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Site Suitability for the Production of Fonio (Acha) in Adamawa State, Nigeria: GIS Approach

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Abstract:

This paper demonstrates the potentials of Remote Sensing and Geographic Information System (GIS) technologies for mapping and delineating site suitable for fonio production in Adamawa State. Site Suitability is necessary to create a data bank and guide to the farmer in decision making. (site that suitable for crop production). The six criteria that are used for the study include soil map, Relief (Topography) map, Vegetation map, Temperature map, Annual rainfall map and Rainfall Length map of Adamawa State. Combination of both non-GIS and GIS software were used. Corel draw 12 was used for data capture, ILWIS 3.7 was used for georeferencing, Arcview 3.2 Academy was used for digitizing the map while idrisi 32 were used for overlay and other calculation. The study reveals that about 70% of the state's landmass is suitable and most suitable for the production of fonio. As part of the recommendation Government should encourage the production of the cereal in the state, especially in the central part of the state to meet the need of the people.

Keywords: Remote Sensing, GIS, Georeferencing, Digitizing, Overlay

1. Introduction

Farmers all over the world, no doubt, need a comprehensive information and data of site suitable for the crops which they grow. Since the world comprises varied climate, soil, vegetable and other determinant factors, for the fact that these requirement for crops also varied in space, there is the need for the study of site suitability of crops, so as to enhance optimum production.

Remote sensing is regarded as potential sources of accurate and timely data needed to create site suitability, while geographical information system (GIS) has the capabilities to integrate these data together for accurate and comprehensive analysis.

In Adamawa state, very few works have been carried out on site suitability of crops, among the previous work was that of Adebayo and Musa (2004) "using GIS to map areas suitable for upland Rice production in Adamawa State". In their works, only rainfall conditions were used as criteria, other factors such as soil, vegetation, temperature and relief were not considered.

This research work therefore, used relief, vegetation, soil and climate parameters for – assessment and mapping of site suitable of Fonio (*Digitaria exilis*) production in Adamawa State, showing the local government and villages where this crop is suitable or unsuitable.

Fonio is one of the most nutritious of all grains. Its seed is rich in methionine and cystine, amino acids which is vital to human health and deficient in today's major cereals such as Wheat, rice, maize, sorghum, barley and rye. This combination of nutrition and taste could be of outstanding future importance. Most valuable of all, however is fonio potential for reducing human misery during hungry time, the grain is used in variety of ways. For instance, it is made into porridge and couscous, ground and mixed with other flours to make breads, popped, and brewed for bear. Fonio grain is digested efficiently by cattle, sheep, goats, donkeys and other ruminant livestock. It is a valuable feed for monogastric animals.

Fonio contains protein (methionine) almost twice as much as egg protein contains. Thus, fonio has important potential not only as survival food, but as a complement for standard diets.

2. Study Area

It shares boundary with Taraba state in the south – western part, Gombe state in the North – Western part and Borno in the North. The state has international boundary with the Republic of Cameroon along the Eastern side. Adamawa is divided into twenty – one Local Government Areas. The climate of the state generally is of the hot humid tropical type, with two distinct seasons: the dry season which

last for a minimum of five months (non - March), and the wet season that last from April to October. (Adebayo and Musa, 1999) classified the soils of Adamawa state as ferruginous Tropical soils with marked difference in horizons with an abundance of free oxides. Usually deposited in yellow or red concretion. The vegetation comprised of the southern Guinea Savannah, the Northern Guinea Savannah and the Sudan Savannah types.

