Journal of Agriculture and Ecology Research International
8(2): 1-7, 2016; Article no.JAERI.26821
ISSN: 2394-1073

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Identification of Efficient Cropping Zones for Cassava Production in Nigeria

Idorenyin A. Otung[1*] and Aniekan J. Akpaeti[2]

[1]Department of Crop Science, Akwa Ibom State University, Obio Akpa Campus, P.M.B. 1167, Uyo, Akwa Ibom State, Nigeria.
[2]Department of Agricultural Economics and Extension, Akwa Ibom State University, Obio Akpa Campus, P.M.B. 1167, Uyo, Akwa Ibom State, Nigeria.

Authors' contributions

This work was carried out in collaboration between both authors. Author IAO designed the study, preformed the statistical analysis, wrote the protocol, wrote the first draft of the manuscript and author AJA modified the structure, analysed and carried a further sub-classification of the zones. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JAERI/2016/26821
Editor(s):
(1) Inz. Krzysztof Skowron, Department of Microbiology, Nicolaus Copernicus University in Torun, Collegium Medicum of L. Rydygier in Bydgoszcz, Poland.
Reviewers:
(1) Mtaita Tuarira, Africa University, Zimbabwe.
(2) Levent Son, University of Mersin, Turkey.
Complete Peer review History: http://sciencedomain.org/review-history/14832

Original Research Article

Received 3rd May 2016
Accepted 23rd May 2016
Published 30th May 2016

ABSTRACT

Aim: When the productivity of a crop is higher and stable in an area/zone probably due to prevalence of optimum condition for crop growth and yield, it is considered an efficient crop zone. But identification of these cropping efficient zones which also serves to encourage comparative advantage and specialization in crop production may be a challenge to investors desiring to invest in these zones. Therefore this paper sought to investigate the efficient cropping zone for cassava, with a view to providing a practicable guide for policy considerations in production, processing (Such as the staple crop processing zones - SCPZ) and value chain development.
Methodology: To achieve this feat, secondary data collected from Nigerian bureau of statistics (NBS) data portal and the food and agriculture organization (FAO) from 1997-2006 were used to categorize the country into six geo-political zones by using stratified sampling method. Five criteria were adopted based on relative yield index (RYI) and relative spread index (RSI) to determine

**Corresponding author: E-mail: idorenyin.otung@gmail.com;*

efficiency of cropping zone by computing the mean yield of a state in relation to country crop yield and state crop area in relation to total crop area in the country.
Results: The results showed that ten (10) states (Akwa Ibom, Benue, Cross River, Enugu, Imo, Kaduna, Kogi, Oyo, Rivers and Taraba) out of thirty one (31) states spread across the six-political zones were identified as the most efficient cropping zones (MECZ) for cassava production. Their RYI values were 115.72, 366.38, 229.88, 234.30, 229.13, 188.60, 271.28, 133.49, 153.77, 171.11 respectively while their RSI values were 153.19, 318.05, 217.32, 238.96, 186.63, 228.27, 206.93, 165.57, 165.52, 174.72 respectively. the south-south geo-political zone had the highest number of states -three (3); south-east was next with two (2) states. Other zones had one each.
Conclusion: The policy implication is that investors can be potentially guided to invest in cassava production and development of value chain from the product. Also uneconomical crops can be replaced with the most economic crops for better returns on investment as well as productivity.

Keywords: Cassava production; efficient cropping zones; export; Relative Spread Index (RSI); Relative Yield Index (RYI).

1. INTRODUCTION

Cassava is a major source of dietary food energy for the people living in lowland tropics as well as the humid tropics of Central and West Africa including Nigeria [1]. Its utilisation is majorly traditional in the form of garri, fufu and animal feed. The Federal Minstry of Agriculture has a policy on the domestic content for food, stipulating an inclusion of 10% cassava flour in bread baking [2]. Also, current policy interventions will further drive production of cassava which has been on a steady rise since 2009 (Fig. 2).

