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COMMODITY FLOW ANALYSIS OF YAM (*DIOSCOREA SPP*) IN BENUE NORTH REGION, NIGERIA

Abstract: This study investigates the movement of yam from the Zaki Biam International Yam Market to deficit regions of Nigeria to unravel yam flow pattern/magnitude for economic census while also revealing major distribution destinations. Both primary and secondary data were utilized for the study. Primary data were collected using a questionnaire survey, while secondary data were retrieved from published articles and reports. Data were analyzed using inferential, descriptive statistics, and GIS flow mapping procedures. The study revealed that more yam (4,752,000 tubers) flows from the Zaki Biam yam market to the Southern part of Nigeria than to the Northern part of the country (1,824,000 tubers) as observed in November 2023. It also observed that the volume of the yam distributed is not a function of distance to the source region alone. Other factors, such as market demand, may also play a role, though this study did not directly measure them. The research concluded that flow mapping is powerful and promotes economic understanding, efficiency, and managerial prowess, particularly in commodity distribution, economic statistics, and trend observation, while ensuring food security. The study recommended innovative collaborative efforts between the relevant stakeholders to ensure commodity flow data acquisition and survey for economic census, effective decision-making, and growth.

Keywords: commodity flow mapping, yam distribution, food security, GIS

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Introduction

Commodity flow analysis examines the movement of products like yam (*Dioscorea spp*) within a region and between supplying and receiving areas. The analysis is fundamental within the transportation domain, health sector, trade/commerce, agricultural produce flow, academic disciplines, and other economic sectors (Lih & Lynette, 2016). This helps policy formulators, city planners, and transporters understand the pattern of commodity exchange and the movement of commodities within the economy.

According to Ullman (1957) and Beyer, Hagemann, and Misselwitz (2020), commodity flow entails identifying commodity markets and recognizing how a commodity moves from producers to markets and, by extension, to final consumers. The concept identifies impediments, obstacles, bottlenecks, and challenges in the commodity transportation system within a region, thereby generating information for a better understanding of future flow patterns and for policy formulation. In the food and agricultural sector, market forces influence both consumers' choices and farmers' production decisions (FAO, 2020). This study draws on the gravity model and the concept of spatial interaction, which addresses the forces responsible for the flow of products, people, services, information, or energy from a supply region to a deficit region.

Flow analyses are typically conducted with respect to points of production (origin) and destination points, using spatial tools such as Geographic Information Systems (GIS). Commodity flow studies provide a thorough understanding of the movement of goods from one point to another and are therefore crucial for economic analysis and planning. Despite this importance, studies on yam in Nigeria have largely concentrated on indigenous production practices (Eti-Obong et al., 2023), its significance as a staple food and its socio-cultural and economic value (Degla & Sourokou, 2020), and the role of transportation systems in commodity distribution generally (Olutumise, 2020). What remains largely absent from this body of work is an empirical account of how yam actually moves from Benue State, Nigeria's principal yam-producing region, to the markets and consumers that depend on it. This is a significant omission: without an understanding of the spatial pattern of yam distribution from its major surplus zone, efforts to plan for food security, minimize wastage, and improve distribution efficiency remain guesswork rather than evidence-based policy.

The question of food flow and the availability of food for a growing population cannot be overstated, and it is in response to this challenge that nations worldwide have adopted various measures to ensure food security. In Nigeria, efforts to increase agricultural productivity and improve food distribution have not produced the desired outcomes, and food flow challenges persist (Otaha, 2013). For instance, the Federal Government introduced parastatals and programs alongside the River Basin farming system in 1973, beginning in Sokoto, to curtail hunger and achieve food self-sufficiency (Adegeye, 1982). This was followed by Operation Feed the Nation in 1976 and the Green Revolution in 1980. However, these programs fell short of their goals, as many parts of the country

remain deficient in food production and continue to depend on produce from other states or on food imports.

Benue State is widely recognized as a major supplier of food across the nation and beyond (Omotolani, 2022), and is the principal surplus zone for yam. Yet, despite this critical role, no known study has systematically examined how food commodities, particularly yam, are distributed from Benue State to the rest of the country, a gap that leaves both policymakers and market actors without the spatial evidence needed to guide planning. This is the central problem this study addresses: the absence of a documented understanding of yam distribution patterns from Benue State constitutes a barrier to informed food security planning, and to minimizing the wastage that results from inefficient distribution in the source region.

An adequate food supply is a vital component of socioeconomic fairness, and it is expected that a study of this nature can help address the recurring problems of commodity flow, food shortage, wastage, and storage. While related studies such as those of Nahanga & Vera (2014) and Irohibe & Agwu (2014) have applied varying approaches to food commodity research, none have mapped the actual commodity flow of yam from its production base. This study therefore fills this gap by adopting commodity flow mapping procedures to analyze yam movement from Ukum in Benue State, Nigeria – an approach that not only clarifies the spatial pattern of yam distribution but also reveals the underlying choices made by both farmers and buyers, insights that are of considerable value for distribution and food security planning.

Material and methods

Study area. Ukum is one of the 23 Local Government Areas in Benue State, popularly known for large yam production. It is situated within the middle belt of Nigeria, around the River Benue. Ukum Local Government Area is located between longitudes 9° 22' 14" and 9° 50' 23" E of Greenwich Meridian and Latitudes 7° 42' 12" and 7° 36' 6" N of the equator with a total area of 1,514 km². It is the home of Zaki Biam International Yam Market. Benue State is located in the derived forest ecological zone of Nigeria (Figure 1).

