisions. Typical objectives of the planning process are expanding facilities, improving performance creating greater capacity, or making better use of labour. Akintoki (1986), said that Farmstead planning includes mapping where things are and also evaluating how useful they are. Careful planning includes reviewing the present, accessing the future and providing flexibility for expansion.

2.2 Plans for the Planning

GIS planning should not be taken lightly. Forget for a moment about actually implementing a GIS. Just planning a GIS takes a commitment of resources and people.

Before planning begins, there must be a distinction between planning and implementing and that provisions are made for resources needed to make the planning happen. Making the case means understanding what needs to be done and what it will take to get it done.

Commitment to the planning process is essential to a successful GIS implementation, especially in municipal government agencies and other public-sector organizations.

A good farmstead plan helps determine the location and arrangement of new facilities to provide more pleasing appearance, allow for expansion space, minimize wasted workers times and avoid hazardous situations. Many factors determine a good plan and while some are based on common sense. Overlooking critical factors result in a farmstead that is unsafe or functions poorly. A building in a wrong place is a mistake that can have a twenty years effect on farmstead use and expansion. While there is seldom a single best plan, some plans work better than others. (Akintoki, 2001).

Good planning can help up you avoid costly errors and prevent you from having to live with poorly designed facilities or inefficiently arranged work areas. It can prevent you from trying to build on a site with poor drainages. It can also help you avoid selecting a site that will make expansion difficult or avoid dangerous access to a busy road.

Since farmstead evolve over time, careful planning is needed for a farmstead to adapt and grow over a period of many years.

In short, planning helps develop an environmentally friendly and efficient farmstead that can provide for a variety of needs, enterprises, and sizes of agricultural operations (Hardwood, 1979).

2.3 Geographic Information Systems: Functions and Equipment

Geographic Information System, usually abbreviated to GIS, is a term which first appeared in general use in the late 1960s. It is normally used to describe computer facilities, which are used to handle data referenced to the spatial domain, with the capability to interrelate datasets, to carry out functions assist in their analysis and the presentation of the results.

2.3.1 GIS Functions

Functions which are required in a comprehensive Geographic Information System have been summarized by Rhind (1981) as:

Capabilities to retrieve data for any geographical areas specified by name or co-ordinates and on any combination of attributes.

Internal decision rules to assess which operations are feasible given the data available to the system.

Facilities to transform data from one co-ordinate system to another empirical basis using control points and to transform data on the basis of global expressions (e.g. from co-ordinates in latitude and longitude to plotting co-ordinates on a specified map projection).

Facilities to update records for given geographical entities automatically by matching new and old records on the basis of a given, unique identifier creating file linkages.

Facilities to convert data in string notation into raster notation and vice versa.

Facilities to build polygons from supplied line segments. The capability is to be possible where left hand and right hand area attributes are present and where no information other than segment and points is present.

Facilities to aggregate geographical entities, their geometric representation and their attributes to larger units, on the basis of some in-built hierarchy and on the basis of an externally supplied list, irrespective of the measurement scales of attributes.

Facilities to disaggregate geographical entities and their attributes, on the basis of the overlay of other entities and specified rules for the allocation of attributes over space.

Facilities either to carry out simple statistical sampling and summation or to re-format data appropriately for a standard statistical or modeling package.

Clearly documented interfaces to allow the transfer of data to or from the system at any stage.

Capabilities to generate tabulated records, graphs, histograms etc. and to map the data at scales and with symbols specified by the user.

Capability to monitor operations and to build up a composite picture of the user so that default values for parameters are progressively and automatically adjusted closer to the appropriate values with increasing use of the system.

In addition to these functions, interactive access to the system with a graphic computer terminal is presupposed.

2.3.2 Components of a GIS

The use of a Geographic Information System with the functions outlined above involves a chain of activities from the observation and collection of data through to its analysis and use in some decision-making process. A GIS may therefore be considered to have six main sub-systems:

Data Acquisition and Input

Data Storage

Data Retrieval

Data Manipulation and Analysis

Output

System Management.

Data Acquistion and Input involves the acquisition of data in both digital and analogue form, map data for processing, digitizing and editing and the transformation of these data into a standardized pre-specified format.

Data Storage involves data formats, hardware configurations, storage media and storage structure and is closely related to the data input and to the data retrieval sub-systems.

Data Retrieval is a critical component since it directly affects the user's ability to get at the information behind the data and to structure the information to solve specific problem. Different forms of data are retrievable in different ways. Map data are structured around the cartographic objects (point, lines or areas) often configured into networks and polygons. Non-map data may consists of values for attributes (variables) ordered by entity (observation or record). Database management system are used to manage both types of data and are usually based on a data model the standard models being the hierarchical, the network and the relational.

Data Manipulation and Analysis operations are frequently embedded into a GIS, although additional capabilities can be added as modules as required. Simple analyses might involve polygon overlay, conversion to different sets of polygons, tabulation of attributes by districts, density and area tabulations and the computation of attribute means. Spatial analyses may consist of terrain analyses, trend-surface analyses, spectral analyses, network solutions, location-allocation optimization, model testing and simulation.

Output of information involves similar technology to that of automated cartography. Output may be by means of an interactive display where the user can re-specify the image on demand or by the more traditional hard copy permanent imaging devices. Commonly used devices are screen copiers, electrostatic plotters, matrix printer, pen plotters, laser plotters and ink-jet plotters. A GIS may be able to output grid cell maps, network maps, flow maps, base reference maps, isopleths map and perspective views. In addition statistical output can be displayed in the form of histograms, pie-charts and graphs.

System Management should address the requirements for evaluation and the organizational aspects of the use and effectiveness of the information transferred through the system. This includes the preservation of accuracy and the reliability of data in order to avoid the production of misleading results.