However, recent development has seen the crop beginning to gain industrial significance and with a potential as an export crop. The three main cassava products that are exported are cassava chips, Cassava pellets and Cassava tapioca or starch and flour [3]. According to [4], Thailand is said to be the largest exporter (94%) of cassava whereas Nigeria which is the world's largest producer produces about at about 38 million tons of cassava (Fig. 1) and barely exports. This is an indication that production is essentially for domestic consumption. But current production shows that it is possible to export significant proportions because current policy strategies have further driven production of cassava which has been on a steady rise since 2009 (Fig. 2). It is pertinent to direct cassava production intensification in a sustainable manner through efficient utilisation of resources such as land.

In crop production, an efficient zone is an area, which has suitable soil and climatic features to obtain the maximum productivity of a crop [5]. Crop productivity is a function of area planted and yield of crop [6]. The productivity levels of crops can be enhanced and sustained through the identification of efficient locations [7]. To attain efficiency in crop production that enhances suitable utilization of resources particularly the scarce ones such as land, sustainable approaches through efficient use of resources need to be employed. One of the tools for identifying potential area of crops is by

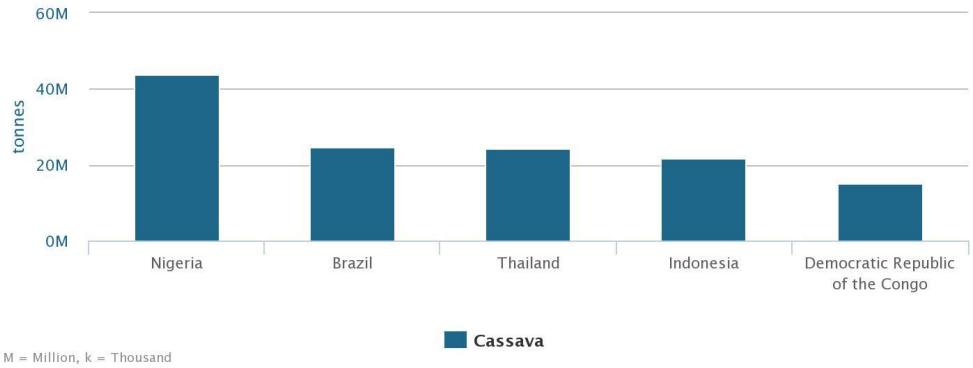

Fig. 1. Top five world producers of cassava (1993-2013)
Source: FAOSTAT (FAO, 2015)

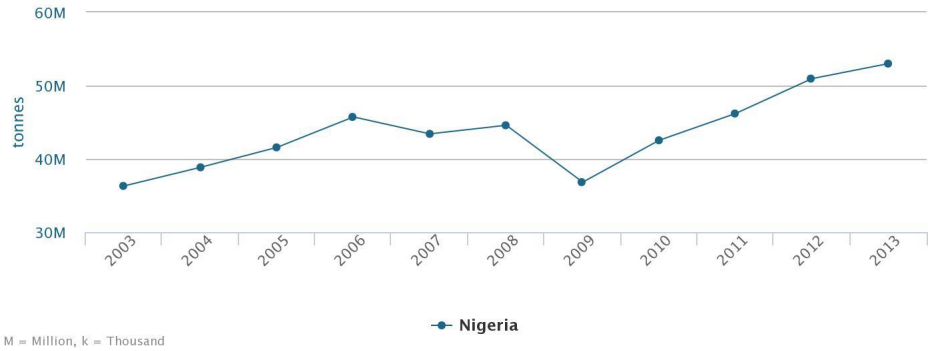

Fig. 2. Cassava production in Nigeria (1993 – 2013)
Source: FAOSTAT, (FAO, 2015)

calculating the Relative Yield Index, Relative Spread Index and in turn Efficient Cropping Zone of crops. However this information is based on cultivation and so fluctuates, the suitability of a crop for states should be verified frequently (every 2–5 years). There is currently a gap in literature on the efficient crop zones for cassava production in Nigeria. Therefore this paper sought to investigate the efficient cropping zones for cassava production, with a view to providing a practicable guide for commercial considerations in production, processing (such as the Staple Crop Processing Zones - SCPZ) and value chain development.