Research design. The survey research design was adopted for the study. Data for the analysis include the volume of yams (truckloads) sold from the Zaki Biam Yam Market in November 2023. The data utilized for the flow mapping were the yam movement records obtained from the yam sellers in the Zaki Biam yam market. Primary data were collected through on-site observation and questionnaire administration. Data acquired from the yam sellers were the number of truckloads (12,000 and 24,000 tubers for Mercedes-Benz-911 trucks and Trailer trucks, respectively) of yam from the Zaki Biam yam market in November and their respective destinations. The month of November was earmarked for the study because this is the peak period of yam sales in the Zaki Biam yam market. Secondary data sources consist of current official and unofficial statistics and publications, as well as reports on the yam trade.

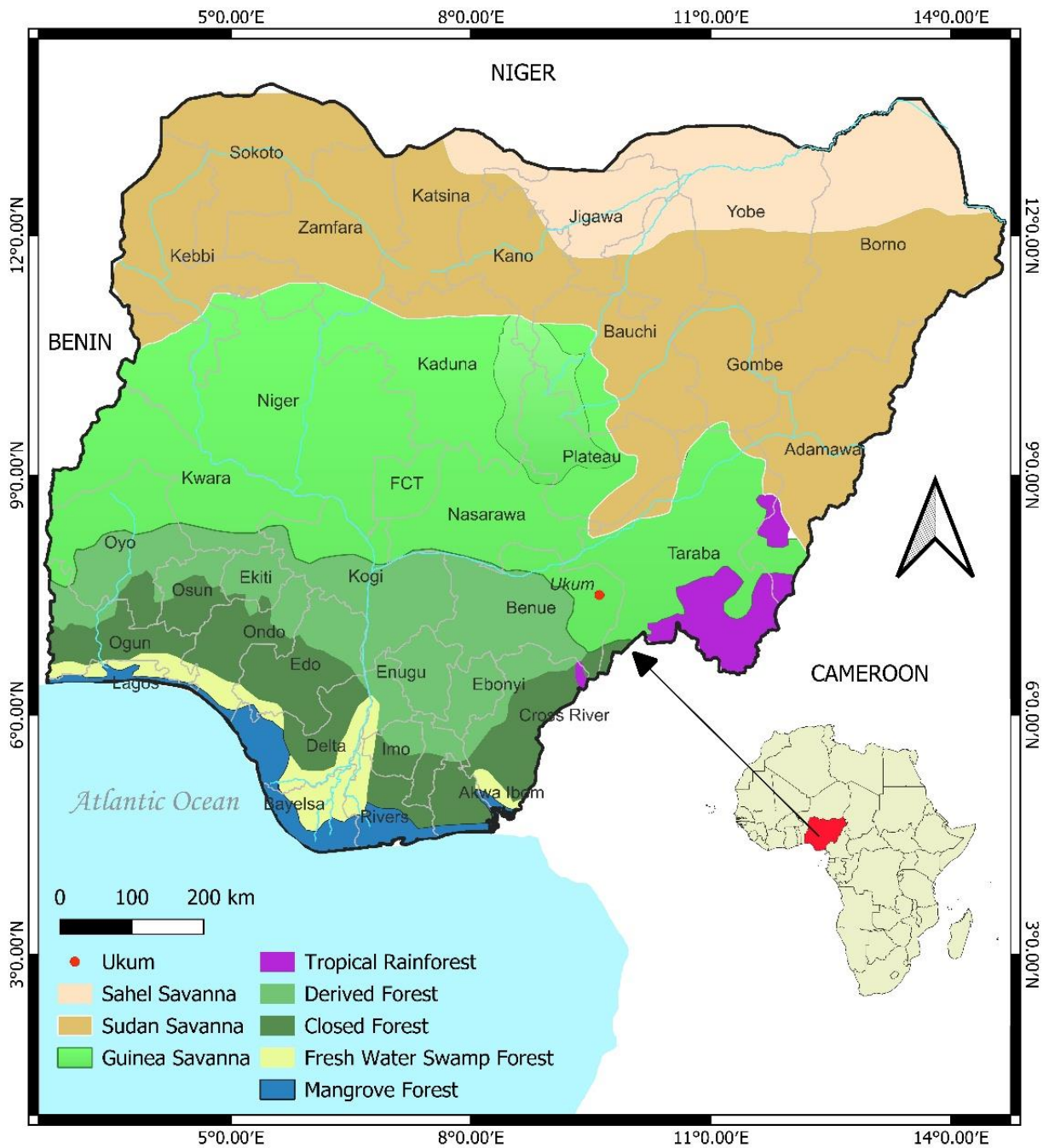


Fig. 1. Ecological zones of Nigeria

Source: own study, 2023

A two-stage sampling technique was utilized for this study – purposive, stratified random sampling. In the initial phase, Ukum Local Government Area and Zaki Biam yam market were purposively selected for the study because of the enormous yam production in the area. The sample size was drawn from the population of 706 yam sellers occupying 706 stores in the Zaki Biam yam market. To define the sample size, the population was fed into the sample size calculator using the Yamane (1973) formula to determine a sample size of 250. The population was further divided into six groups (Groups A (1-118), B (119-236), C (237-354), D (355-472), E (473-590), and F (591-706) to ensure

samples are picked from each part of the population. The numbers within each group were fed into the random sample generator tool to select the random sample from each group. The tool picked 42 numbers (yam stores) randomly from each of the six groups. This produced the 250-sample size used for the study.