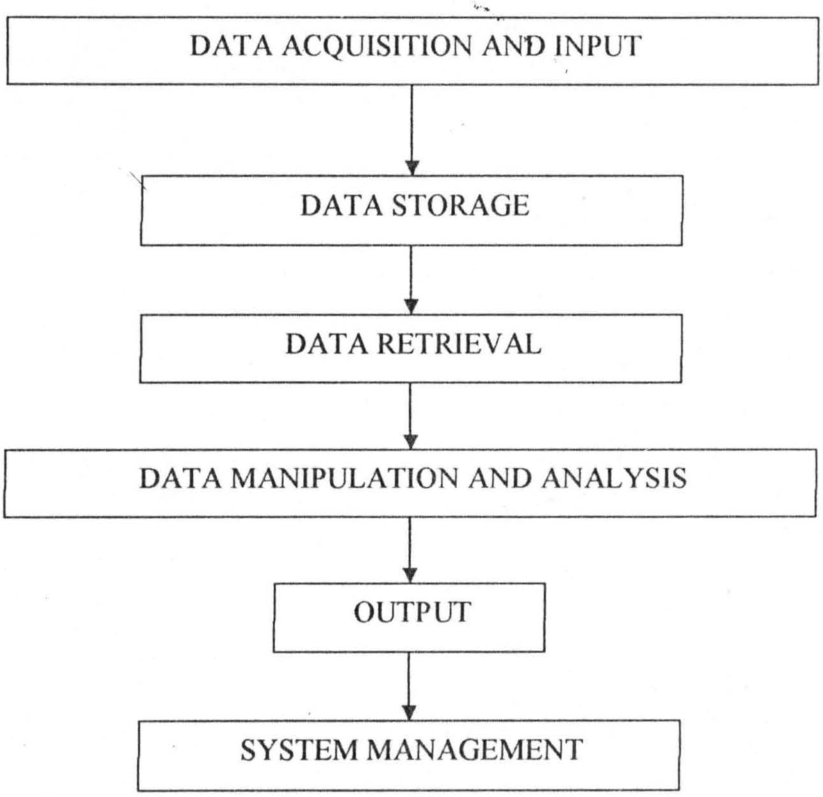


FIG 2.1 GIS COMPONENT

2.4 An Overview of Farmstead Planning

Farmstead planning usually starts with a question: Is this site or place suitable for a new livestock operation? Should the machine be remodeled? How can the grains handling facilities be upgraded? Where can we build a new dairy ban? How can we modernize our manure handling facilities? e.t.c.

At the start of the planning process, assess your short and long term needs. The analysis should include a mix of factors, including family needs as well as production and enterprise goals. A typical list might look like the following:

a Increase labour efficiency

b. Better cash flow

c. More time off for family members

d. Higher family income

e. Gradual expansion to limit risk

f. Reliance on sound business principles when making decision

g. Need to separate farm activities from living area.

Note that at some point you may need to obtain a competent and professional advice from experts to help with the planning process. Persons with farmstead planning experiences can help evaluate options and provide big picture advice to show how all the components fit together as a system. Plan on paper, where mistake can be easily corrected and seek financial advice to make a cost/return analysis and evaluate a plan feasibility of the changed involves a significant investment.

2.5 Farmstead Activities Areas

Begin by assessing the farmstead activity areas. Most farmsteads include a family living area, a shade with machinery area and an adjoining service. May also have areas for crop storage/processing chemical/fertilizer storage stores handling, fuel storage and livestock changing and developing one area often affect another farmstead area e.g. purchasing larger field machinery requires more space for movement and parking. A new or remodel may require more living area, an added enterprise requires more space.

2.6 Zone Planning

One way to plan a farmstead activities and the family living area is to use zone planning to allocate space on the farmstead for specific activities. Zone planning can be a useful tool, but it is most effective when planning a new farmstead. Using zone planning can improve overall farm efficiency, increase farm safety, future opportunities for expansion and increase control over nuisance situations.

The farmstead is divided into zones 10 to 30 meters wide by concentric circles. The larger the enterprise on the farmstead the larger the diameter the zones should be.

The advantage of zone planning is that it provides space for present farm operations, future expansion and a good living environment.

2.6.1 Zone 1

Zone 1 is for family living lawn, recreation, gardens and visitor parking. It must be protected from odours, dust, incessant field machinery traffic and other unwanted visitors by locating farm production enterprises outside zone 1.

Locating the family living area to one side of the farmstead close to the public road showing the farmstead, permits control of traffic access to the farmstead. This type of location also presents the most aesthetically pleasing view to the public. Choose a location that allows an unobstructed view of entering vehicles, machinery, livestock and people. Such a location deters theft and vandalizing and improves security. Consider locating the family living area at a separate site on very large farms with lots of outside labour and vehicles traffic, to improve privacy and safety in larger operations and office may replace the residence and serve the functions at enhancing security.

2.6.2 Zone II

Zone II is for machinery storage, a repair workshop and related activities that are relatively quite. Dry and odour free such as much of the drive way, service yard, and temporary parking space. Locate fuel storage, chemical handling and other more hazardous activities in the outer part of the zone II, away from the family living area.

2.6.3 Zone III

Zone III contain grain/feed storage structures and smaller livestock units, activities that have more frequent noise, dust, traffic and odour, but which require careful supervision. Locate the electric power distribution centre, propane storage, and temporary anhydrous ammonia, wagon parking either in the outer portion of zone II makes sure that no tall metal equipment will be used in the vicinity of over head power lines.

2.6.4 Zone IV

Zone IV is for major livestock enterprises needing more expansion space and facilities for feeds and manure management. Large source of noise, dust, odours and traffic are placed in this zone. They should be the farthest from the house and from public road and neighbours. The location of farmstead with respect to public roads affects the living area (zone I) and overall farmstead layout. In the upper mid-west, the preference is to have the driveway enter the farmstead from the South or east. This arrangement allows for an undisturbed free windbreak along the west and north to protect the farmstead from snow and prevailing winter winds yet allow prevailing south westerly winds to freely enter the farmstead in summer.

