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Application of Remote Sensing and Geographic Information System in Parcel Mapping for Irrigation Farm Scheme in Pampaida Millenium Village, Ikara, Kaduna State, Nigeria

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Abstract: This study used the techniques of remote sensing and Geographic Information System to map farm parcels in irrigation farm scheme of Pampaida Millenium village, Ikara, Kaduna state Nigeria with a view to showing the efficiency of the techniques in mapping and database creation. The findings show the different crop types, the farm sizes, distances of the farms to irrigation canal and farm owner profile in a database format, which is a data retrieval method based on location and attribute. This was done to identify the exact position of the farms from the canal within a 150 m buffer corridor, which is a convenient and affordable distance for peasant farmers to channel water to their farms during the dry season and to further assess the vulnerable extent of the farms in event of a flood disaster.

Key words: Canal, farm parcel, GIS, irrigation, remote sensing

INTRODUCTION

The concept of parcel mapping goes as far back as ancient China, Egypt and Babylonia (Goodwin, 1994). In colonial North America, the most common techniques of keeping track of land ownership were surveying and deed registration, but not actual parcel mapping. As a result, prior to 1950 most towns in New England referenced land parcels within the town by Register of Deed's book and page numbers, subdivision map, or record plan rather than depicted groups of adjoining parcels on detailed maps. Since then, mostly due to increasing property values and rapid development, towns began to realize the importance of having accurate parcel maps and they started to invest in this area (Goodwin, 1994).

It is the proposition of this guide, that parcel maps are reference tools and do not replace deeds or record plans and the legal conveyance of a property either by boundary, dimension, or ownership. The utility of a parcel map is that it allows for easy identification of where a property is located relative to public ways and adjacent properties. For planners, assessors, and engineers it provides a construct to aid in the evaluation of proposed subdivision, compliance to local zoning, expansion of municipal utilities, and as a tool for managing the tax assessment process. A parcel map is perhaps the most convenient resource available to the public to determine the location and parcel identification number of a property.

An adequate parcel map should reflect size and shape of each individual parcel owned in a town. Many town officials (assessors, planners, engineers, and others) use parcel maps on a daily basis, that is why it is very important that parcel maps should show the most current and updated information. Development of computer technologies along with Geographic Information Systems (GIS) created opportunities to conduct this study more efficiently. It is much easier to store, maintain and update a digital map than an analog paper map. Digital parcel mapping also simplifies the process of locating the information about any of the parcels and markedly reduces time necessary for making changes and printing new copies of the maps on paper.

Irrigation farm management is fast becoming a blue print for agricultural development and generally, an aspect of natural resource management in most parts of the country today. The knowledge of the land use and hydrology of an irrigation path is important for its planning and management. Assessing the land use potential and conservation needs can help in planning for alternative uses that will maintain the quality of the land and water. Jain (2001) posited that irrigation farm management implies rational utilization of land and water resources for optimal and sustained production with the minimum hazard to natural resources and environment.

Perumal *et al*. (1997) and Jain (2001) suggested that the success in planning developmental activities of irrigation farm depends on the quality and quantity of information available on the natural primary production systems (interaction among the basic resources of land, water and vegetation) and socio-economic resources. This knowledge will allow efficient and effective generation of development plans showing new land use practices that would be suitable in the watershed. This will assist in