ArcMap tools were used to produce the flow maps. The yam flow volume was generated and displayed for a month with reference to truck count and distance (kilometers) traveled from the Zaki Biam yam market. The correlation statistics were used to test for the relationship between the volume of yams distributed and the corresponding distance. The stated hypothesis was tested using the Pearson correlation coefficient analysis.

Pearson's r is given as:

$$r = \frac{\sum xy - Nxy}{\sqrt{(\sum x^2 - Nx^2)(\sum y^2 - Ny^2)}} \quad (1)$$

Where:

r = Pearson's r correlation coefficient

N = Number of respondents

X = yam production (yam flow count)

Y = yam distribution (distance)

$\sum x$ = sum of x production

$\sum y$ = sum of y distribution

$\sum x^2$ = sum of squared x production

$\sum y^2$ = sum of squared y distribution

$\sum xy$ = sum of the product of production and distribution

If the correlation result is $+1$, it means there is a correlation (dependence), and a positive relationship exists. A correlation result of 0 , means there is no correlation (i.e., no relationship).

The ' x ' variable is the yam flow count, whereas the ' y ' variable is distance. Before the application of this equation, the study determined the total product of all data pairings, the *means* of both variables, and the total squared values of both variables. To calculate the p -value to determine whether the correlation is statistically significant or not, the study first calculated a t ratio using the equation:

$$t = \frac{r\sqrt{N-2}}{\sqrt{1-r^2}} \quad (2)$$

The degree of freedom (df) was calculated. This is equivalent to the number of data pairs minus two. The t -table was consulted to compare the calculated t value with the critical t value to determine statistical significance (P value).

Yam flow mapping shows the linear movement of the commodity between the Zaki Biam yam market and other states in Nigeria. The flow employed varying thickness of line symbols to show the quantity of yam truck count along the respective routes. In this regard, absolute scaling was used to reflect the various quantities to a particular destination. The flow lines also reflect the direction of commodity movement.

Results

Yam distribution from the Zaki Biam yam market. Efficient management of the distribution of food requires the determination of two key locations: the source region and the destination. The identification and mapping of the Zaki Biam yam market as the major point of yam source, and the various flow destinations in the study, is in line with the concept of commodity flow by Ullman (1957), which explains that commodity flow entails the identification of commodity markets and understanding how commodities move to the final consumers. Table 1 shows yam distribution from the Zaki Biam yam market to other parts of Nigeria. Onitsha in Anambra State received the highest number of yam trucks, with 31.77 percent of the total number of yams sold from the yam market within the duration of the study. Other states with a high flow of yams from Benue include Edo (16.94%) and Lagos (12.71%), respectively. Figure 2 shows the yam commodity flow from the source to the respective destinations.

Table 1. Statistical summary of yam distribution

Origin	Destination (State)	Location of Market (City)	Percentage (%)
Zaki Biam	Sokoto	Sokoto	1.69
	Kano	Kano	4.23
	Bauchi	Bauchi	2.11
	Borno	Maiduguri	2.11
	Gombe	Gombe	1.69
	Plateau	Jos	2.11
	FCT	Abuja	2.11
	Lagos	Ikeja	12.71
	Edo	Benin city	16.94
	Enugu	Enugu	4.23
	Anambra	Onitsha	31.77
	Delta	Asaba	8.47
	Cross River	Calabar	1.69
	Akwa-Ibom	Uyo	1.69
	Rivers	Portharcourt	6.35
			Total: 100

Source: own study, 2023

Yam commodity distribution pattern. The yam distribution pattern in Table 1 shows that four States (Cross River, Akwa Ibom, Gombe, and Sokoto) received 8 trucks of yam each in November. The flow also shows that Borno, Bauchi, FCT, and Plateau in the northern part of Nigeria received 10 trucks of yam each in the month of November. Kano and Enugu States received 20 trucks of yam in November 2023. Lagos State and Edo State got 60 and 80 trucks, respectively, while Anambra State received the highest number of trucks, with 150 trucks going to Onitsha and Awka. Delta State received 40 trucks of yam

from Zaki Biam, while Rivers State got 30 trucks of yam. Figure 2 indicates the direction and pattern of yam distribution categorized according to the yam truck count values, differentiated by the diverse colors to reveal the pattern on the map. The implication of this pattern for business decisions is visible in the number of Yam trucks going to each State. This pattern identifies areas of high and low demand for food security and key customers for business purposes. It also shows areas with repeated interactions (evident in the number of trucks) with the Zaki Biam yam market in Benue State.