2.7 Separation Distance

Closely spaced building interfere with too much space, however, wastes labour and increases utility and road cost and yard maintenance effort, so deciding in separations distances often involves compromise. Separation distances between farmstead buildings and between the farmstead and off farm features depend on a wide variety of factors. Following one several guidelines:

2.7.1 Operation Size: Heavy and larger operations create more noise, odours, dust and traffic, thus require greater separation distance from the farm house and from the off farm feature e.g. a feed centre for processing a few bushels a day will have less impact on the living area than one handling large grain volumes and large vehicles. The smaller feed centre can be closer to the farm house and to other buildings than the large operation.

2.7.2 Management Needs: Locate high labour facilities closer to the farm centre than those that require less labour.

2.7.3 Potential Pollution Hazard: Livestock operation results in odour, dust and noise from large livestock operation can often be detected half mile or more down wind consider combined influence of other neighbour and the types of operations on a neighbouring farm. Chemical, fertilizers, pesticides and fuels can cause air and water pollution problems if improperly handled, so facilities for handling of these materials must have adequate separation from other elements on the farmstead.

2.7.4 Appearance: A neat and attractive farmstead is very important. Facilities that are near the living area, and visible from the public roads should be well landscaped and have a pleasant appearance. Locate less attractive materials farther away.

2.7.5 Ventilation Needs: Large, naturally ventilated livestock buildings (more than 30m wide or more than 60m) require at least short clearance; both provide and downwind to prevent blocking air current . (75ft is mostly preferred) for security concerns may dictate even greater distances to minimize disease spread.

2.7.6. Water Supply: To protect the well, spring, or surface water supplies from potential sources of contamination, they must be separated from sources and activities that could cause contamination. In most cases at least a soft separation is needed to protect the waste source from contamination, but some states or local jurisdiction may require (100 – 300ft) or more.

2.7.7 Access Need: Separate all buildings by at least 35ft is being for bid to allow for access, for removing and storing snow and for fire protection.

2.7.8 Future Expansion: Assume that your operation will double in size over the next 10-20 years provide adequate space for new buildings, enough space for adequate clearance between buildings and space for other expansion. Consider space needed for vehicle access and parking. To ensure adequate space for future expansion developed a drawing of the existing farmstead that includes that expansion (perhaps dotted in). Farm size plays a major role in farmstead planning.

In addition to the amount of space involved, the size of a livestock operation affects farmstead planning e.g. doubling the number at livestock affects the needs for water, drainage, space for feeds and equipments storage and access routes. It also increase nuisances such as dust, odour and noise of farm factors to be accounted for in planning the expansion of an operation including zoning, environmental regulations, set backs and neighbour/and consumer attitudes.

Farmstead planning also depends on enterprises type a green farm requires less farmstead space than a green and livestock farm. Also, noise and dust from harvesting, transporting and processing cash green occurs on relatively few days each your and has less impact on a farmstead than those daily livestock processing and handling.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Project Site

3.1.1 Site Location

The Federal University of Technology Gidan Kwano site is located about 12km along the new Minna – Kataregi – Bida road. A stretch of 12.8km of this site actually borders the Minna – Bida road. This starts from the Minna and at km 74 and moves out of the road at km 62. The site is a horseshoe shaped stretch lying in a near North/South direction between latitude 9°26'15" and 9°37'30" N and longitude 6°21'15" and 6°28'45" E with the arms pointing West.

The site is bounded to the North by the Western railway to Lagos, Maikunkele railway station 11km away and 16km from Minna and the link main road F126 passing through Minna to Tegina. To the North east is the Shadna hill, the new Minna International Airport and the Maikunkele hills. To the entire east there is the Minna to Bida main road stretching along the site for 12km.

There are villages immediately across this main road for the 12km and some of these include; the new Gidan Kwano, Dan Zaria, Gidan Panti and Garatu. There is the Garatu hill actually within the site at the tail end of the South east. There is also the Dagga hill and the Dagga River at the south-West. Immediately next to the site at the West is an agricultural land strapping the middle part of the site. There is also another agricultural piece of land adjacent to the sire in the South. There is also to the North-West the Kpaina hill that actually starts within the sire and continues beyond. There's also a twin PHCN high tension line running from the North-West to the North-East from Kainji to Shiroro within 5km of the site but outside (Adesoye,1986).

3.1.2 Land Area.

The site covers an area of 10,600 hectare. This area takes the shape of a horseshoe. The site is therefore, in three sections defined by the shape.

It has been stated that the middle portion of the site lies along the Minna – Bida road for 12km. This is the only side of the site directly in contact with the main road. To the northwest of the F126 passes quite close to the site by a railway level-crossing providing another possible land for the site. The Northern arm of the site is about 5km across, while the Southern is yet another 5km across. Running from the North to the South along the central axis, the Northern strip is about 7.5km, likewise the middle strip while the Southern strip is only about 5.5km long. These three pieces combine to form the double elbow-like strip of about 20km long north south.

When this is compared to the present land area of Minna town about (1000ha) the University site is about 10 times bigger than the present town. Out of this total area of 10,600ha, 8,600ha was estimated as the total land area compensated for either as part of the village settlement or farm lands. There is an estimated total area of about 42.03has with natural constraints. Out of this, about 35ha or 83% is rock outcrops mainly granites and gneisses (Adesoye,1986).

3.2 Materials

The materials used in undertaking this project work are:

1. Topographic map of Federal University of Technology Gidan Kwano, Minna.
2. Surface soil classification map of the same site.
3. Sub-surface soil classification map of the same site.
4. Geological map of the same site.