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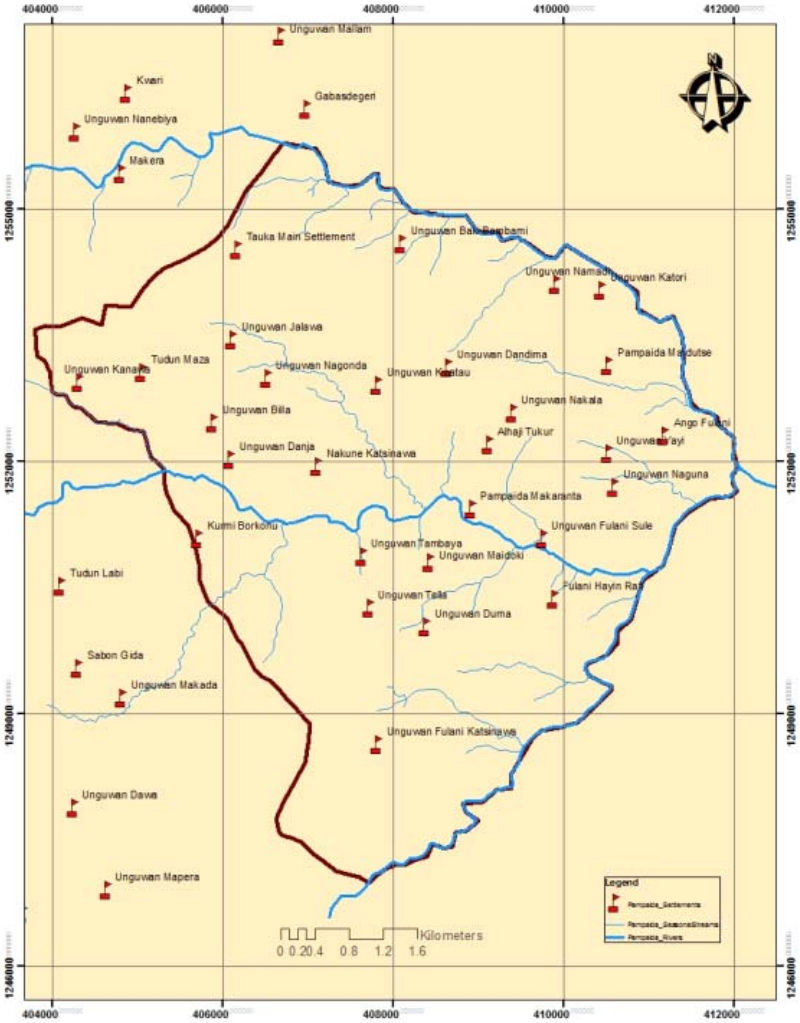

Fig. 1: Map of the study area

achieving and maintaining a balance between resources development to increase the welfare of its population and resource conservation to safeguard resources for future exploitation and to maintain ecological diversity, both for ethical reasons and as an assumed prerequisite for the survival of mankind.

Agriculture has been identified as a critical component in successful attainment of the Millennium Development Goals (MDGs) by all nations (Benson *et al*., 2008). This is because all the goals have link with agriculture. But the current global food crisis and the upward trend in global food prices in the last quarter of this decade makes it a dream in Africa and Nigeria in particular. African continent have all it takes to combat poverty and food insecurity in the environment. The land is blessed with human and natural resources and vast agricultural potential. It has 23% of the world's land of which less than 25% is cultivable and not more than 5% is irrigated (FAO, 1988). Food and Agricultural Organization (FAO, 1988) estimated 9.5 million Ha of African land to be under irrigation and Sudano Sahelian region accounted for 2.3 million hectares. At least 65% of the economically active population of Africa is currently engaged in agriculture. Yet, hunger and poverty are ravaging the land and militating against the dream of achieving the MDGs (FAO, 1988).

Nigeria has one of the best agro-ecology to grow variety of crops. The country is endowed with an environment characterized by fair to good soils. Nigeria's cultivable land has been estimated to about 71.2 million hectares but less than 50% is put to use due to water constraint (Aremu and Ogunwale, 1994).

With 77% of her population engaged in agricultural activities, yet the nation is facing food crisis. The situation is so critical that the nation has become a food deficit country. For example, importation of consumer goods

increased from N662,884.58 million in 2002 to N756,849.36 million in 2004 and N2, 086, 152.06 in 2007 (CBN, 2007).

However, modern irrigation technology has offered the opportunity to cultivate more land all the year round. Irrigation farm management is fast becoming a blue print for agricultural development and generally, an aspect of natural resource management in most parts of the country today. The knowledge of the land use and hydrology of an irrigation path is important for its planning and management. Assessing the land use potential and conservation needs can help in planning for alternative uses that will maintain the quality of the land and water. Jain (2001) posited that irrigation farm management implies rational utilization of land and water resources for optimal and sustained production with the minimum hazard to natural resources and environment.

The Pampaida irrigation resources such as Land, Soil, Vegetation and Water are facing threats posed by unsustainable depletion, poor farming practices, indiscriminate utilization of resources, resource conflict between Nomads and settlers and farm boundary issues among others as a which are as a result of lack of knowledge on basic scientific practices, use of manual tapes for farm size measurements and yield estimates, farm location, profile of farm owner, and possible vulnerability of these farms to flood.