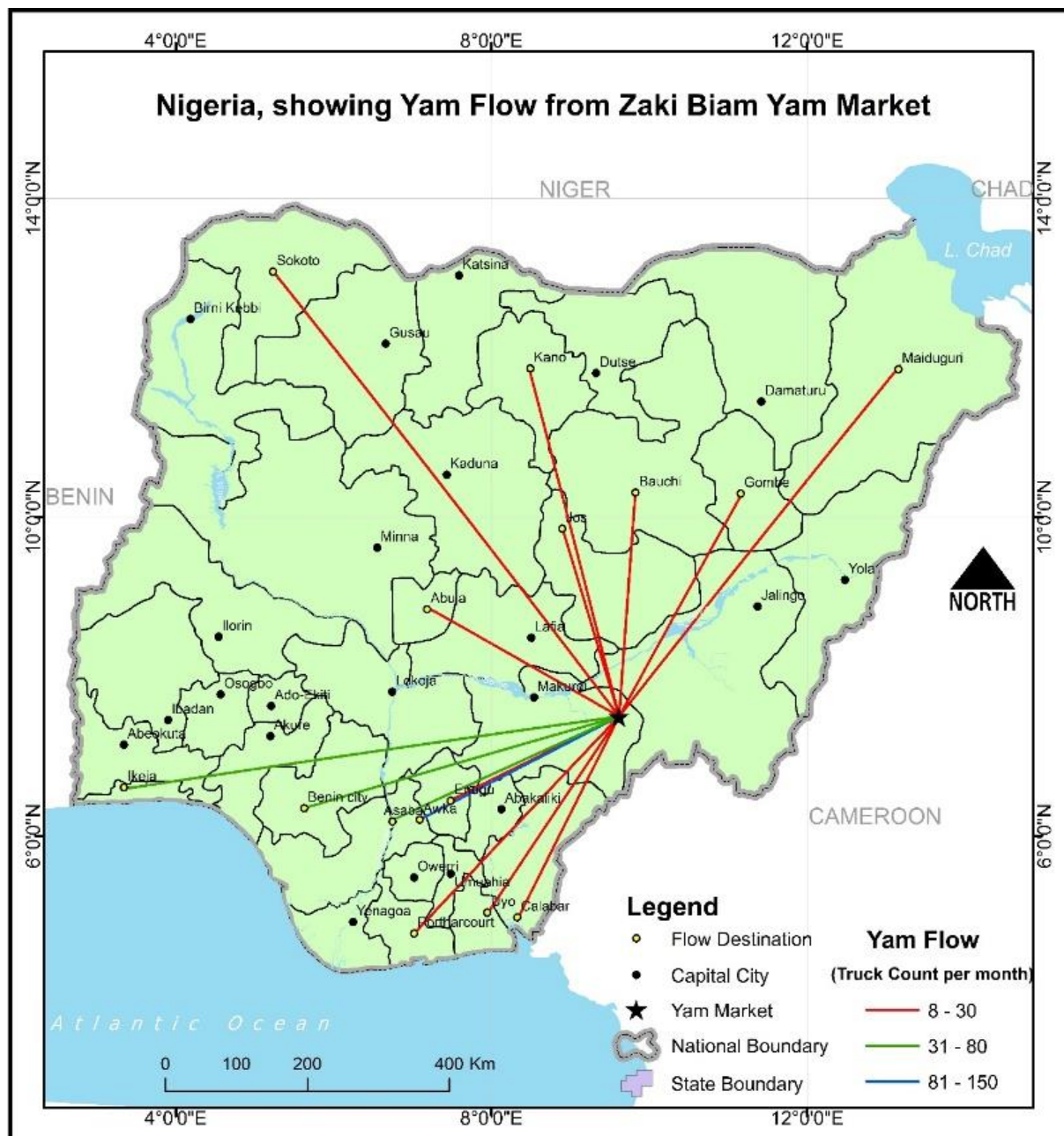


Fig. 2. Yam commodity flow from Benue North region

Source: own study, 2023

Magnitude and direction of Yam flow from Benue State. The results of the yam flow mapping further showed that more yam flows towards the southern part of the country, as shown in Figures 2 and 3. Out of the 472-truck count of yam movement recorded between Mondays and Thursdays (official market days of the Zaki Biam yam market) within the hours of 7 am to 5 pm in November 2023, 396 trucks were transported to the southern part of Nigeria. Such destination States include: Lagos, Edo, Akwa-Ibom, Cross River, Delta, Anambra, Rivers, and Enugu (Figure 3). The magnitude of 396 Mercedes-Benz 911 trucks with 12,000 yam tubers each moved southwards in November 2023 (4,752,000). This showed how important the Benue yam is to food security in the southern region.

