



Transport Accessibility and Agricultural Produce Marketing in Makarfi Local Government Area, Kaduna State, Nigeria

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ABSTRACT

Road transportation constrains agricultural marketing in rural Nigeria, where poor road networks and inadequate vehicles hinder produce movement. This study examined the effect of road transport accessibility on the marketing of agricultural produce in Makarfi Local Government Area (LGA) of Kaduna State, Nigeria. A quantitative cross-sectional survey was adopted; reconnaissance and questionnaire administration were carried out between March and July 2025, using stratified and purposive sampling to select 247 respondents comprising vehicle operators (46%), farmers (30%), and marketers (24%), of whom 235 valid responses were obtained (95.1%). Data were analysed using descriptive statistics and the Kruskal-Wallis H test. Motorcycles (34%) and bicycles (29%) were the most used transport modes; Trunk A roads accounted for 66% of market connectivity, used mainly by vehicle operators. Maize (29%) was the most purchased produce, 40% was moved to other markets, and lorries (35%) were the primary outbound means. Transport costs burdened 37% of respondents (₦1,000–₦3,000 per trip), while poor roads (35%) were the leading challenge. The Kruskal-Wallis test revealed a significant difference in produce volume across six modes ($H = 163.35$, $df = 5$, $p < .001$, $\epsilon^2 = 0.698$); post-hoc analysis confirmed that lorries, buses, and taxis moved significantly larger volumes than bicycles, motorcycles, and donkeys. The study concludes that inadequate roads and high transport costs constrain marketing efficiency and recommends rural road investment, storage facilities, transport cost regulation, and intergovernmental collaboration.

Keywords: Agricultural Produce; Kaduna State; Makarfi LGA; Marketing; Transport Accessibility

1. Introduction

Transport is a fundamental factor in agricultural development globally, serving as the primary means by which food produced on farms reaches homes and markets (Tunde & Adeniyi, 2012). It creates markets for agricultural produce, enhances interaction among geographical and economic regions, and opens new areas to economic activity. It is a key ingredient in rural development, providing people with access to goods and services (Njenga & Mbara, 2005); recent cross-country evidence confirms that transport connectivity remains a binding constraint on agricultural production and food security in developing economies (Iimi, 2022; World Bank, 2025).

Agriculture is the major occupation of the population of Makarfi LGA and of Nigeria generally, providing employment directly or indirectly for at least 60% of people in Kaduna State (Foin, 2002). The major agricultural produce found in the area includes maize, rice, guinea corn, millet, beans, sugar cane, and melon. These products serve as food and raw materials for industries within and outside the state, and also provide revenue to farmers and generate foreign exchange. Nigeria is basically an agrarian nation, and most goods requiring transport are agricultural products, which are by nature bulky, low-priced, and highly perishable, and must be conveyed from production to consumption with minimum delay and cost (Onwudinjo et al., 2013). A correspondingly widespread transport network is required to move produce from farms to markets. Njenga and Mbara (2005) noted that inadequate supply and high foodstuff costs are a consequence of inefficient transportation, which leads to the waste of about 25% of total agricultural foodstuff produced. The role of transport is crucial, as production is not complete until the commodity reaches the final consumer (Adefolalu, 1977); availability of transport facilities is a critical investment factor that stimulates economic growth through increased accessibility, efficiency, and effectiveness, also influencing the cost of commodities and the purchasing power of consumers (Hine & Ellis, 2001).

Vehicular modes for moving agricultural goods include tractors, pick-up vans, trucks, cars, buses, motorcycles, and bicycles, each with its own cost profile; transportation cost is determined by haulage length, the nature of the goods, the environment, competition among transporters, and the availability of return haulage (Winston, 1983). Makarfi LGA, in northern Nigeria, is predominantly agrarian and dominated by road transportation, with only two major roads and a number of feeder roads, motivating this study's examination of transport accessibility on agricultural produce marketing in the area.