2. MATERIALS AND METHODS

2.1 The Study Area

The study area is the Federal Republic of Nigeria. Geographically, Nigeria occupies a landmass of 923,770 sqkm in West Africa. It falls within the latitudes 4° & 14°N and longitudes of 2°45 & 14°30E. Nigeria is bordered to the North West by Niger Republic, Chad and Cameroun to the East, Benin Republic to the west and Guinea Republic to the south. Administratively, the country is divided into the 36 states and Abuja, the Federal Capital Territory (FCT). Nigeria has a total landmass of 92,387,000 hectares, 74,500,000 hectares constitute its agricultural area. The climate is humid tropical in the south while the north is predominantly sub-humid tropical with a few dry and arid zones in the north. Nigeria has two distinct seasons; wet and dry. The country is divided into six geo-political zones namely: South-South, South-East, South-West, North-Central, North-East and North-West for effective and efficient allocation of resources.

2.2 Sampling and Data Collection Methods

Secondary data for area, production, and total agricultural area for cassava for the administrative units for ten (10) years: 1997 – 2006 were collected from National Bureau of Statistics data portal [8] and the FAO Nigeria-country profile.

2.3 Methods of Data Analysis

Secondary data collected from Nigerian Bureau of Statistics (NBS) data portal and the Food and Agriculture Organization (FAO) were used to categorize the country into six geo-political groups by using Stratified sampling method. The study then adopted a methodology of empirical work employed by [9,10]. From this data, Relative Spread Index (RSI) and Relative Yield Index (RYI) were computed by using the following formula:

Relative Yield Index (RYI) = [Mean Yield of Cassava for State (MT) / Mean Yield of Cassava in the Country] x 100

Relative Spread Index (RSI) = [Area of Planted Cassava in a State[1] / Area of Total Cultivated Cassava[2]] x 100

Five (modified) categories of cropping zones have been identified (Table 1) by computing indices for relative yield and spread as stated by [11].

[1] *Area of Planted Cassava in a State expressed as % of Total Area of Cassava in the Country.*
[2] *Area of Total Cultivated Cassava as % to the Total Agricultural Land in the Country.*

Table 1. Criteria for efficient cropping zone

RSI	RYI	Cropping zone
High	High	Most Efficient Cropping Zone (MECZ)
Medium or high	High or medium	Efficient Cropping Zone (ECZ)
High or medium	Low or medium	Less Efficient Cropping Zone (LECZ)
Low	High or medium	Not Efficient Cropping Zone (NECZ)
Low	Low	Highly Inefficient Cropping Zone (HICZ)

3. RESULTS AND DISCUSSION

3.1 Efficient Cropping Zone

Cassava production data was available for 31 states of the federation including FCT, out of which 10 states (Akwa Ibom, Benue, Cross River, Enugu, Imo, Kaduna, Kogi, Oyo, Rivers and Taraba) were identified as the Most Efficient Cropping Zones (MECZ). Five criteria was used based on relative yield index (RYI) and relative spread index (RSI) to determine efficiency of cropping zone by computing the mean yield of a state in relation to country crop yield and state crop area in relation to total crop area in the country as presented in Table 2 and Fig. 3. Both the yield and spread indices for the MECZ was higher than 100, their RYI values were 115.72, 366.38, 229.88, 234.30, 229.13, 188.60, 271.28, 133.49, 153.77, 171.11 respectively while their RSI values were 153.19, 318.05, 217.32, 238.96, 186.63, 228.27, 206.93, 165.57, 165.52, 174.72 respectively. High RYI for cassava in these states suggests that the climatic conditions are optimum for cassava crop growth and yield in corroboration to [5,12] view that crop yield is one of the indicators to the determination of an efficient cropping zone. On the other hand, high RSI could partly be attributed to the popularity of cassava in the diet of people in these states (as 'Garri and fufu') and for economic reasons.