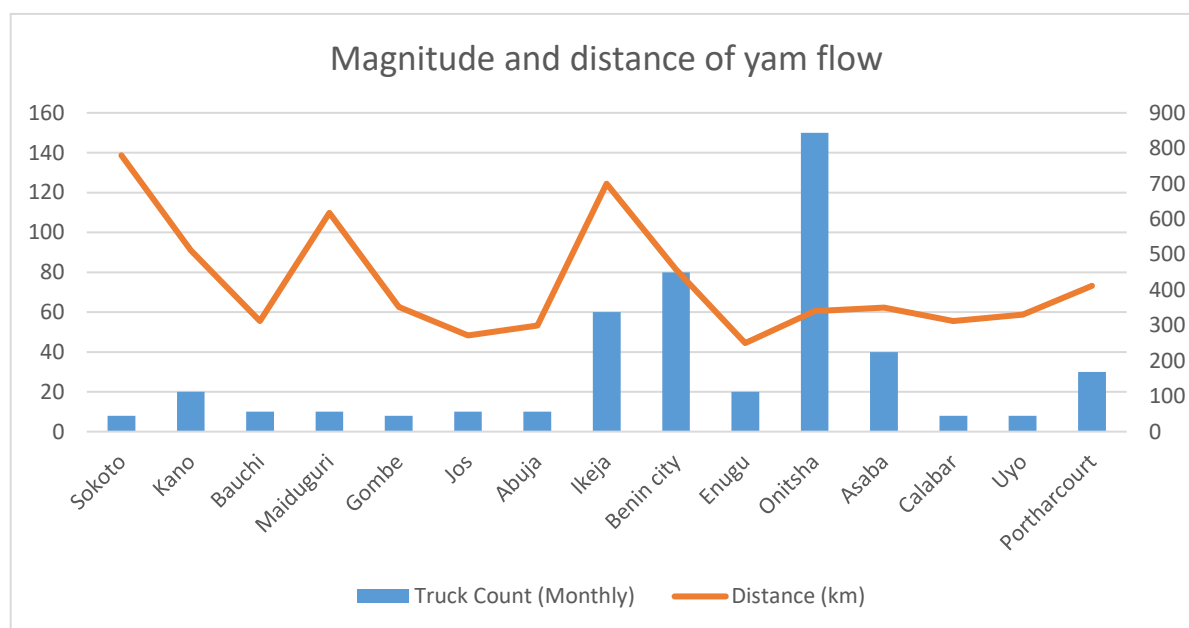


Fig. 3. Magnitude and distance of the yam flow
Source: own study, 2023

On the other hand, 76 trailer trucks with a count of 24,000 yam tubers in each trailer truck were used in transporting yam to the northern part of Nigeria (1,824,000). This is at the ratio of 4:1. The study observed that the Mercedes-Benz 911 trucks were used to transport yams within shorter distances, while the trailer trucks were used for longer trips. The southern part of Nigeria is also a yam-producing zone. The quantity being transported from Benue to the southern part augments the quantity produced in the zone. This shows that yam consumption in the south is very high. The findings here indicate that with the total number of 396 trucks of yam demanded within one month (4,752,000 tubers) by the southern population, if there is an inadequate quantity of yam flow from Benue State, the southern part of the country may lack supply, and yam supply shortage may plunge in, impacting food security. To ensure a steady supply, policies should hinge on stringent agreements and transportation infrastructure to ensure the supplying and receiving regions are connected for the continuous flow of the commodity. It took about 8 hours to load the Mercedes-Benz 911 truck when 5 persons were engaged to load the yams (40 man-hours), while 9 hours to load the trailer truck using 8 workers (72 man-

hours). However, it was revealed that during June, July, August, and September, when the quantity of yam is low, as the new yam season approaches, it takes 2 to 3 days to load a single truck, even with the same number of workers. This is because the yam sellers needed time to source the yams to complete a truck.

History of Yam production and Yam flow from Benue State. With a land area of about 226,000 hectares, Benue State is the top producer of yams, yielding 2.8 million tons annually (Gumh, 2019). According to Akiga (1935), the Tiv people had other crops like beans, guinea corn, and millet, but yam took center stage among the crops produced. This is attributed to the favorable nature of yam as food to the Tiv people and their farming system and fertile land. Yam production quickly transformed into a valuable commodity for trade after harvesting (Gumh, 2019). As a result, its output increased gradually during the pre-colonial, colonial, and post-colonial periods.

Table 2 shows responses from yam sellers on the factors responsible for the volume of yam produced in the Benue North region. The answers obtained showed that 48% of respondents observed that the quest for wealth is the major reason many people are engaged in yam farming in the area, since there is demand. Further interaction with the respondents revealed that yam trading is one of the fastest ways to earn money. Relatedly, 22% agreed that fertile land and the need to feed (19%), as well as cultural significance (10%), are the other reasons for the enormous yams produced in the area. It is pertinent to emphasize here that excess produce for feeding, which accounts for 19%, is usually taken to the market for sale.

Table 2. Factors responsible for the volume of yams in the Benue North region

Factors	Frequency	Percentage (%)
Fertile land	56	22
Quest for wealth	120	48
Cultural significance	26	10
Feeding	48	19
Total	250	100

Source: own study, 2023

Yam flow mapping. ArcMap was used to produce the flow maps. To determine the scale of the flow line, the truck count values were classified into three categories. Table 3 shows the value range of 1-50, 51-100, and 101-150, which were grouped according to states and symbolized on the map. The symbol shows the direction and magnitude of the flow map in Figure 4. The volume of trade determines the thickness of the flow line conveying the product.

Table 3. Yam truck count magnitude proportion classification

S/N	Proportion group (State)	Truck count value range	Proportion class
1.	Sokoto, Kano, Bauchi, Borno, Gombe, Plateau, FCT, Enugu, Delta, Cross-River, Akwa-Ibom, and Rivers	1 – 50	10
2.	Lagos, Edo	51 – 100	50
3.	Anambra	101 – 150	100