According to Onwudinjo et al. (2013), there is an inadequacy of vehicles to convey farm outputs from farms to markets in Nigeria; roads are inadequate and in poor condition, forcing the use of donkeys, bicycles, wheelbarrows, and trekking, which makes agricultural marketing costly and difficult. A Central Bank of Nigeria report (2003) stated that the poor transport system negatively impacts production costs, triggering cost-push inflation. Previous studies (Filani, 1976; Gana, 1976; Ogunsanya, 1979; Ogwude, 1997; Dominic, 2009; Haruna, 2011) examined various aspects of agricultural transportation, and more recent empirical work confirms the centrality of road transport to agricultural marketing outcomes across Nigeria and other developing economies (Akpan & Morimoto, 2022; Utuk et al., 2024; Aboyeji & Aguda, 2024; Ezeudu & Obimbua, 2024; Oyinlola et al., 2025; Ugwu et al., 2025). Despite this body of work, limited attention has been given specifically to the relationship between transport accessibility and the marketing of agricultural produce in Makarfi LGA. Poor feeder roads, inadequate transport services, and high transport costs increase travel time and may contribute to produce losses, yet empirical evidence on how these accessibility constraints affect agricultural produce marketing in this specific setting remains limited. This study addresses that gap by examining the means of transport used, the types and volume of produce moved, the movement pattern, the cost of transportation, and the associated challenges.

Specifically, the study examines the modes of transportation used, the types and volume of produce moved, the movement pattern, the cost of moving produce, the challenges encountered, and the differences in volume transported across modes. Accordingly, the study tests the hypothesis that there is no significant difference in the volume of agricultural produce transported by the different modes of transportation in Makarfi LGA (H_0), against the alternative that such a difference exists (H_1).

2. Literature Review

2.1 Role of Transportation in Agricultural Development

Transport is a fundamental factor in agricultural development, serving as the primary means by which farm produce reaches homes and markets, creating access to markets, enhancing regional interaction, and opening new areas to economic focus (Tunde & Adeniyi, 2012; Njenga & Mbara, 2005). The role of transport is crucial, as production is incomplete until commodities reach final consumers (Adefolalu, 1977). Availability of transport facilities stimulates economic growth through increased accessibility, efficiency, and effectiveness; recent multi-country evidence corroborates this, finding that improved transport connectivity is directly associated with higher agricultural output and market participation among smallholder farmers (Iimi, 2022).

2.2 Road Transport Network and Accessibility

Transportation systems are typically represented as networks of routes connecting locations identified as nodes; road networks grow over time, comprising nodes (settlements), edges (links), and routes. Foin (2002) found that road transport networks alone, without other farm inputs, cannot improve agricultural yields, and although road networks have expanded, they have not significantly influenced agricultural produce marketing in his study area. This continues to be borne out in more recent Nigerian evidence: Utuk et al. (2024) found that road transport infrastructure remains a statistically significant determinant of agricultural output at the national level, even after accounting for other inputs, reinforcing the view that road accessibility is a necessary, though not sufficient, condition for agricultural marketing efficiency.

2.3 Rural Transportation Systems

The demand for rural transport involves moving people and agricultural produce between locations. The World Bank (1976) observed that off-farm transport is essential since few farms and markets are directly served by roads. Nigeria has one of the lowest rural road densities, with 70% of rural roads in poor condition (World Bank, 1996). Idachaba (1985) emphasised that rural roads increase agricultural output and improve access to markets, medical centres, and schools; transport availability motivates free exchange between rural and urban communities, raising farmers' incomes above subsistence levels. Akpan and Morimoto (2022) modelled the motorised travel mode choices of smallholder farmers in Akwa Ibom State, Nigeria, and found that road condition, distance, and haulage cost jointly determine whether farmers rely on motorcycles or larger motorised vehicles, a finding directly relevant to the mode choices examined in the present study.

2.4 Marketing of Agricultural Produce

Agricultural marketing involves assembling, storing, transporting, and distributing commodities. Markets are groups of buyers and sellers with trading facilities (Narteh, 2012). The pattern of agricultural marketing is strongly influenced by transport services; developing countries often suffer from monopolistic, low-volume, and high-cost transport systems (Orakwue et al., 2015), and transport charges vary significantly between countries and between rural short-haul and long-distance transport (Hine & Ellis, 2001). Ezeudu and Obimbua (2024) similarly found that poor transport and logistics infrastructure remain among the most binding constraints preventing rural producers from realising the full value of their produce, alongside inadequate storage and weak market information systems.

2.5 Agricultural Produce Market Structure

Traditional agricultural marketing systems involve numerous individuals performing assembling, storage, transportation, and break-of-bulk functions (Owusu, 2005). Rural periodic markets, such as Makarfi Central Market, serve village and local community needs. Tumbuan et al. (2006) found that the most common transport modes to rural markets are foot and bicycle; accessible rural markets located on motorable roads serve as collection points for produce destined for urban centres, drawing farmers and traders from distances of up to 10 km. This pattern of market accessibility shaping marketing outcomes is echoed in Oyinlola et al.'s (2025) recent study of Ekiti State, Nigeria, which found that farmers connected to markets by better-quality roads recorded significantly higher marketing efficiency and lower post-harvest losses.