All the above maps were collected from the Physical Planning of the Works Department of the Federal University of Technology Minna, Niger state,

3.3 Methods

3.3.1 Data Conversion

The Topographic, Surface Soil classification, Sub-surface Soil classification and Geological Maps acquired were converted into digital format using Tablet Digitizing. This was done by placing the analogue maps acquired on a digitizing table which has an orthogonal net of embedded wire that is sensed by a cursor as it passes overhead. The resulting electrical impulses are converted into a measurement of position of the cursor on the board, which was transmitted on the screen at the Visual Display Unit.

The data were converted into digital form for the following reasons:

1. To enable users to relate their own digital data to topographic features (e.g. a gas main to the edge of a building).
2. To aid selection of other data for analysis and presentation (e.g. all addresses within 50m of a water hydrant or the shortest road routes between points).
3. To facilitate the manipulation or linkage of other data sets.

3.3.2 Spatial and Attribute Database Creation

The data collected were converted into digital form readable by GIS software. The topographic map and other maps were converted into digital format through scanning and on-screen digitization and geo-referencing. The purpose of geo-referencing the digitized map was to establish the relationship between the ground co-ordinate system and the software coordinate system.

Theme layers were created according to their specific characteristics in order to distinctively differentiate and analyse the thematic features. The layer concept is helpful since it reminds us that many geographical features in the study area overlap with one another. By these principles features that are similar in property are group under the same layer e.g. geological features, rock outcrops, roads, drainages, built-up areas, boundaries, soil type etc.

The database created was made up of spatial and attributes. The spatial talks about the location and distribution of features while attributes refers to the specific properties of the features such as the size, length, height, distance with respect to another.

3.3.3 Linking Data Sets

The data sets were linked together so as to be able to build a query that will facilitate the decision to be made concerning planning of the farmstead of the study area.

Surface soil classification was linked with some topographic features such as road network of the area, drainage pattern, and built-up areas. Also the sub-surface soil classification was linked with topographic map to aid decision making.

It was discovered that an important feature of applying Information Technology to the handling of spatial data is the ability to link data sets; that is, to merge and compare different area for the same location. This makes a Geographic Information System an analytical and decision making tool fundamentally different from a paper map. It is the ability to manipulate readily and quickly large volume of data for the same areas which has the potential for adding great value to spatial data.

3.3.4 Digital Map Data

The handling of digital map data introduces special problems because there was a fundamental distinction between the digital representation of cartographic data and its paper form. In the digital form, there was a requirement to encode information explicitly where as in graphical form many details such as where the edge not a river may coincide with a boundary are implicit. A second distinction between the traditional map and its digital representation was the need to encode numerically the attributes of the cartographic data which are normally conveyed to the reader of the printed map by colour, line weight symbol or labels. This can be done in a number of different ways; without governing standards a variety of incompatible schemes would undoubtedly arise.

3.3.5 Database Query

Simple queries were performed on the linked dataset using Arc view 3.1 query builder. The query syntax, the spatial and the tabular results are captured together in the figures corresponding to each query. The highlighted items in these figures are the query results.

A database query was built for the following to assist in farmstead planning decision. For decision-making, the following database query was created for each of the under listed to take decision for the best area to choose.

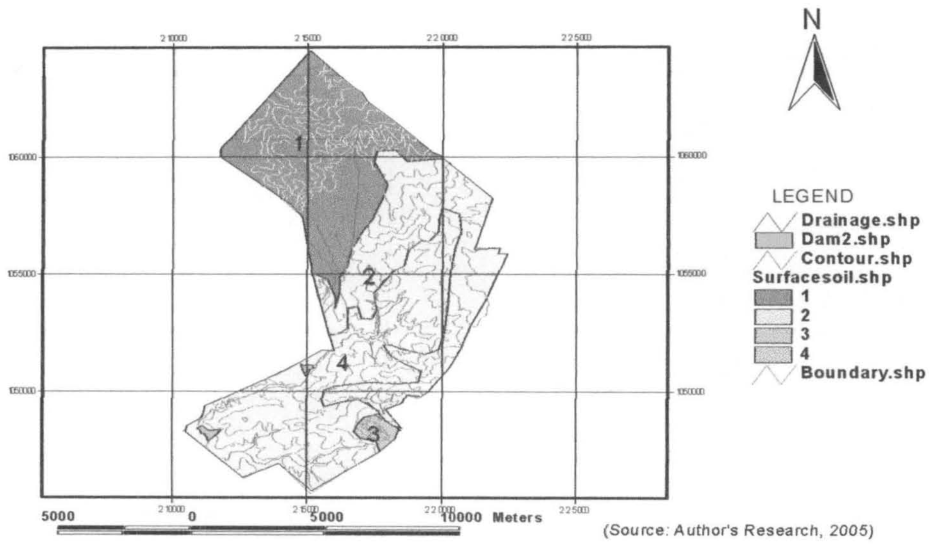
For farmhouse:	area>= 280m interval
	area close to main road.
For road:	soils having clay sub soil
For crop:	area<= 200m interval
For livestock house:	Direction of prevailing wind direction

CHAPTER FOUR

RESULTS AND DISCUSSION

Result and Discussion

The maps of the area under consideration are shown in the following figures below:-



(Source: Author's Research, 2005)

Figure 4.1 Surface soil classification map.

The surface soil classification is classified into four:-

a). 1 – Minna Association

b). 2 – Minna Association

c). 3- Isolated granitic Association

d). 4- Malaji Association.

The general soil map of the study area shows broad areas called associations that have distinctive five patterns of soils, reliefs, and drainage. A soil association consists of one or more major soils. The soils making up one unit occur in other units but in different patterns.

The surface classification of the study area is as follows:

1 Mapping Unit A: (Minna Association)

The soil is deep, nearly level to gently sloping, high physiographic position, well-drained and moderately well-drained soil that have a clay loam surface and subsurface.

This association is on a broad surface developed on undifferentiated basement complex consisting mainly of granitic rocks and some gneisses.