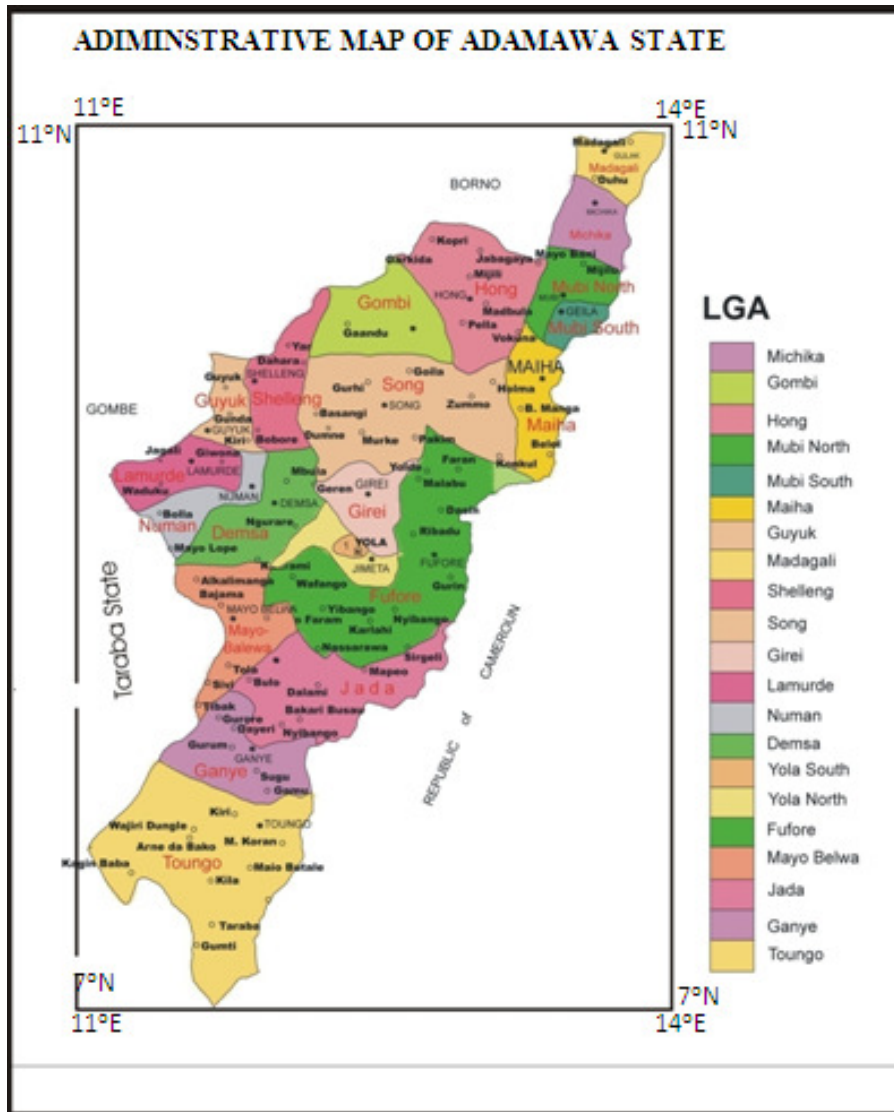


Figure 1: The Study area
Source: Adamawa State in Map

3. Materials and Method

Hp 620 Laptop, scanner, and a colour Hp printer as well as three GIS packages: ILWIS Academic 3.7; which was used for georeferencing, ARCWIEW GIS 3.2a was used for digitizing maps, and IDRISI 32 was used for all analysis as well as other complimentary, other supporting non – GIS packages was used (Corel draw I2).

The Adamawa state maps were used as data for the creation of site suitability for the crops were; relief map, vegetation map, Temperature map, annual rainfall map. Rainfall length map and soil map. Settlement and political map were additional maps that were used for analysis. The maps of each of the six criteria are presented in (Figure 2 and Figure 3).