2.6 Freight Transport Demand for Agricultural Produce

Road transport has a competitive advantage over rail owing to flexibility in routing and responding to dispersed transport demand (Hay & Smith, 1968). Ogunsanya (1979) identified three types of freight movement in urban settlements: metro-imports, metro-transit movements, and intra-metropolitan freight. Ogwude (1997) found that vehicle ownership, transport arrangements, and distribution strategy shape industrial transport demand, while Dominic (2009) revealed that motorcycles and buses are mostly used for agricultural produce movement in rural areas. Ugwu et al. (2025), in a recent case study of Karu LGA, Nasarawa State, similarly found that the type and capacity of the transport mode used by marketers is the single strongest predictor of the volume of produce moved per trip, a finding this study's Kruskal-Wallis analysis directly tests for Makarfi LGA.

2.7 Challenges in Agricultural Produce Transportation

Inefficient transportation leads to inadequate supply and high food costs, resulting in waste of agricultural produce (Njenga & Mbara, 2005). Idah et al. (2007) found that the non-availability of vehicles forces buyers to use unsuitable transport means, resulting in losses. Kassali et al. (2012) revealed that trekking and bicycle use negatively affect farmers' efficiency, suggesting the adoption of motorised transport to optimise farming time and increase productivity. Aboyeji and Aguda's (2024) recent study of cashew farmers across 36 rural settlements in Kwara State similarly found that poor road condition and limited access to motorised transport services significantly depressed both farm output and marketed income, reinforcing the continued relevance of these challenges.

Taken together, the literature agrees that road condition, transport mode availability, and transport cost jointly shape agricultural marketing outcomes in Nigeria and other developing economies, and that non-motorised, low-capacity modes constrain the volume of produce moved per trip. Consensus is weaker on whether infrastructure investment (Foin, 2002; Utuk et al., 2024) or transport-service factors such as vehicle availability and cost (Akpan & Morimoto, 2022; Ugwu et al., 2025) is the more binding constraint. Despite this body of work, limited empirical attention has been paid to Makarfi LGA specifically, and in particular to the statistical relationship between transport mode and the volume of produce moved, which this study examines directly through the Kruskal-Wallis H test.

3. Methodology

3.1 Research Design

This study employed a quantitative cross-sectional survey design to measure transport accessibility challenges, patterns, and barriers affecting agricultural marketing in Makarfi LGA.

3.2 Study Area

Makarfi LGA is situated between Latitude 11°20'N and Longitude 7°58'E, on the Hausa high plains of central northern Nigeria at a height of about 650 m above sea level, at the centre of the northern Guinea savannah, with a land size of 562.39 km². The area is bounded by Rogo LGA of Kano State to the northwest, Ikara LGA to the northeast, Likoro and Kudan LGA to the southwest, and Soba LGA to the southeast (Nomau, 2004). Makarfi has two distinct seasons, the rainy season (May to October) and the dry season (November to April), with a mean annual rainfall of about 1,100 mm. Mean daily maximum temperature rises gradually from January (35°C) to April (40°C); atmospheric humidity is generally low (around 15%) in the dry season, with the highest humidity (65% and above) experienced during the wet season (Kowal & Kassim, 1977). These climatic conditions make the area suitable for the cultivation of both food and cash crops in commercial quantities.

The population of Makarfi LGA was 146,574, comprising 73,282 females and 73,292 males (NPC, 2009). The area is predominantly occupied by Hausas, with other ethnic groups as minorities, and the people are actively engaged in agriculture as their major economic activity, producing crops including maize, sorghum, guinea corn, beans, pepper, onion, groundnut, rice, millet, sugarcane, and tomatoes. Makarfi has a periodic market that holds every Wednesday (Jumare, 2006). The LGA is mainly served by Trunk B and Trunk C type road networks, and the Nigerian Railway Track passes through the area, enhancing movement of people, goods, and services, though it has

declined since the late 1980s.

3.3 Population and Sampling

The target population comprised registered vehicle operators ($n = 300$), registered farmers ($n = 200$), and registered marketers ($n = 150$) in Makarfi LGA, giving a combined population of 650. The sample size was determined using the Yamane (1967) formula, $n = N / (1 + N(e^2))$, where n is the sample size, N is the study population (650), and e is the sampling error (0.05): $n = 650 / (1 + 650(0.05^2)) = 650 / 2.625 \approx 247$. Using proportionate allocation, a sample of 247 respondents was selected (38% of the population), comprising 114 vehicle operators (46%), 76 farmers (30%), and 57 marketers (24%), as summarised in Table 1.