The study specific objectives are therefore to identify the distribution of the farm parcels, parcel sizes, crop types peculiar to each parcel, distances of the parcels to the irrigation canal and the various owners of the parcels through the creation of a robust database.

Pampaida is found in Ikara Local Government Area of Kaduna state, it is located on 8º6′ E, 11º16′ N (Fig. 1) with a broad low lying topography and extensive mash land for fadama farming. It is a crest land which has a water shed that feed most of the tributaries of river Bambami. It lies within the northern guinea savanna of Nigeria, and receives an annual rainfall of 1,500-2000 mm, which last for about 6-7 months and sometimes starts at April or May and end in October. This town has an average temperature of 26ºC. Pampaida consists of primary and secondary roads and footpaths for transportation of good.

The place is dominated by Hausa-Fulani whose major occupation is farming and livestock (rain-fed farming) and also the cultivation of millet, sorghum, onions, tomatoes, pepper and ginger. A good percentage of the people engage in agro-based commercial activities with the main market located at the major roadside. The main economic activities are: agriculture, small scale industries such as blacksmith, milling and mud block construction. Pampaida has a nucleated settlement in remote areas as dispersed settlements structure in other parts of the town. Most of the houses are made of mud blocks, corroded zinc roofs, thatched roofs and in some compound we can find silos built of mud blocks for storage of harvested food crops. The variation in housing depends on the people's social class. We can find places for religious worship like churches and mosques.

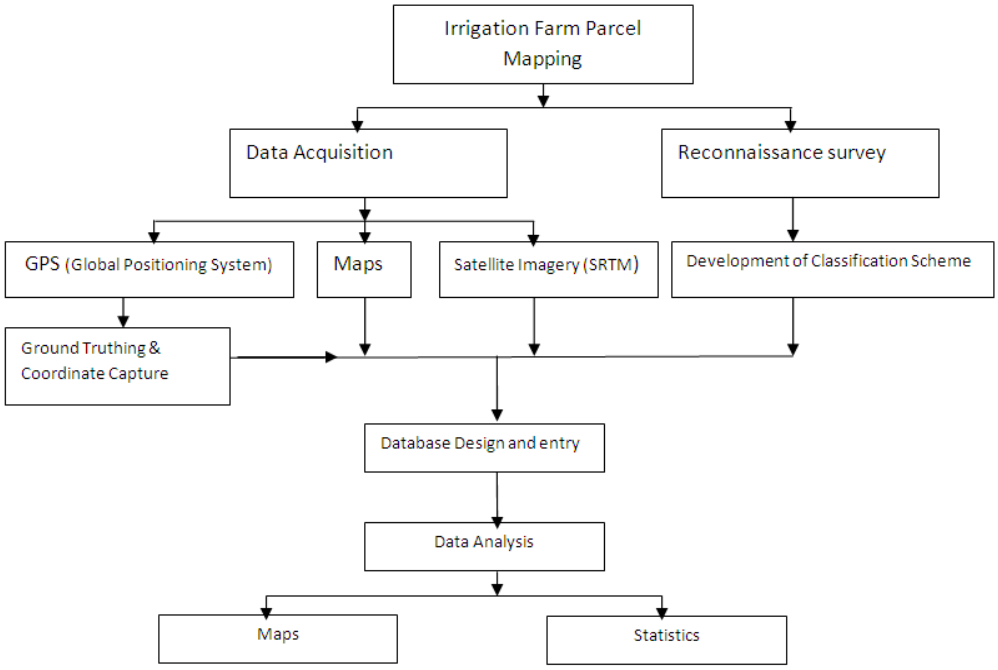

Fig. 2: The research framework

MATERIALS AND METHODS

This study was carried out in Pampaida Millennium village, Ikara, Kaduna state of Nigeria in 2009 and the methodology used is as shown in Fig. 2.

The framework above is a schematic guide to a stepwise means of achieving the irrigation farm parcel mapping and database creation. The stages involved are:

Stage 1: involves data acquisition using both GPS (Global Positioning System) to capture absolute locations of the study area. Field survey is done alongside to ascertain the information on the satellite image and map.