Generally, the soils are deep and brownish in colour. The surface soils are greyish brown (10 Y hue), they are medium-or-fine-textured. Soil reaction ranges from slightly acid to slightly alkaline; total nitrogen is low, available phosphorus is medium; cation exchange capacity is very low to low; exchangeable calcium is very low to low; exchangeable magnesium is moderate and exchangeable potassium and sodium are very low.

2 Mapping Unit B: (Minna Association)

This is deep, nearly level to gently sloping, middle physiographic position, moderately well drained soils. Surface texture ranges from sandy loam to clay. The subsurface layers are dominantly sandy loam.

This soil is found south of Unit A and is quite extensive. It is similar to the soil described Unit A but because of its position, it receives more water in the form of surface runoff from the higher areas.

The soils are deep. The surface soils are olive in colour and the subsoil is olive yellow (2.5 Y hue), with high chromate. Soil reaction ranges from neutral to slightly alkaline, total nitrogen varies from medium to high, cation exchange capacity is very low and exchangeable potassium is very low.

3 Mapping Unit C (Malaji Association)

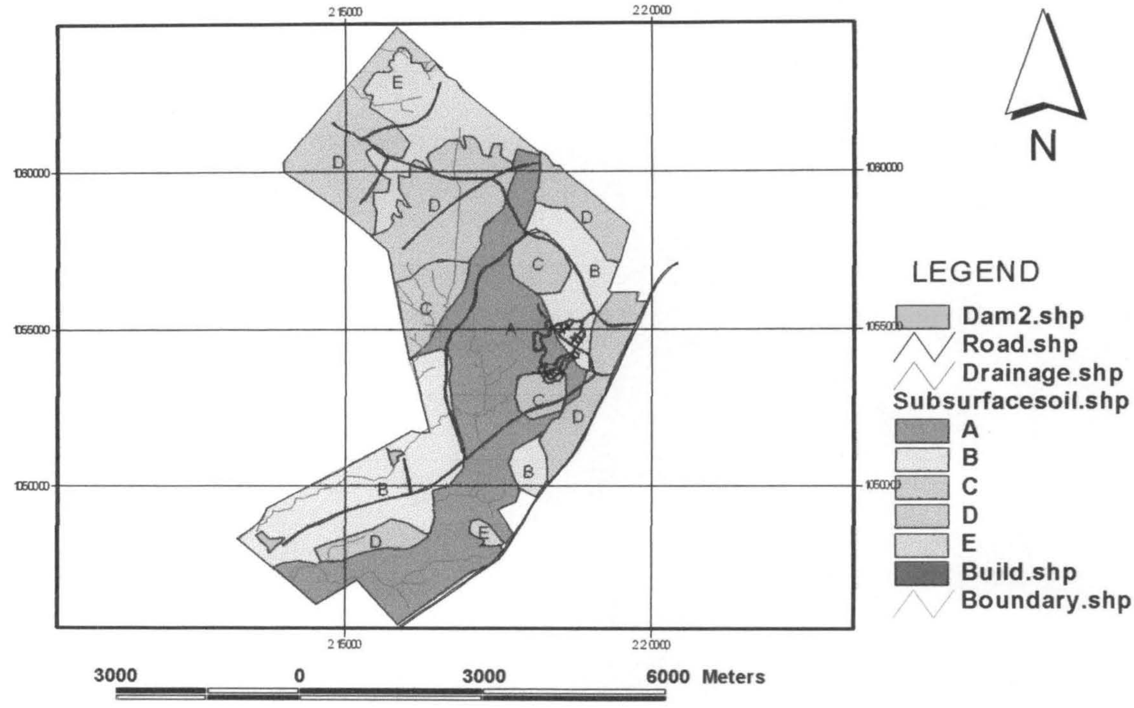
These soils classification are deep, nearly level to gently sloping, low physiographic position. Soils of mapping Unit C occur on slightly dissected plains with moderately low inter-flues. The soils are developed from colluvial materials of older granites of basement complex rocks.

The soils are moderately well structured, have friable to firm consistency. Textures are generally clay loam over clay with yellowish red mottles.

Soil reaction is generally neutral. Organic matter contents are moderately to very high, total nitrogen contents are generally very low; available phosphorus varies from moderate to high; exchangeable potassium and sodium vary from very low to low.

4 Mapping Unit D

This unit is mainly isolated rock outcrops that are lithic to paralithic.



(Source: Author's Research, 2005)

Figure 4.2 Sub-surface soil classification map.

The sub-surface soil classification is classified into five.

a). A – 4

Clayey Silty soils.

b) A – 6

Clay soils.