Table 1: Sample Size

Group	Population	Sample
Vehicle operators	300	114
Farmers	200	76
Marketers	150	57
Total	650	247

Source: Compiled from Author's Reconnaissance Survey, 2025.

A stratified sampling technique was employed to divide the population into three strata (vehicle operators, farmers, and marketers), and proportionate allocation was used to determine the sample size for each stratum. Because no complete, up-to-date sampling frame exists for informal rural market participants in Makarfi LGA, purposive sampling was then used to select individual respondents within each stratum from among those present and willing to participate during market days; this combination of stratified allocation with purposive selection within each stratum is a widely used practical adaptation in rural surveys where formal registries are incomplete, and is applied here as a non-probability approach for respondent selection within probability-based strata. A total of 247 questionnaires were administered, of which 235 were validly completed and analysed, representing a valid response rate of 95.1%.

3.4 Data Collection Methods

Data were collected using structured questionnaires administered through face-to-face interviews with the assistance of six field assistants conversant with the indigenous language. The questionnaire captured demographic information, travel patterns, transportation modes, costs incurred, and challenges faced. A reconnaissance survey was carried out to properly acquaint the researcher with the study area and to seek the cooperation of farmers, loaders, and vehicle operators. The reconnaissance survey, questionnaire administration, data processing, and analysis all took place in 2025.

3.5 Ethical Considerations

Ethical approval and institutional permission for the study were obtained prior to data collection. Participation was voluntary, and respondents were assured of confidentiality and anonymity. Verbal informed consent was obtained from each respondent before administration of the questionnaire, and respondents retained the right to decline or withdraw at any stage.

3.6 Data Analysis Techniques

Quantitative data were analysed using descriptive statistics (frequencies, percentages, means) and the Kruskal-Wallis H test, which was employed to examine differences in the volume of farm produce transported by the various means of transport available in the area. All analyses were conducted using SPSS version 20, Microsoft Excel 2007, and Python (SciPy and scikit-posthocs libraries), with statistical significance set at $p < 0.05$.

The Kruskal-Wallis H test was employed to examine differences in the volume of farm produce transported across six distinct transport modes (bicycle, motorcycle, bus, taxi, lorry, and donkey). Because the volume data were

ordinal (categorical ranks: <1 bag, 1-5, 6-10, 11-15, 16-20, >20 bags) and the assumption of normality was violated, this non-parametric alternative to one-way ANOVA was appropriate. Upon a significant overall result, Dunn's post-hoc test with Bonferroni correction was applied to identify which specific mode pairs differed significantly. The H statistic was computed as $H = [12 / (N(N+1))] \times \sum (R_i^2/n_i) - 3(N+1)$, where N is the total sample size across all groups (235), R_i is the sum of ranks for group i, and n_i is the sample size of group i. The effect size (epsilon-squared) was computed as $\epsilon^2 = H / (N - 1)$. Dunn's post-hoc pairwise test statistic was computed as $Z = (\bar{y}_1 - \bar{y}_2) / \sqrt{[(N(N+1)/12) \times (1/n_1 + 1/n_2)]}$, where $\bar{y}_1$ and $\bar{y}_2$ are the mean ranks of the two groups being compared and n_1 and n_2 are their respective sample sizes. To control the family-wise error rate across all 15 pairwise comparisons, p-values from Dunn's test were adjusted using the Bonferroni method, $p_{\text{adjusted}} = p_{\text{raw}} \times k$, where k is the number of pairwise comparisons (15).

4. Results and Discussion

4.1 Socio-Economic Characteristics of Respondents

Table 2 presents the sex and age distribution of respondents.

Table 2: Sex and Age of Respondents

Category	Sub-category	Frequency	Percentage
Sex	Male	153	65.0
	Female	82	35.0
	Total	235	100.0
Age	18–28 years	63	27.0
	29–39 years	77	33.0
	40–50 years	48	20.0
	51–61 years	28	12.0
	Above 61 years	19	8.0
	Total	235	100.0

Source: Author's Field Survey, 2025.

Male respondents (65%) dominated, while females constituted 35%. The majority of respondents (33%) fell within the 29–39 years age bracket, followed by 27% in the 18–28 years category, while the lowest proportion (8%) were above 61 years. The predominance of younger respondents indicates that market activities, particularly loading and offloading of farm produce, attract youthful and physically capable individuals; the gender disparity reflects cultural norms in northern Nigeria, where market participation is predominantly male-oriented.