Stage2: At this stage, classification is done to distinguish the different attributes to be established such as farm parcels and irrigation canal.

Stage 3: At this stage, a database is design to collate and manage the data captured. It is further linked with the map to bring out the basic representations that are set as the basic objectives of the project in form of maps and statistics.

For the study, SRTM (Shuttle Radar Topographic Mission) satellite image of Ikara for the year 2009 was acquired from Global Land Cover Facility (GLCF) an Earth Science Data Interface. 0n the image, a notable feature can be observed which is the presence of Rivers Duku, Bambami and Karai.

The local government boundary map and Nigerian Administrative map was also obtained from Ministry of Lands Survey and Country Planning, Kaduna. These were brought to Universal Transverse Marcator projection in

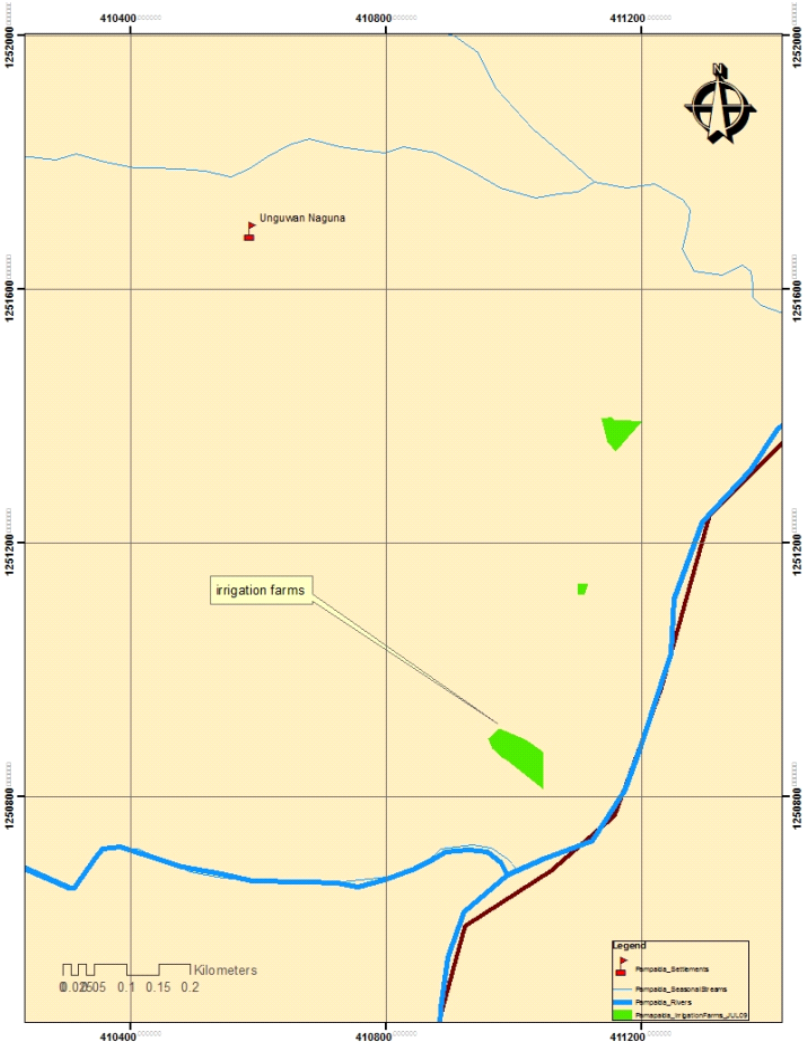

Fig. 3: Map of the study area showing canal and irrigation farms (GIS analysis)

zone 32. ILWIS 2.2 software was used for displaying and subsequent processing and enhancement of the image. Arc GIS 9.2 software was also used to compliment the display and processing of the data, database design and analysis using SQL (Structured Query Language) for data query. The DNR Garmin GPS was used for point data collection in the field.

RESULTS AND DISCUSSION

After all the processes mentioned above, the GIS method then identify and map the irrigated farm parcels and the irrigation canals in the study area for the year 2009 as shown in Fig. 3.

Figure 3 shows the full length of the canal that provides seasonal water source for irrigation farming, the green parcels are the irrigation farms cultivated by the local inhabitants, these farm parcels range from tomatoes, through pepper to onions.