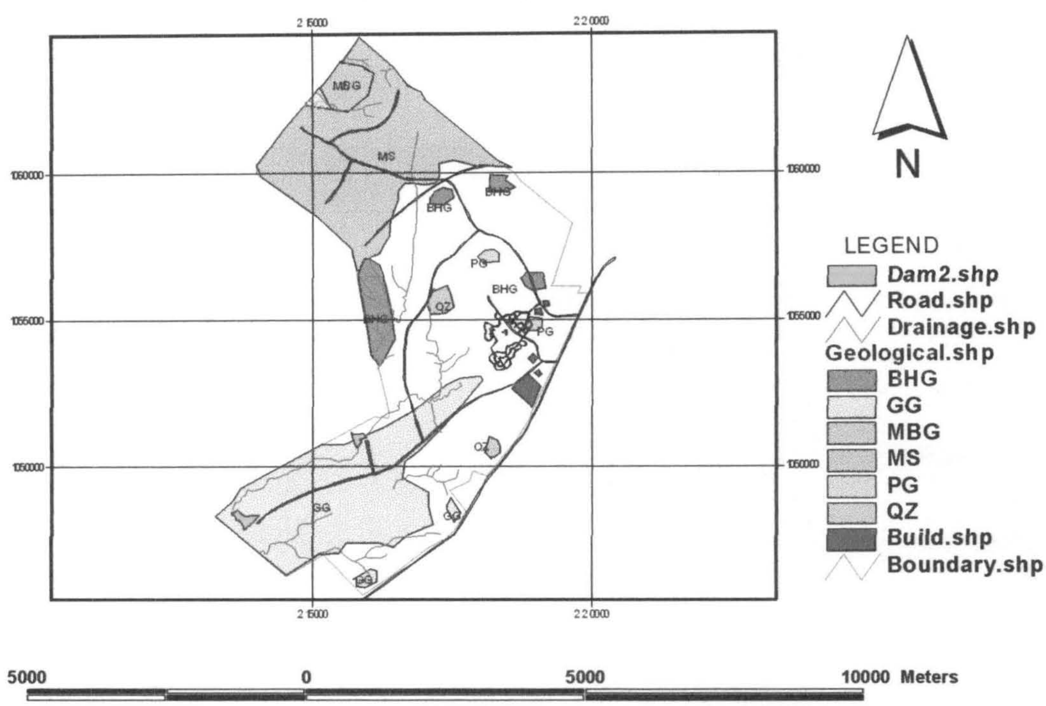
c) A – 7 – 5

Soft Clayey soils.

d) A – 2

Silty or Clayey gravel or Sand.

e) Hills.



(Source: Author's Research, 2005)

Figure 4.3 Geological map.

The map is classified into:

i) Mica Schist (MS)

ii) Granite Gneiss (GG)

iii) Muscovite Biotite Granite (MBG)

iv) Pegmatite (PG)

v) Biotite Hornblende Granite (BHG)

vi) Quartz Vein (QZ)

The entire area has a lot of outcropping stones especially granites and gneisses. The granites are potential targets that can be quarried as aggregates for major construction works on the site. However, the biotite-hornblende granite variety has a peculiar disadvantage as aggregates particularly for road construction because of structural weakness association with the foliations and the aligned biotite and hornblende minerals in it. The more massive and resistant biotite – muscovite granite occurring as low ridges and hills in the northern part especially, and as scattered occurrences elsewhere on the site will provide competent aggregates for civil engineering works.

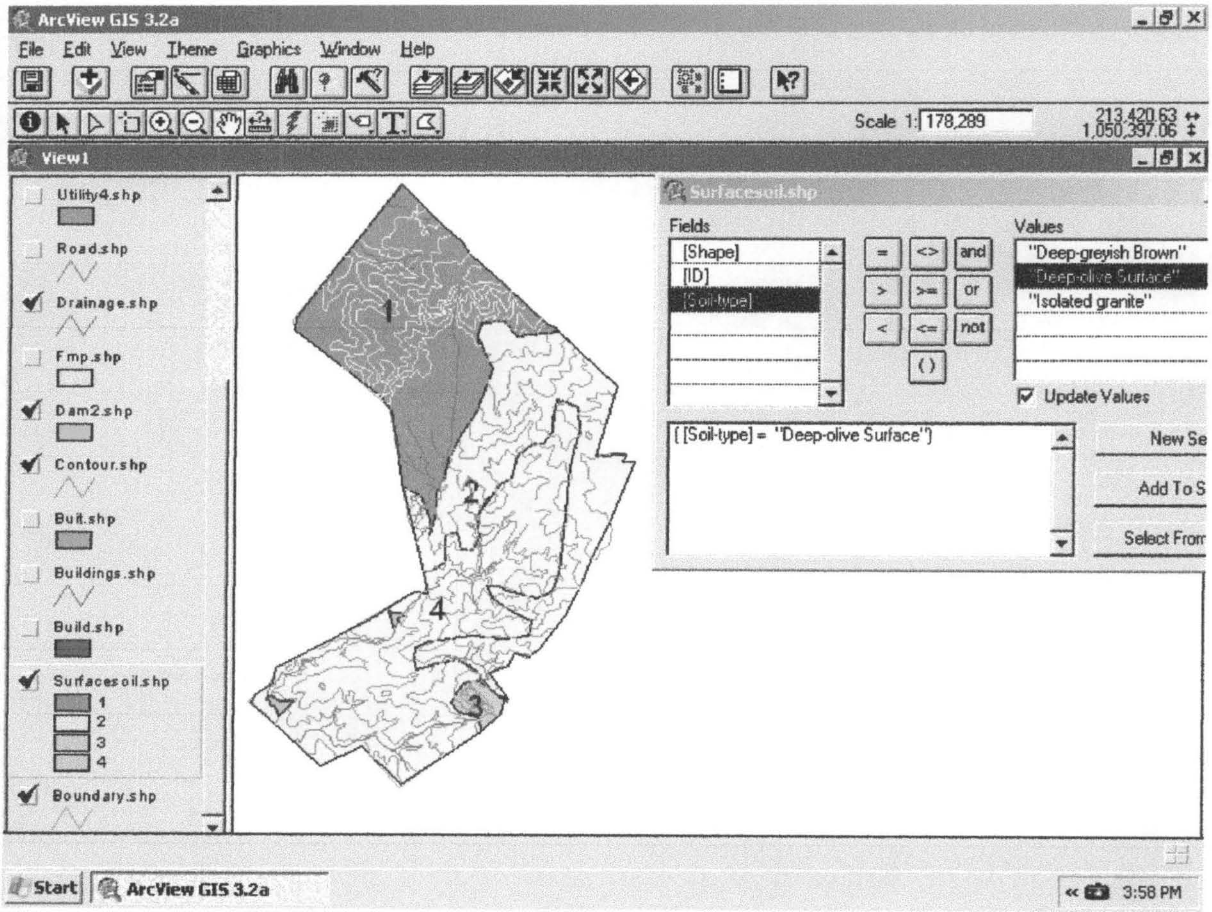
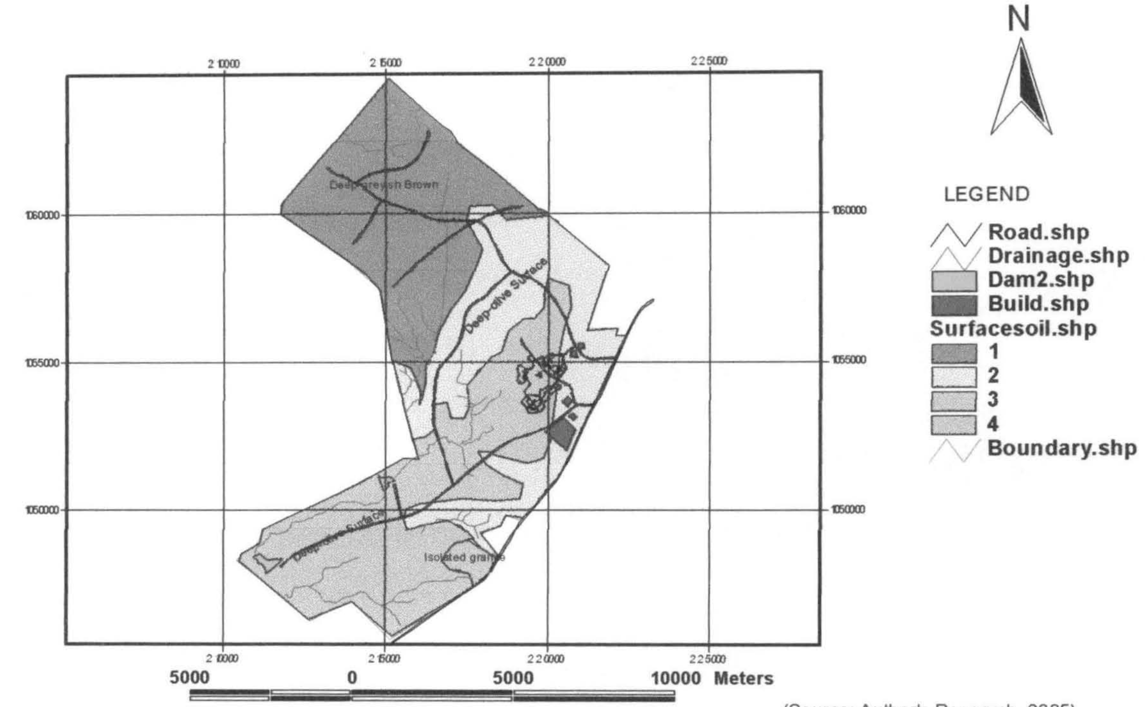