Table 3: Educational Qualification and Occupation of Respondents

Category	Sub-category	Frequency	Percentage
Level of education	No formal education	60	26
	Qur'anic	90	38
	Primary	47	20
	Secondary	27	11
	Tertiary	11	5
	Total	235	100
Occupation	Farming	66	28
	Trading	87	37
	Driving	56	24
	Civil servant	11	5
	Others	15	6
	Total	235	100

Source: Author's Field Survey, 2025.

Qur'anic education (38%) constituted the highest proportion, followed by no formal education (26%), while tertiary education (5%) recorded the lowest. Trading (37%) was the most dominant occupation, followed by farming (28%), while civil servants (5%) were the least represented. The relatively high proportion of respondents with Qur'anic education indicates limited participation in formal education; the high proportion of traders reflects the survey being conducted in the marketplace, while the low civil-servant representation corresponds with low tertiary-education attainment.

Table 4: Marital Status of Respondents

Marital Status	Percentage
Married	50
Single	38
Widowed	5
Other	7
Total	100

Source: Author's Field Survey, 2025.

Half of respondents (50%) were married, 38% were single, and 5% were widowed. The substantial proportion of unmarried respondents suggests that many youth actively participate in market activities.

4.2 Modes of Transport Used for the Movement of Agricultural Produce

Table 5: Modes of Transport Available in the Study Area

Means of Transport	Frequency	Percentage
Trekking	54	23.0
Bicycle	69	29.0
Donkey	17	8.0
Motorcycle	81	34.0
Others	14	6.0
Total	235	100.0

Source: Author's Field Survey, 2025.

Motorcycles (34.0%) were the most commonly used mode, followed by bicycles (29.0%) and trekking (23.0%), while donkeys (8.0%) and other means (6.0%) recorded the lowest usage. The predominance of motorcycles and bicycles reflects poor road conditions and inaccessibility between farms, markets, and homes; the absence of tarred, motorable roads implies that large volumes of farm produce cannot be easily moved, forcing reliance on smaller-capacity vehicles and manual transportation. This pattern is consistent with Foin (2002), who found that untarred roads make transportation difficult, and is corroborated by Akpan and Morimoto's (2022) finding that road condition and haulage distance are the strongest predictors of whether Nigerian smallholder farmers rely on motorcycles rather than larger motorised vehicles.

4.3 Road Connectivity and Distance to Market

Table 6: Road Connectivity to the Market

Group	Footpath	%	Trunk A	%	Trunk B	%	Trunk C	%	Total
Vehicle operators	5	12.0	57	66.0	35	54.0	11	26.0	108
Farmers	25	61.0	9	10.0	17	26.0	22	52.0	73
Marketers	11	27.0	21	24.0	13	20.0	9	22.0	54
Total	41	100.0	87	100.0	65	100.0	42	100.0	235

Source: Author's Field Survey, 2025. Percentages are each group's share of that road type's own column total.

Among vehicle operators, 57 (66.0%) reported Trunk A roads as recording the highest connectivity. Among farmers, 25 (61.0%) reported footpaths as having the highest connectivity, followed by Trunk C roads (52.0%). Among marketers, footpaths and Trunk A roads recorded comparable connectivity (27.0% and 24.0% respectively). The high reliance on footpaths by farmers (61.0%) limits their ability to transport large produce volumes. That Trunk A roads provide 66% connectivity for vehicle operators while farmers rely predominantly on footpaths suggests a marked disparity in road access across stakeholder groups, echoing Foin's (2002) observation that road infrastructure in Makarfi LGA disproportionately serves motorised users.

Table 7: Distances from Respondents' Farm to Market

Group	<1 km	%	1–2 km	%	3–5 km	%	6–10 km	%	>10 km	%	Total
Vehicle operators	16	48	23	43	31	38	28	68	10	40	108
Farmers	12	36	17	31	28	34	10	24	6	24	73
Marketers	5	16	14	26	23	28	3	8	9	36	54
Total	33	100	54	100	82	100	41	100	25	100	235

Source: Author's Field Survey, 2025. Percentages are each group's share of that distance band's own column total.

Among vehicle operators, the largest share (68% of those travelling 6–10 km) reported this as the most common distance; among farmers, 3–5 km was the most frequently reported (34%); among marketers, distances above 10 km were most common (36%). Vehicle operators service comparatively longer routes, while farmers and marketers more often operate within shorter radii of the market.

Table 8: Condition of Road to the Farm

Road Condition	Percentage
Not motorable	55
Motorable	45
Total	100

Source: Author's Field Survey, 2025.