Source: own study, 2023

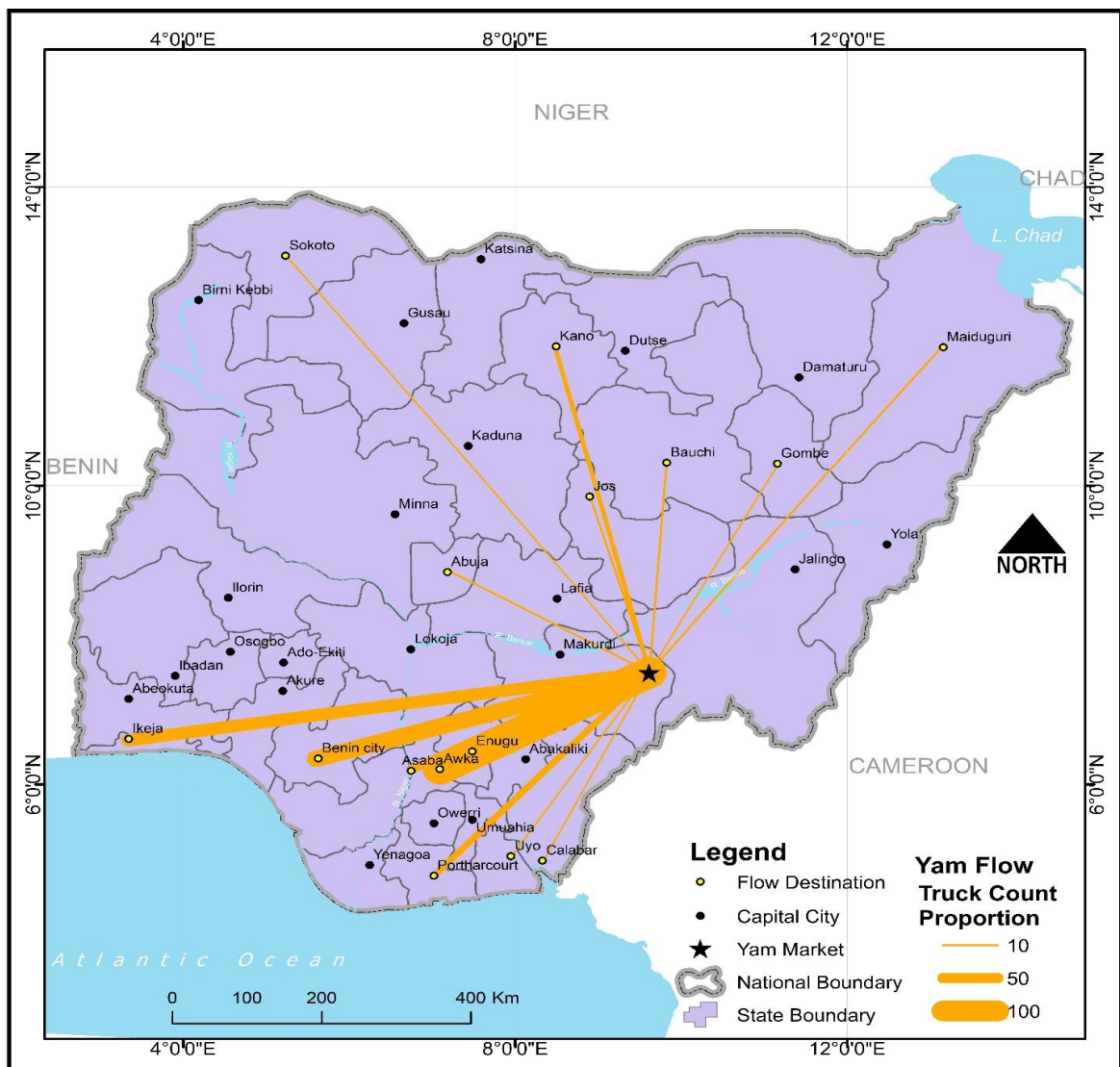


Fig. 4. Magnitude and direction of Yam flow from Benue

Source: own study, 2023

Correlation analysis between the volume of yams distributed and the distance.

The study observed a very weak negative correlation coefficient ($r = -0.063$) between the volume of yams distributed and distance (see Table 5), indicating that there is no meaningful linear dependence between truck count and distance. The relationship is negligible and, as reported below, statistically non-significant ($p = .823$); truck count to a given destination cannot be reliably attributed to distance alone. Other factors, such as market demand, population size at the destination, and seasonal variation in supply, more plausibly account for the observed distribution pattern. These factors were not directly measured in this study and are proposed here as plausible explanations warranting further investigation.

In Table 4, the volume of yams distributed and the distance are presented. The destination cities have been identified with the corresponding truck count and distance in kilometers. Among the notable destinations in southern Nigeria, Ikeja received 60 trucks of yam shipments covering a distance of 896 kilometers. Benin City traded 80 trucks within a month, covering 588 kilometers. Onitsha ranked first, receiving 150 truckloads of yams over a distance of 445 kilometers. Uyo, Calabar, Sokoto, and Gombe received 8 trucks of yam, with varying distances each in November 2023. Bauchi, Maiduguri, Jos, and Abuja got 10 trucks of yams, respectively. Kano and Enugu received 20 trucks each, while Asaba got 40 yam trucks with a distance of 460 kilometers.

Table 4. Volume of yams distributed and distance covered

Location of Market (City)	Truck Count (Month) (X)	Distance (km) (Y)
Sokoto	8	1150
Kano	20	684
Bauchi	10	398
Maiduguri	10	846
Gombe	8	552
Jos	10	358
Abuja	10	470
Ikeja	60	896
Benin city	80	588
Enugu	20	343
Onitsha	150	445
Asaba	40	460
Calabar	8	448
Uyo	8	475
Port Harcourt	30	552

Source: own study, 2023

Table 4 also presents data sorted for Pearson's correlation analysis. Pearson's correlation (Pearson's r) was used to examine the relationship between two variables. Variable X represents the number of trucks of yams, while variable Y represents the distance covered in kilometers. The correlation procedure was used to test the stated hypothesis that the volume of yams distributed from the Zaki Biam yam market is not a function of distance. The varying destination cities for these yam shipments served as the correlation category. The correlation line fit plot in Figure 5 does not show a consistent distance-decay pattern. Some nearer destinations (e.g., Jos, Bauchi) recorded low truck counts, while a farther destination (Onitsha) recorded the highest, which is consistent with the negligible and statistically non-significant correlation reported above. This suggests that factors other than distance, such as market demand and logistical decisions, are more useful for decision-making in the logistics of yam transportation from the Benue North region to the different markets (States) in Nigeria.