The GIS analysis also determined the proximity of farm parcels to the canal as shown in Fig. 4.

Figure 4 shows a 150 m buffer corridor on both sides of the canal, this was done to determine proximity of farm parcels to canal and to further determine the average distance required to channel water to the farms during the dry season for sustainable production. This buffer corridor also provides information on vulnerable farm parcels in event of flood disaster.

The various farm sizes and the crops in them were also identified and displayed in Table 1. Table 1 shows the different crop types and the corresponding farm sizes. Farm A has the largest size occupying 58.09296508% of the total land mass with tomatoes as its primary crop type; farm B is 37.36208224% large with pepper as its primary crop type while farm C occupied 4.544952683% area coverage with onions as its primary crop type.

The GIS analysis also helps to develop a farm database system that will identify the crop types, farm owners and distance from the canal. This is as shown in Fig. 5.

Figure 5 shows a farmer profile output generated from the database designed to manage irrigation farming

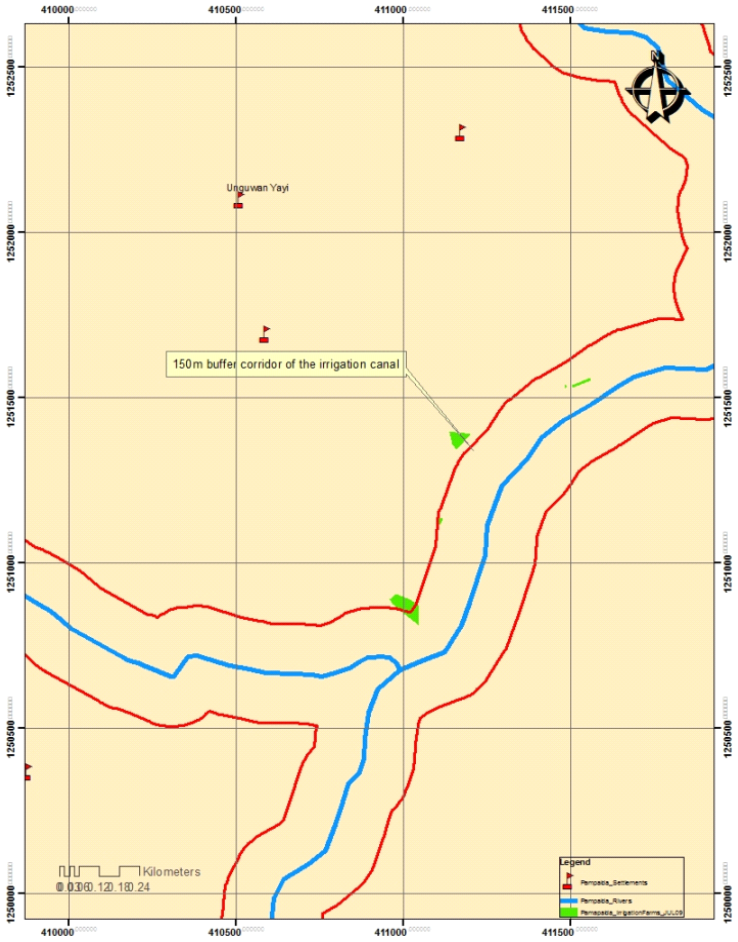

Fig. 4: Map of the study area showing 150 m corridor of canal identifying farm parcels within the proximity (GIS analysis)