More than half of respondents (55%) reported that the road to their farm is not motorable, indicating a degree of neglect in the maintenance of feeder roads, which may reduce the volume of agricultural produce transported to market.

4.4 Types and Volume of Agricultural Produce Transported

Table 9: Type of Agricultural Produce Purchased by Respondents

Agricultural Produce	Frequency	Percentage
Maize	67	29
Sugarcane	21	9
Sorghum	16	7
Millet	34	14
Rice/beans	43	18
Other	54	23
Total	235	100

Source: Author's Field Survey, 2025.

Maize (29%) was the most commonly purchased, followed by rice/beans (18%) and millet (14%), while sorghum (7%) recorded the lowest patronage. The predominance of maize indicates that cereal crops are the most cultivated in the area, consistent with the known agro-ecological profile of the northern Guinea savannah (Kowal & Kassim, 1977); the low purchase of sorghum suggests limited market demand for this crop in the study area.

Table 10: Type of Crop Cultivated Versus Means of Transportation to the Market (%)

Crop Type	Bicycle	Motorcycle	Bus	Lorry	Taxi	Donkey
Maize	11.2	15.2	15.2	19.0	9.0	8.3
Millet	6.7	13.1	9.2	14.0	10.0	23.7
Sorghum	13.9	23.1	16.1	21.3	12.0	18.3
Beans	10.6	9.2	11.2	14.4	17.0	17.0
Rice	13.0	27.3	40.1	18.0	47.0	3.3
Sugarcane	1.2	2.1	1.5	11.3	1.0	1.7
Sweet potatoes	43.4	10.0	6.7	2.0	4.0	27.7
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Author's Field Survey, 2025.

Rice was mostly moved by taxi (47%) and bus (40.1%), while sweet potatoes were predominantly transported by bicycle (43.4%), reflecting their small-scale, low-volume cultivation; heavier cereals such as sorghum and maize were more evenly spread across motorised modes. This suggests that the weight and nature of the produce, not only its point of origin, shapes the transport mode chosen, consistent with Akoel et al. (2014).

Table 11: Volume of Produce Versus Means of Transportation (%)

Crop Volume (100 kg bags)	Bicycle	Motorcycle	Bus	Lorry	Taxi	Donkey
Less than 1 bag	87.3	36.7	2.3	0.0	3.3	36.3
1–5 bags	12.7	63.3	7.7	0.0	10.0	63.7
6–10 bags	0.0	0.0	22.9	3.3	54.1	0.0
11–15 bags	0.0	0.0	19.0	13.4	21.0	0.0
16–20 bags	0.0	0.0	41.4	30.8	11.6	0.0
Above 20 bags	0.0	0.0	6.7	52.5	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Author's Field Survey, 2025.

Loads under 1 bag were predominantly moved by bicycles (87.3%) and motorcycles (36.7%), while 1–5 bags were mostly moved by donkeys (63.7%) and motorcycles (63.3%). Buses handled mainly 6–20 bags (peaking at 41.4% for 16–20 bags); taxis handled mainly 6–15 bags; and 52.5% of lorry loads exceeded 20 bags. This confirms a direct relationship between produce volume and mode capacity, foreshadowing the Kruskal-Wallis result reported below.

4.5 Movement Pattern of Agricultural Produce

Table 12: Destination of Agricultural Produce Purchase

Destination	No. of Respondents	Percentage
Home	64	27
Market	93	40
Industries	35	15
Other	43	18
Total	235	100

Source: Author's Field Survey, 2025.

Most produce (40%) went to other markets for further exchange, followed by homes (27%), while industries (15%) recorded the lowest share. The predominance of market-bound produce indicates that most commodities are traded rather than consumed locally, highlighting the area's role as a distribution hub (Onwudingo et al., 2013); the low industrial share reflects limited agro-allied activity, attributable to power-supply challenges and the absence of processing industries.

Table 13: Means of Transporting Agricultural Produce

Means of Transport	No. of Respondents	Percentage
Bicycle	24	10
Motorcycle	37	16
Bus/taxi	47	20
Lorry	82	35
Donkey	16	7
Head portorage	29	12
Total	235	100

Source: Author's Field Survey, 2025.

Lorries (35%) were the most common means of transporting produce out of Makarfi, followed by bus/taxi (20%) and motorcycle (16%), while donkeys (7%) recorded the lowest usage. The predominance of lorries indicates that most respondents purchase in bulk and pool costs by boarding larger vehicles. Ezeudu and Obimbua (2024) found that bulk purchasers in rural Nigerian markets similarly rely on higher-capacity vehicles to spread costs.