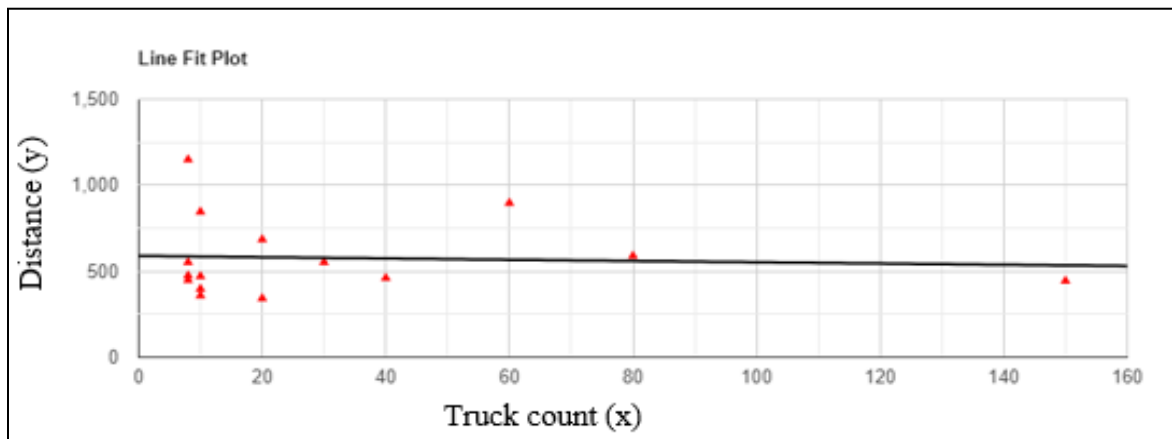


Fig. 5. Volume of yam flow and distance correlation line fit plot

Source: own study, 2023

Table 5. Correlation parameter results

Parameter	Value
Pearson's correlation coefficient (r)	-0.06327
P-Value	0.823
Covariance	-563.4762
Sample size (n)	15
Statistic (t-statistic)	-0.2286

Source: own study, 2023

Results of the Pearson correlation analysis in Table 5 showed a non-significant, negligible negative relationship between truck count (X) and distance (Y), $r(13) = -.063$, $p = .823$. Since the p-value (.823) exceeds the conventional alpha level of .05, the null hypothesis was retained (failed to be rejected), indicating no statistically significant linear relationship between truck count and distance. This suggests that, within this dataset, the

volume of yam distributed (as reflected in truck count) is not significantly predicted by distance alone. Table 5. The P-value of 0.823 implies that the chance of rejecting H_0 is low.

Figure 5 shows more yam trade interaction within a distance of 0 – 600 on the correlation graph. The volume of yam truck count (x) is plotted against distance (y) to reveal the concentration of points within the nearest distance to the Zaki Biam yam market (at point zero 0, on the graph). However, this clustering largely reflects that most destinations happen to lie within this distance range, rather than indicating a genuine distance effect: the near-zero, non-significant correlation coefficient ($r = -.063$, $p = .823$) shows that truck count does not systematically decline with distance. The pattern is therefore not consistent with a simple distance-decay relationship as posited in Ullman's (1957) gravity model; rather, it points to market demand and logistical decisions as the stronger determinants of flow volume, in line with the discussion.

Discussion

Implications of flow mapping for food security. The location of the point of distribution is crucial in ensuring proper food dissemination to demanding parts of the country. Figures 2 and 3 show the centrality of Zaki Biam, the source region. It is located within the middle belt of Nigeria. The location is strategic and can easily be accessed from every State of the country. The Yam flow revealed the continuous availability of yams for export to other States throughout the year. This has fulfilled the availability element of the food security dimension concept. This means that there is enough yam available for consumption at the Zaki Biam market that can take care of the yam needs of the population.

Furthermore, the availability and flow of yams from the region show that food is accessible to all, regardless of which part of the country a buyer comes from. The flow maps (Figures 1 and 3) show that buyers access the market from all ends of the country. For example, the flow lines terminate at Sokoto, Kano, Borno, Lagos, and Cross River States, respectively. The continuous flow of the yam commodity also shows that the yam flow is stable throughout the year. Preliminary findings show that in June and July, when the new yam is expected, the Zaki Biam yam market was still trading trucks of yam from the old stock. This implies that the yam supply from that market can be relied upon throughout the year.

Taken together, these findings make two contributions to knowledge. First, they close a documented gap in the Nigerian yam literature. Whereas earlier studies examined indigenous production practices, the socio-cultural significance of yam, and transportation systems in general terms, this study empirically maps and quantifies the actual commodity flow of yam from Benue State, Nigeria's principal surplus zone, to its destination markets. By disaggregating flow volumes by truck type, route, and destination, and by testing the statistical relationship between distance and volume, the study shows that farmers'/sellers' and buyers'/transporters' choices, rather than distance alone, shape the pattern of yam distribution. This refines the assumption drawn from the gravity model that flow volume simply decays with distance, and demonstrates

that market demand and logistical decisions are equally, if not more, important for understanding commodity flow from Benue State. Figure 6 shows the major road network connection in Nigeria and the location of the Zaki Biam yam market in Benue State.



Fig. 6. Map of Nigeria showing major road network/flow connectivity

Source: © OpenStreetMap contributors, 2026

Implications of yam flow to policy and planning. Commodity flow is not restricted to food commodities but includes raw materials, other goods, and services from their point of origin to the end-users. Policies are designed to ensure smooth and efficient commodity flow. However, before a commodity flow policy can be arrived at, the flow of the commodity concerned must be determined before issues about the flow can be addressed through policy formulation. It, therefore, means that commodity flow surveys are crucial as the bedrock of commodity policy and planning, particularly to ensure food security.

Food security investigation begins with a basic understanding of the location of food sources, availability, and vulnerability within a region. The identification of areas of food demand and the monitoring of food flows have implications for the food security of local populations. This gives information on the commodities sold, their value, weight, and

mode of transportation. Commodity flow data are utilized by researchers, planners, businessmen, the government, and other stakeholders for proper decision-making.