Figure 4.4 Surface soil classification and query dialogue box for soil type.

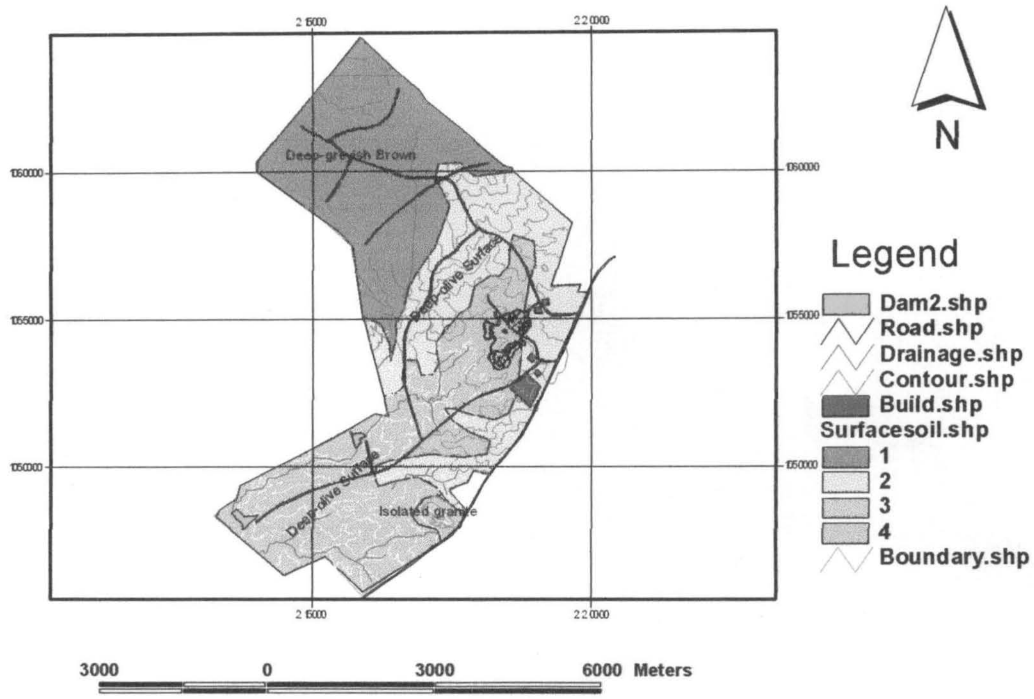
The soil type query was built up in a manner that it reflects the soil ability to support the crops that will be planted on it. It was observed that soil type 2 and 4 from the map will serve this purpose better.



(Source: Author's Research, 2005)

Fig 4.5 Surface soil classification and some topographic features.