4.6 Cost of Transporting Agricultural Produce

Table 14: Cost of Moving Agricultural Produce to the Market

Amount Paid (₦)	No. of Respondents	Percentage
Less than 1,000	35	15
1,000–3,000	87	37
3,000–5,000	62	26
Above 5,000	51	22
Total	235	100

Source: Author's Field Survey, 2025.

Most respondents (37%) paid ₦1,000–₦3,000, 26% paid ₦3,000–₦5,000, and only 15% paid less than ₦1,000. This moderate-to-high cost burden reflects fuel-price increases, the monopolistic nature of local road transport, and poor

rural road conditions raising vehicle operating costs. This is corroborated by Ugwu et al.'s (2025) finding that transport costs in rural Nigerian markets rise disproportionately where road quality is poor, reducing farmers' profit margins.

Table 15: Purchase of Agricultural Produce by Respondents

Purchase Category	No. of Respondents	Percentage
Farmers	63	27
Retailer	59	25
Wholesale	77	33
Others	36	15
Total	235	100

Source: Author's Field Survey, 2025.

Wholesale buyers (33%) accounted for the largest share, followed by farmers themselves (27%) and retailers (25%), while others, including industries, accounted for the smallest share (15%), consistent with the area's subsistence orientation and low industrial activity.

4.7 Challenges Affecting the Movement of Agricultural Produce

Table 16: Challenges in the Movement of Agricultural Produce by Respondents

Group	Insufficient Means	%	High Cost	%	Road Condition	%	Road Network	%	Revenue Collectors	%
Vehicle operators	16	48	17	31	31	38	28	68	10	40
Farmers	12	36	23	43	28	34	10	24	6	24
Marketers	5	16	14	26	23	28	3	8	9	36
Total	33	100	54	100	82	100	41	100	25	100

Source: Author's Field Survey, 2025. "Insufficient Means" = insufficient transport means. Percentages are each group's share of that challenge's own column total.

Poor road condition (35% overall) was the most pressing challenge, perceived predominantly by vehicle operators (68%), followed by high cost of transport (23% overall), mostly experienced by farmers (43%); insufficient transport means (14%) and poor road network (17%) were also significant. This dominance of poor road conditions, which raises travel time, fuel consumption, and maintenance costs, is consistent with the Central Bank of Nigeria (2003), and Aboyeji and Aguda's (2024) recent Kwara State study confirms these constraints remain materially unchanged.

Table 17: Effects of Challenges in the Movement of Agricultural Produce

Group	Energy Consumption	%	Low Profit	%	Produce Damage	%	Transport Cost	%	Reduced Quality	%
Vehicle operators	32	76	44	73	14	23	11	23	7	29
Farmers	6	14	10	17	26	43	19	40	12	50
Marketers	4	10	6	10	21	34	18	37	5	21
Total	42	100	60	100	61	100	48	100	24	100

Source: Author's Field Survey, 2025. "Energy Consumption" = high energy consumption; "Low Profit" = low profit on produce; "Transport Cost" = high transport cost. Percentages are each group's share of that effect's own column total.

Vehicle operators bore the highest burden of high energy consumption (76%) and low profit on sales (73%); farmers bore the highest burden of damage to produce (43%), high transportation cost (40%), and reduced produce quality (50%). This is consistent with Idah et al. (2007), who found that vehicle unavailability leads to losses, and Kassali et al. (2012), who recommended motorised transport to improve farmers' efficiency; these challenges significantly affect food security, farmer incomes, and marketing efficiency.

4.8 Differences in the Volume of Produce Transported by Mode

To examine the sixth research objective, the Kruskal-Wallis H test was performed on the ordinal volume categories across the six transport modes.

Table 18: Volume Differences Across Transport Modes

Test Statistic	Value	df	p-value
Kruskal-Wallis H	163.35	5	< 0.001

Effect size (epsilon-squared, ϵ^2) = 0.698, a very large effect ($\epsilon^2 > 0.25$).