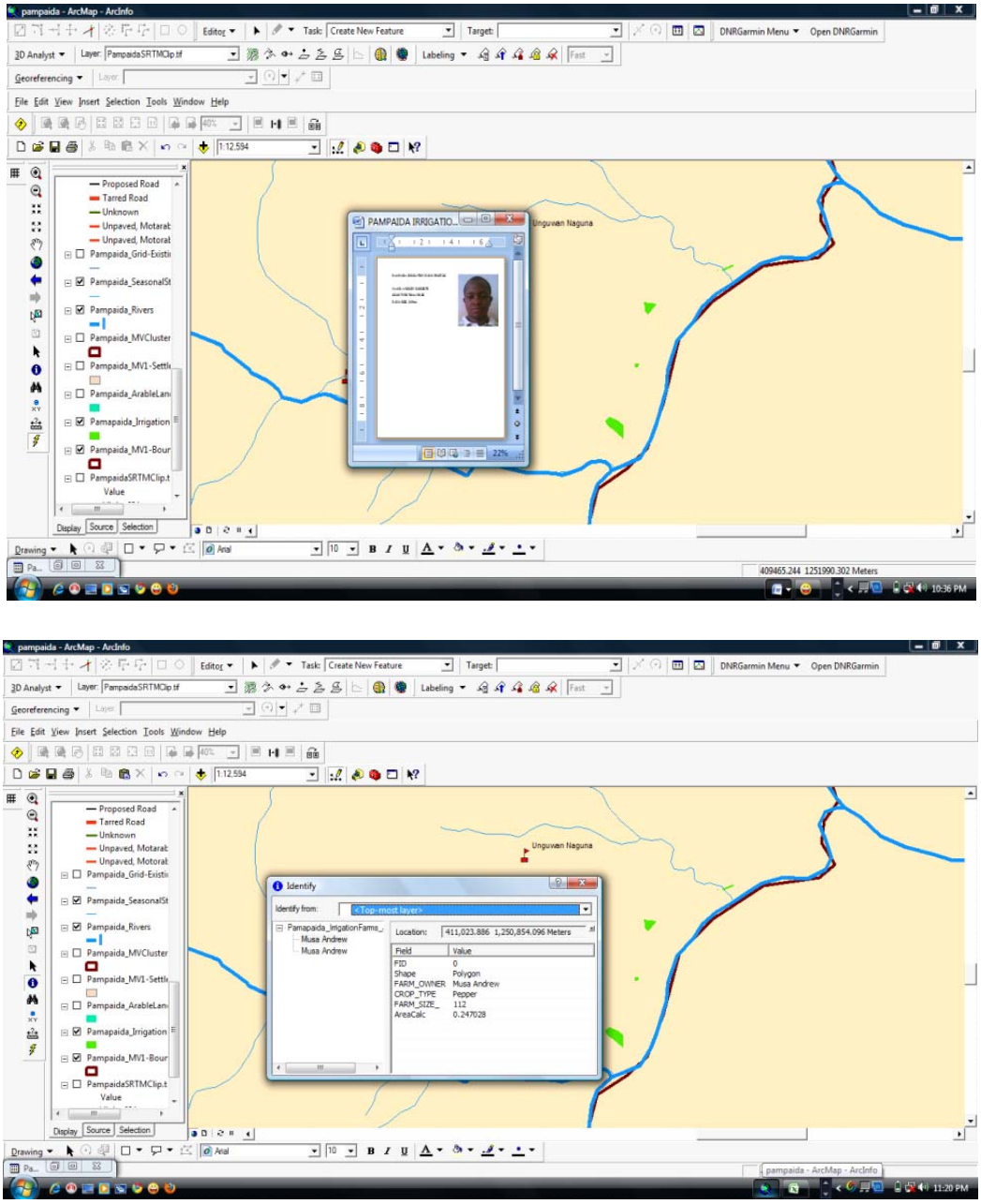

Fig. 5: Map query showing parcel profile from database (GIS analysis)

Table 1: Farm size and crop type in 2009

Farm	Farm size (Ha)	Percentage (%)	Crop type
A	0.247028	37.36208224	Pepper
B	0.384095	58.09296508	Tomatoes
C	0.03005	4.544952683	Onions
Total	0.661173	100	

GIS analysis

activities. This information system provides effective and efficient retrieval of farm owner information, it further provides rapid search tool for different fields in irrigation farm operations.

CONCLUSION

From the study, it is obvious that Geographic Information System (GIS) was able to generate location based information as regards exact position of farm parcels, able to generate a search method for tracking

farmer and farm profile so as to aid efficient data retrieval and was further able to run a spatial analysis on irrigation farms to identify proximity of farms to canals and also the varying farm sizes and crop types.

The employment of irrigation farm parcel mapping may result in the sustainable land use management and proper utilization of inherent natural resources. The integrated approach of remote sensing and GIS techniques provide the major tool in the evaluation of all attributes of an irrigation farm parcel. The proper understanding of these attributes (farm owner, crop type, parcel size, canal proximity to farms) will provide the necessary information in the detection of problem and proffering solution to the problem faced by the human population in their quest for survival and food security.

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