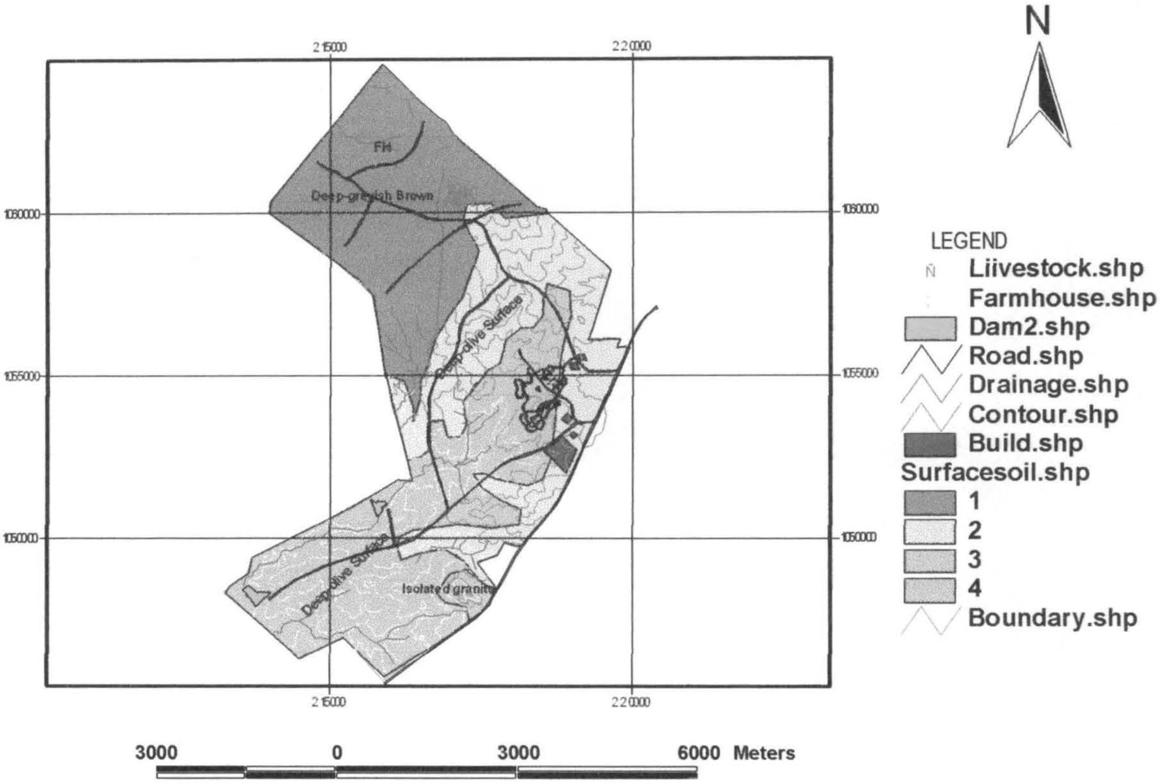
The surface soil classification with some topographic features which include road networks, drainage, reservoirs and built up areas.



(Source: Author's Research, 2005)

Fig 4.6 Surface soil classification and query for area suitable for rice production.

The query was built in such a way that it took into consideration the soil water needed for rice production and access to road network for easy transportation of input and produce to and from the farm.



(Source: Author's Research, 2005)

Fig 4.7: Farmstead plan of the study area.

The design was based on the aforementioned criteria discussed on section 2.5. The soil type, elevation, wind direction, proximity to road network, safety and security were taking into consideration. Room for future expansion of the farm enterprise was also taken into consideration in planning the farmstead.

The distance between the farm house and that of animal shelter was measured and it was 2.6km. The farm house was located on high elevation (area >= 280m interval). The animal shelter was sited down the wind direction to prevent the dwellings from undesirable effect of odour. The upper region was discovered to support the farmstead. While the lower region was good for crop production.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The project was conducted to improve the methods of planning from the former analogue systems to the most modern digital system. The modern world now has been computerized. Every aspect of human endeavour has been further simplified by the use of modern technology i.e. the use of computers.

With the use of GIS in farmstead planning it was discovered that many information can be assessed and compute many different data, query and analyse them, get prompt solution and take decisive decisions.

Similarly, farmstead planning is possible and much easier and faster by using geographical information systems (GIS) which are just a form of modern computerized information technology (IT). The GIS simply gather the geographical data of the place, such as the topography, hills, rocks, valleys, lakes, streams, rivers, soil types, rainfall, climate etc. all over one may to enable the user take fast decisions of where to place what and how to do. Using GIS further simplifies the problem of looking for suitable positions to recommend for planting crops or trees, where to put to buildings, water treatment or storage tanks, structures, shop etc. digitized maps can enable us decide the proximity of a place to urban centres, markets, airports or seaports electricity and communication networks. Adequate planning gives allowances for future expansion.

It was discovered that the northern part of the study area was well suitable for siting farmstead which include dwellings, animal shelter, storage structure, implement shed, workshop and other structures required on the farm as a result of the surface soil and the sub-surface soil available in the area. While the southern part of the study was found to be suitable for crop production because of the availability of the water and the soil type.

5.2 Recommendations

Necessary action should be taken to check soil erosion. Sediments which cap the surface soils occur on the middle to lower slope which occupies a greater percentage of the area. The sediments limit soil aeration, soil micro-biological activities and productivity. It has been observed that if the soils are exposed, water erosion is prominent during the initial rains, and wind erosion when the soils are dry.

Soil conservation measures should be implemented and ridging should follow the contours as closely as possible. These practices, if properly followed will check erosion.

The result of the soil test shows that the nutrient status is low. Calcium Ammonium Nitrate (CAN) should be used as a source of nitrogen. Single super phosphate should be used as a source of phosphorus. Muriate of potash (MOP) should be used to supply potassium, and magnesium sulphate should be used to supply magnesium, especially if hybrid maize is to be grown.

The use of Geographical Information System is highly recommended to be used for planning of our day activities. Regional and town planners, census or population experts, agricultural and education researchers etc. the government at all levels should take the responsibilities of providing geo-referenced maps of their various areas with detailed geographical data which assist most people in different sectors to carry out researches and planning.

The use of GIS in planning farmstead in the field of agriculture is thereby recommended for policy maker if there must be food security to cater for the teeming masses.

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