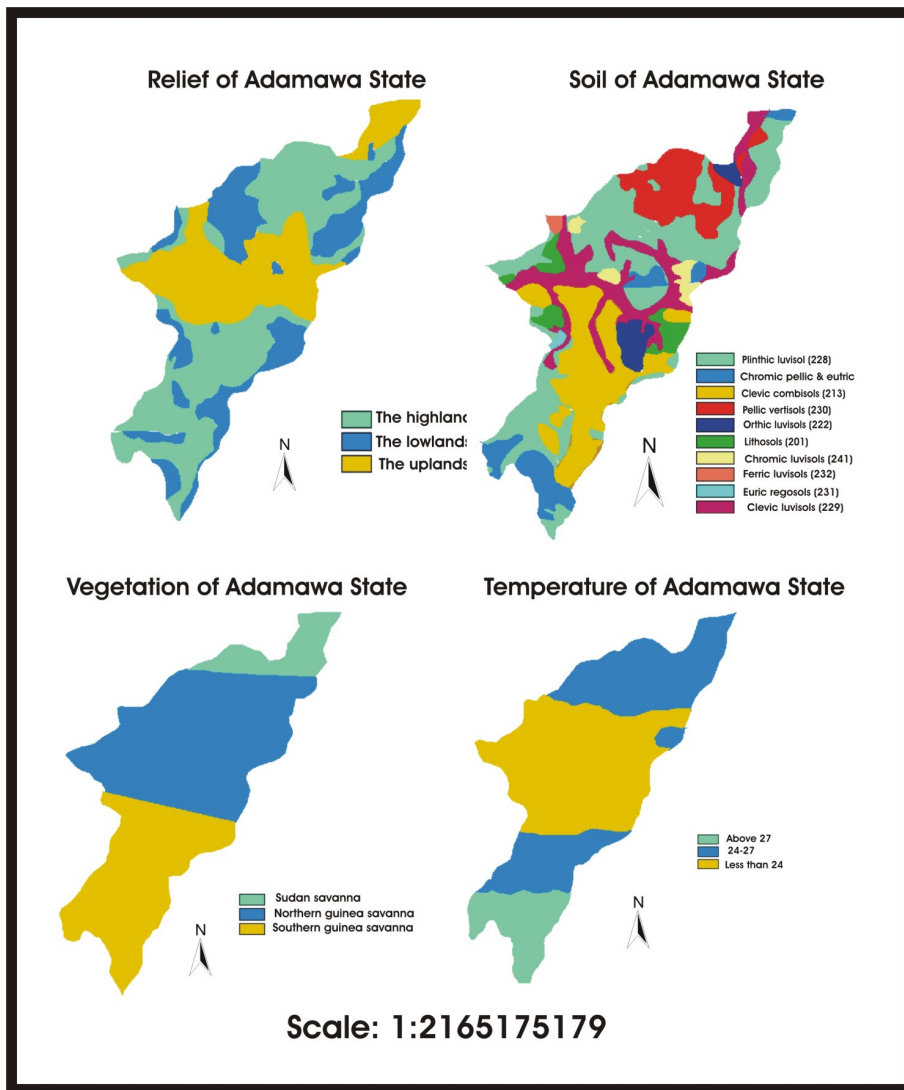


Figure 2

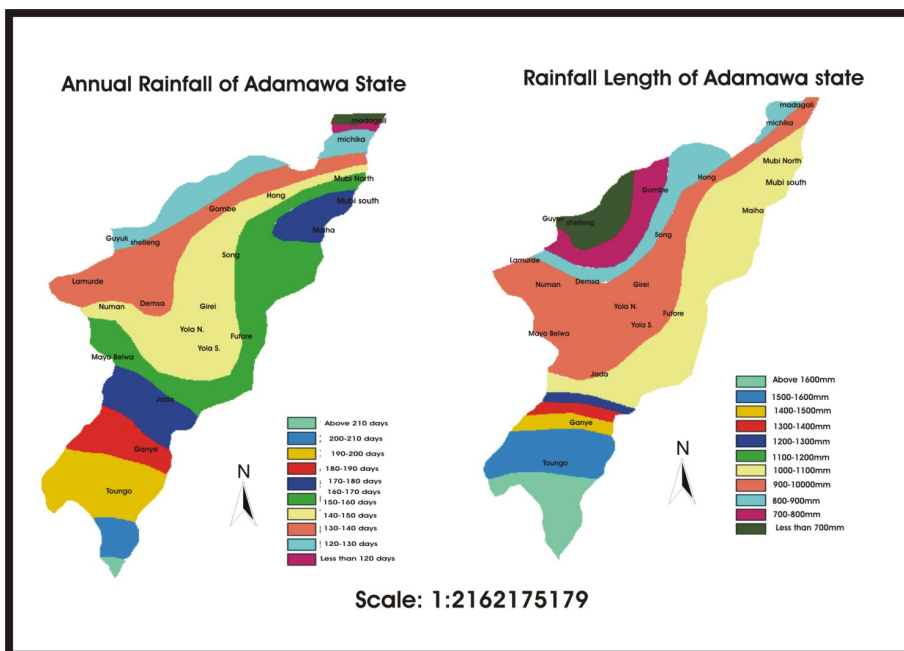


Figure 3

REQUIREMENT	CROPS
	FONIO (ACHA).
Annual rainfall	Fonio requirement an average rainfall of 750 – 1250
Rain fall length	Early variety 6 – 8 weeks, long cycle 80 – 150 days
Temperature	Temperature 25 – 30°C
Soil	Friable loamy and sandy soil (Sandy Loam)
Vegetation	All the savannah belts.
Relief.	Low lands and upland areas

*Table 1: Crop Requirement
Source: Raemaeker R.H (2001)*

4. Map Georeference

Each of the six criteria (Fig 2) was scanned and exported using Corel Draw 12 and imported in the ILWIS environment via Tagged Image File Format (TIFF) at where the maps were Georeferenced. The essence of Georeferencing is to make all maps to have the same rows, columns, pixel numbers and other reference parameters without which the maps will not overlay. Each of the maps was grid and numbered 10,000 to 100,000 and 10,000 to 150,000 as minimum X and Y and maximum X and Y respective. Nine (9) points were selected on one of the maps which were used as tie points for all the other maps. The tie points were then used to Georeferenced all the maps individually. The Georeferenced maps were then resample one after the other into earlier created Georeferenced corner map.

5. Data Capture

All the resample maps in Ilwis environment were exported to arcview, environment were exported to Arcview environment, to create vector data as theme. All area maps were digitized as polygon, lines such as boundaries as line, and location maps such as settlements as points. A fully digitized map was then saved as project map and imported to Idrisi for analysis.

6. Map Algebra