These states are potentially zones in which more investment should be considered to further expand production to an exportable scale since cassava demand for industrial utilization has more than doubled in recent times in global market [3]. This will include high technology practices and establishment of processing clusters around these zones and an overall development of cassava value chain in these states. Furthermore, findings showed that the South-South geo-political zone had the highest number of states- three (3) under the Most Efficient Cropping Zone; South-East was next with two (2) states as shown in Table 3. Others zones had one each. The implication of this is that the zones are potentially profitable grounds for investors who are willing to invest. Also, it theoretically provides guidance on locations to consider to obtain high returns on investment (ROI) for cassava production and value chain development.

3.2 Inefficient Cropping Zone

At the other extreme is the Highly Inefficient Cropping Zone (HICZ), this includes Abuja, Abia, Adamawa, Bauchi, Bayelsa, Ebonyi, Ekiti, Gombe, Kwara, Lagos, Nassarawa, Niger, Plateau, Yobe, and Sokoto states as indicated in Table 2. The relative spread and relative yield indices for these states are less than 75, which suggest a poor return on investment in cassava production. The rational option as suggested by [10,12], is to replace cassava production in these states with a more efficient crop and save further degradation of natural resources. Figures from FAOSTAT (Fig. 4) show that the average growth rate for yield of cassava is extremely poor compared to the growth rate in area harvested which is growing at almost the same rate as total production. This clearly shows that increasing production of cassava is inefficient because poor yields are obtained per unit area. Another way of putting it is that the area of land used in production of cassava in the inefficient cropping zones constitutes wastage of land resources. Nigeria should aim for high efficiency in cassava production just like India (Fig. 5) as well as Thailand. Introduction of modern technology such as higher yielding varieties and other inputs (e.g. fertilizer) is expedient for an efficient production.

However, a relatively inefficient area is assumed to have an average yield of between 75-100 or >100 with a relative spread of less than 75 and is referred to as Not Efficient Cropping Zone (NECZ). There are two states in this category namely: Anambra and Osun. The Less Efficient Cropping Zones (LECZ) have yields 75 to 100 whereas spread is between 75 and 125 in both groups that make up the LECZ. In either scenarios where yield is greater than spread, the crop may be promoted by better extension methodologies or the reasons for the low spread be examined [7,13].