An economic choice may be made once the spatial distribution, linkages, and description of the roles of specific markets (such as the feeder markets) are identified, how markets within a system interact with one another, and the weight of commodities delivered to each region has been established. In general, sustaining a healthy economy, assuring consumer welfare, and promoting sustainable development all depend on policies governing the flow of commodities. Economic development, improved trade ties, and increased efficiency of the global supply chain may all be attributed to effective policies.

Commodity flow policies often include regulations and standards to ensure the quality, safety, and compliance of commodities during transportation and distribution. Policies related to security and border control aim to prevent smuggling, illegal trade, and other activities that can disrupt commodity flow, and national security should be put in place. Policies related to transportation infrastructure, including roads, railways, ports, and airports, play a crucial role in facilitating commodity flow. It is through commodity flow investigations of this nature that such issues can be identified and the proper recommendations made.

Social significance of commodity flow. The flow of commodities plays a critical role in shaping social structures, influencing economies, and maintaining societal well-being. The yam flow from the Zaki Biam yam market to other parts of Nigeria has also influenced ties between Benue and the neighboring states. When commodities such as food, technology, and raw materials move efficiently across regions and borders, they provide access to resources while influencing other social conditions (Murray et al., 2017). This flow fosters economic interdependence, creates job opportunities, and enhances the standard of living for many. Also, commodity flow ensures that societies can meet basic needs, reducing the risk of shortages and price volatility that could unduly affect vulnerable populations. In this way, a stable and consistent commodity flow promotes social harmony by ensuring the fair distribution of goods and mitigating inequality.

Ensuring the smooth flow of the yam commodity from Zaki Biam is essential to maintaining social stability and fostering cooperation. The yam crop's utility demands and services greatly increased its production and marketing in pre-colonial Tiv territory. Closer interactions between Tiv people in their domain were also brought forth. Interruptions to this flow, whether due to herdsmen attacks on farming households, political conflict, poor road infrastructure, trade restrictions, or logistical challenges, can lead to a significant social divide. For instance, disruptions in food supply chains can cause price spikes and scarcity, brewing tensions among communities and between the states. Ensuring that commodity flows remain unimpeded not only supports economic growth but also promotes intercultural/inter-state collaboration and reduces the likelihood of conflict.

These disruptions are not hypothetical. Empirical studies in Benue State report that a large majority of farming households have experienced direct attacks by herdsmen, with associated loss of farmland, livestock, and, in a substantial proportion of cases, lives

(Sowunmi et al., 2025). Related research documents the displacement of farming communities across several Local Government Areas of Benue State as a direct consequence of these attacks, alongside reduced crop output and the erosion of rural livelihoods (Apenda, 2016; Abbas, 2014). Because Zaki Biam and its surrounding communities sit within this same conflict-affected corridor, sustained insecurity poses a direct threat not only to yam production but to the reliability of the flow patterns documented in this study. Any policy response to these findings must therefore also address the security of farming communities and transport corridors, and not transportation infrastructure alone.

Conclusions

Yam commodity flow from the Zaki Biam yam market has a long history in the Benue region, stretching back to the precolonial era. This study investigated the yam flow from the Zaki Biam yam market to other parts of Nigeria. The study demonstrated the geospatial method of disaggregating data, particularly commodity movement data, for analysis and reporting. Findings revealed the magnitude of yam flows from the Zaki Biam yam market to the northern and southern parts of Nigeria. The weight of the flow was observed to be more towards the south, with 396 trucks of yam sold to the south and 76 trucks to the north within November 2023.

The statistical correlation analysis concluded that the flow is not necessarily tied to distance alone but to other factors like market demands or seasonal/harvest variation. Furthermore, the study identified areas where policy and planning procedures could be initiated in the commodity flow to ensure food security.

Understanding the social implications of commodity flow, market linkages, and their existing characteristics could assist key stakeholders, analysts, and other decision-makers in pinpointing the areas of concern and elaborating on the possible effects of disruptions or stoppage of supply from the supplying region on the food security system. The GIS procedure once again proved to be a viable tool that is very beneficial for comprehensive analysis.

The study recommends that it is crucial to ensure trade relations from the Zaki Biam yam market to other parts of the country. This will boost food supply and social interaction, among other benefits. This can be achieved through government intervention or partnership with relevant organisations and stakeholders. Secondly, the government and other stakeholders should uphold commodity flow record-keeping for proper economic planning and policy formulation. Furthermore, repeated flow analysis should be carried out at regular intervals to discern trends, monitor growth, and observe changes in the movement of goods within a region to avoid breakdown of food supply and security. By adopting such steps, sustainable practices, and efficient risk management strategies, the commodity flow can be improved, leading to greater economic growth and global trade opportunities in Benue State. Considering the crucial role of Benue State in yam production and the dependency of the nation on supply from Benue, to avert food insecurity in the nation, it is also recommended that the incessant attacks by bandits on

Benue State should be checked. This recommendation is reinforced by evidence that herder attacks and rural insecurity have already reduced crop output and displaced farming communities across Benue State (Apenda, 2016; Sowunmi et al., 2025), emphasizing the urgency of security interventions alongside infrastructural and policy measures for sustaining yam flow and national food security.

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Declaration of Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

The data supporting the findings of this study, including the questionnaire survey responses, truck count records, and GIS flow-mapping datasets collected during fieldwork in November 2023, are available from the corresponding author upon reasonable request.

Use of Generative AI and AI-Assisted Technologies

No generative AI or AI-assisted technologies were employed in the preparation of this manuscript.

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