Addition subroutine of the overlay modules of Idrisi was used throughout this work. Climate was considered first with annual rainfall map and the length of rainfall as the first two overlaid maps. All areas that met the annual rainfall requirements for each crop were assigned “3” while those areas without the conditions were assigned “0”. The same was done to the length of rainfall for the crop. The two maps were overlaid to become “crop rainfall Map”. Any area that met the suitable conditions carried “3”, while areas that did not satisfy the conditions carried “0”. The same values (3 and 0) were assigned to suitable and unsuitable areas respectively on the temperature map. Crop rainfall map (annual rainfall + length maps) was overlaid on the temperature map become “Crop climate map”. On crop climate map, all areas that met the conditions in the two maps carried value “9” (addition of 3 scores in three maps) annual rainfall, length of rainfall and temperature maps. Any are with “6” means that the area met the suitability conditions in two out of the three maps. And those that met the requirements in only one out of the three maps had value “0” means that the area did not satisfy any of the conditions in the three maps.

The same process was done to crop vegetation and crop soil maps for each crop to become “crop physical Factors map”. Crop physical factors contained only two maps physical factors which obtained only two maps carried maximum of “6” values. Values “3” and physical factors which contained only maps carried maximum of “6” values. Values “3” and “0” were other possible values on the map.

Finally, crop climate map was overlaid on crop physical factors to produce “Crop suitability Map”. All the areas that have suitable conditions in four maps and an unsuitable condition in only one map carried value “9”, while two suitable areas and thee unsuitable areas carried value “6” was assigned to areas that met suitable conditions in only one map. Any area where no condition was met maintained “0”.