Table 2. Efficient cropping zone for cassava production in Nigeria

S/N	State	RYI value	RYI	RSI value	RSI	Cropping zone
1	Abuja	0.58	L	2.03	L	Highly Inefficient Cropping Zone (HICZ)
2	Abia	61.81	L	34.23	L	Highly Inefficient Cropping Zone (HICZ)
3	Adamawa	1.03	L	1.60	L	Highly Inefficient Cropping Zone (HICZ)
4	Akwa Ibom	115.72	H	153.19	H	Most Efficient Cropping Zone (MECZ)
5	Anambra	80.02	M	70.35	L	Not Efficient Cropping Zone (NECZ)
6	Bauchi	1.71	L	2.36	L	Highly Inefficient Cropping Zone (HICZ)
7	Bayelsa	4.31	L	4.50	L	Highly Inefficient Cropping Zone (HICZ)
8	Benue	366.38	H	318.05	H	Most Efficient Cropping Zone (MECZ)
9	Cross River	229.88	H	217.32	H	Most Efficient Cropping Zone (MECZ)
10	Delta	91.55	M	88.19	M	Less Efficient Cropping Zone (LECZ)
11	Ebonyi	58.61	L	59.50	L	Highly Inefficient Cropping Zone (HICZ)
12	Edo	63.14	L	61.58	L	Highly Inefficient Cropping Zone (HICZ)
13	Ekiti	69.01	L	44.95	L	Highly Inefficient Cropping Zone (HICZ)
14	Enugu	234.30	H	238.96	H	Most Efficient Cropping Zone (MECZ)
15	Gombe	0.89	L	4.29	L	Highly Inefficient Cropping Zone (HICZ)
16	Imo	229.13	H	186.63	H	Most Efficient Cropping Zone (MECZ)
17	Kaduna	188.60	H	228.27	H	Most Efficient Cropping Zone (MECZ)
18	Kogi	271.25	H	206.93	H	Most Efficient Cropping Zone (MECZ)
19	Kwara	44.63	L	41.17	L	Highly Inefficient Cropping Zone (HICZ)
20	Lagos	44.05	L	37.46	L	Highly Inefficient Cropping Zone (HICZ)
21	Nassarawa	48.50	L	45.29	L	Highly Inefficient Cropping Zone (HICZ)
22	Niger	50.37	L	65.49	L	Highly Inefficient Cropping Zone (HICZ)
23	Ogun	115.36	H	85.40	M	Efficient Cropping Zone (ECZ)
24	Ondo	147.28	H	95.88	M	Efficient Cropping Zone (ECZ)
25	Osun	78.81	M	56.42	L	Not Efficient Cropping Zone (NECZ)
26	Oyo	133.49	H	165.57	H	Most Efficient Cropping Zone (MECZ)
27	Plateau	41.88	L	38.12	L	Highly Inefficient Cropping Zone (HICZ)
28	Rivers	153.77	H	165.52	H	Most Efficient Cropping Zone (MECZ)
29	Sokoto	0.97	L	4.03	L	Highly Inefficient Cropping Zone (HICZ)
30	Taraba	171.11	H	174.72	H	Most Efficient Cropping Zone (MECZ)
31	Yobe	1.85	L	5.55	L	Highly Inefficient Cropping Zone (HICZ)

L – Low; M- Medium, H-High

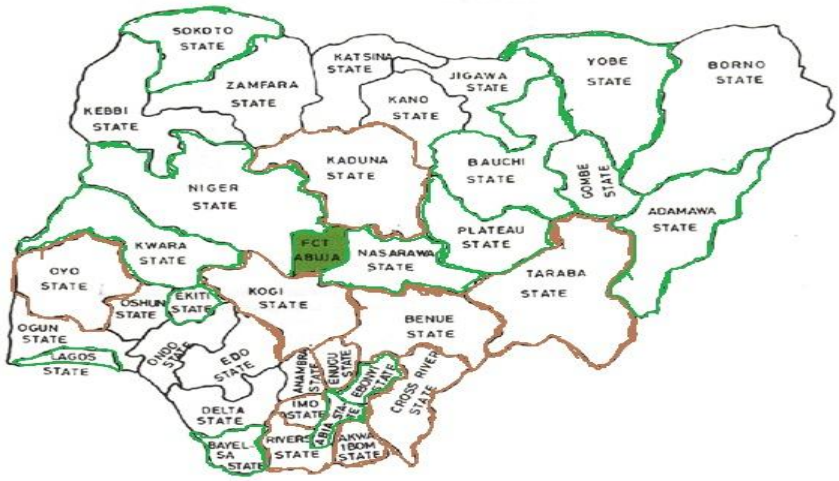

Fig. 3. The map of Nigeria showing the efficient cropping zones for cassava production

(Note: The Most Efficient Cropping Zone (MECZ) states are bordered in brown while Highly Inefficient Cropping Zone (HICZ) states are bordered in green and the states in black borders were excluded from the study)

Table 3. Summary of most efficient cropping zones (states) six-geo-political zones