7. Mapping Suitability Areas

On the map, all areas with value 15 were assigned “4” and were considered “most suitable”, areas with value 12 were assigned “3” and were considered “suitable”, those with values 9 and 6 assigned “2” and were considered “just suitable” and the areas with values 3 were assigned “1” and were classified along with “0” as “suitable”.

8. Discussion and Result

Fonio(acha,digitaliaril exils) is not well-known in adamawa state cultivation system, the crop is most suitable in 19.7% of the study area notable local Governments are Numan,Guyuk,Demsa,Mayo-Belwa, fufore, yola south, yola North, Girei and some part of shelleng, Jada song, mubi North mubi south, michika and madagali. suitable and just suitable are representing 50% and 17.5% respectively of adamawa total land area the unsuitable area were found at the southern part of the state especially Toungo and some part of Ganeye, Jada, Fufore, Maiha, Mubi North,Mubi South, Michika, Madagali, Hong and Shelleng which covers 12.7% of the state land mass.

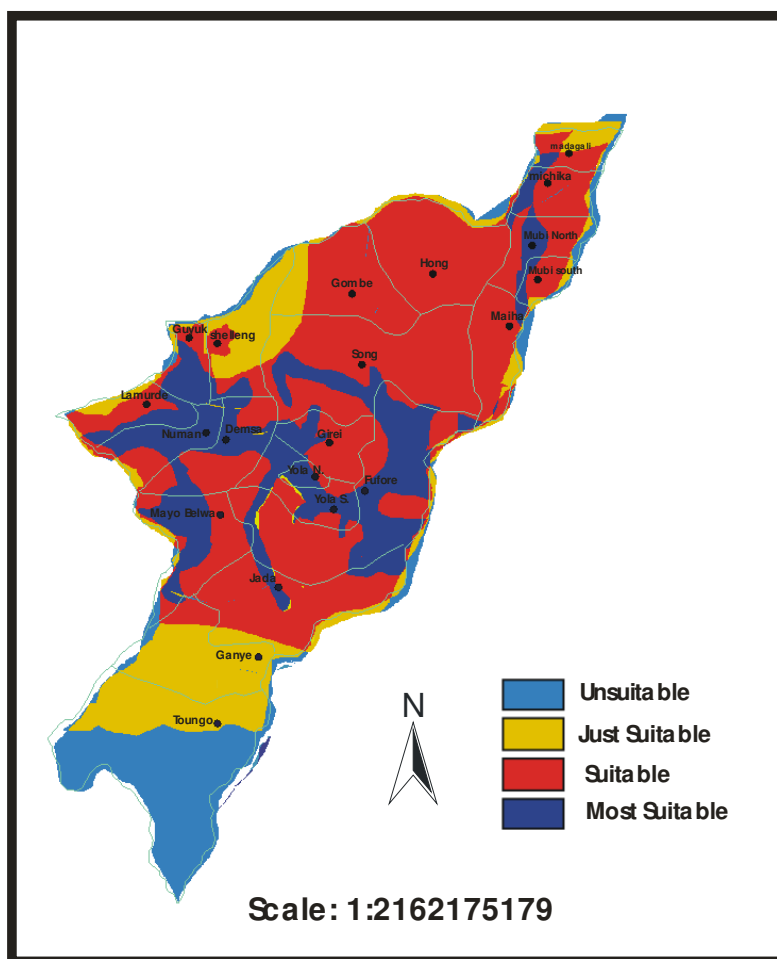


Figure 4:1 site suitability in Adamawa State

9. Conclusion

The research revealed that GIS and Remote Sensing technology are vital tools in agricultural planning. The result of this work really portrayed the real crop situation in the state. Fonio as a cereal is not been cultivated in Adamawa state (either small or large quantity).the population of the state is significantly increasing and the demand for food is also very high.

Fonio can complement allot of cereals that we are having to day because of its early maturity period. Government should hearten the production of the cereal in the state especially in the central part of the state to meet the need of the people since about 70% of the state's land mass is suitable and most suitable for the production of this cereal.

The state can become one of the major producers of fonio in the country if the land area are utilised for the crop production.

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