South–South	South–East	South–West	North-Central	North-East	North-West
Akwa Ibom Cross River Rivers	Enugu Imo	Oyo	Benue Kogi	Taraba	Kaduna

Source: Computed by Author, 2015

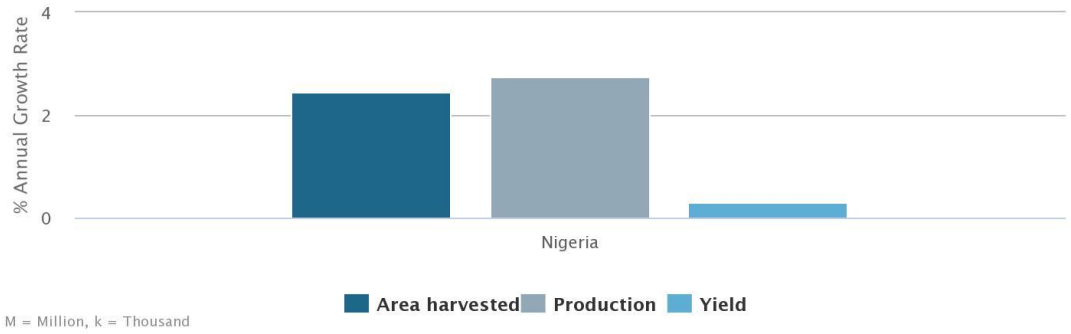

Fig. 4. Cassava growth rate

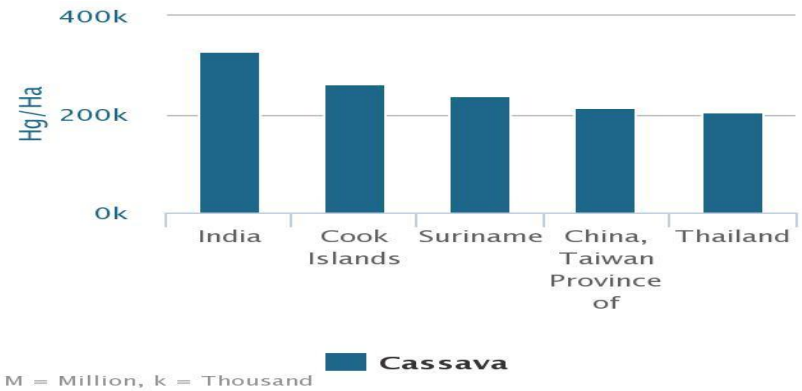

Fig. 5. Top five countries with highest yield per area
Source: FAOSTAT, (FAO, 2015)

4. CONCLUSION

Production is a function of area and yield, hence the application Relative Spread Index (RSI) and Relative Yield Index (RYI) to determine as well as identifying efficient cropping zones for cassava production in Nigeria. Ten (10) states in the country (Akwa Ibom, Benue, Cross River, Enugu, Imo, Kaduna, Kogi, Oyo, Rivers and Taraba) were identified as the Most Efficient Cropping Zones (MECZ). South-South geo-political zone of the country had the highest number of states three (3) with the most efficient cropping zone; South-East was next with two (2) states. Others zones had one each. These were potentially mega-cassava producing hub in Nigeria.

However, the study revealed that cassava production in the inefficient eighteen (18) states constitute a wastage of land resource and so more economical crops should be identified and cultivated as a substitute to cassava. Increasing production of cassava is majorly due to expansion in area not yield per unit area, this makes the production process inefficient since majority (18 states) of the units are inefficient. The study therefore recommends that intensifying production in these states by increasing yield through the use of higher yielding varieties, adequate use of fertilizer as well as other inputs to maximize production rather than emphasis on expansion of area/spread. Also, value chain development in the areas of Staple Crop Processing Zones

(SCPZ) should be targeted towards these states. This applies to both the government and private sector.

COMPETING INTERESTS

There are no competing interests for this work because no funding was received for this work.

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Peer-review history:
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