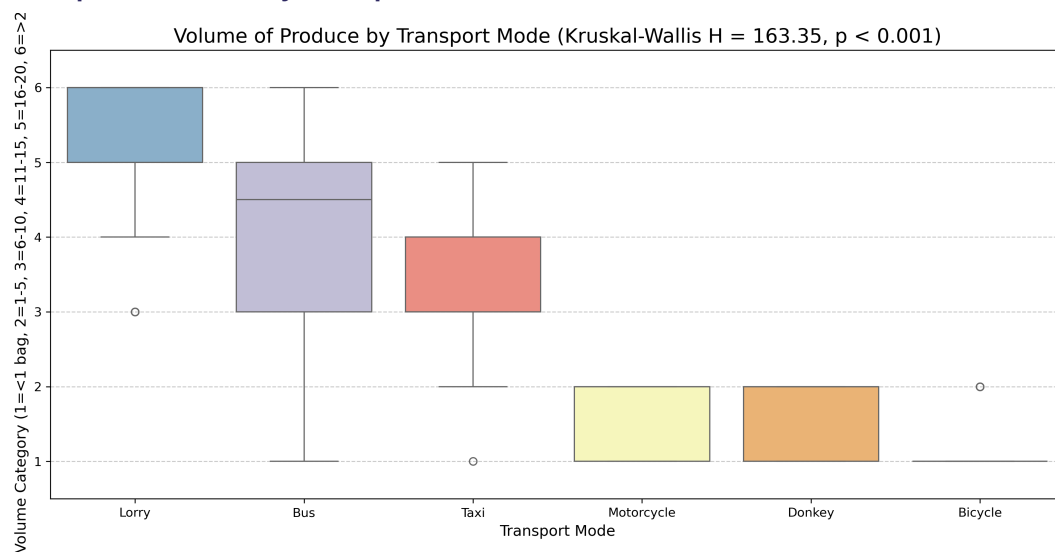
The result reveals a highly significant difference in produce volume across transport modes ($H = 163.35$, $df = 5$, $p < .001$). The effect size ($\epsilon^2 = 0.698$) indicates a very large practical significance, explaining approximately 70% of the variance in volume transported. Post-hoc analysis confirmed that lorries (mean score = 5.32) and buses (4.08) carry substantially larger volumes than bicycles (1.12) and motorcycles (1.62), confirming that vehicle capacity critically determines marketing efficiency; H_0 is therefore rejected and H_1 accepted.

Table 19: Mean Volume by Transport Mode

Transport Mode	Mean Volume Score (1–6 Scale)
Lorry	5.32
Bus	4.08
Taxi	3.30
Donkey	1.62
Motorcycle	1.62
Bicycle	1.12

Source: Author's Kruskal-Wallis Analysis, 2025.

The mean volume scores reveal a distinct capacity hierarchy. Lorries recorded the highest score (5.32), indicating most trips exceed 20 bags, while buses (4.08) and taxis (3.30) handle intermediate volumes; bicycles (1.12), motorcycles (1.62), and donkeys (1.62) are confined to the lowest categories, predominantly under 5 bags. This confirms that non-motorised modes are inadequate for bulk marketing, forcing multiple trips, higher costs, and reduced farmer returns; the hierarchy is materially identical to that reported by Ugwu et al. (2025) for Karu LGA, Nasarawa State, suggesting the pattern generalises across northern and north-central Nigerian rural markets.

Figure 1: Boxplot of Volume by Transport Mode

Source: Author's Kruskal-Wallis Analysis, 2025.

Figure 1 corroborates the statistical findings: lorries exhibit the highest median volume category, followed by buses and taxis, while bicycles, motorcycles, and donkeys cluster at the lowest category. The narrow interquartile ranges for non-motorised modes indicate consistent small-volume transport, whereas the wider spread for lorries reflects their capacity for variable bulk volumes; this confirms the capacity hierarchy from the Kruskal-Wallis test and is consistent with Kassali et al. (2012), who found that motorised transport significantly increases farmers' marketed surplus.

Table 20: Pairwise Comparison Matrix (Dunn's Test, Bonferroni-Adjusted p-Values)

Mode	Bicycle	Motorcycle	Donkey	Taxi	Bus	Lorry
Bicycle	–	1.0000	1.0000	< 0.001	< 0.001	< 0.001
Motorcycle	1.0000	–	1.0000	0.0166	< 0.001	< 0.001
Donkey	1.0000	1.0000	–	0.1195	0.0024	< 0.001
Taxi	< 0.001	0.0166	0.1195	–	1.0000	< 0.001
Bus	< 0.001	< 0.001	0.0024	1.0000	–	0.0579
Lorry	< 0.001	< 0.001	< 0.001	< 0.001	0.0579	–

Note: Values < 0.05 indicate a statistically significant difference.

The pairwise matrix reveals significant volume differences between most mode pairs. Lorries differ significantly from bicycles, motorcycles, donkeys, and taxis ($p < .001$), but the difference with buses is borderline ($p = .0579$); buses and taxis differ significantly from bicycles, motorcycles, and donkeys ($p < .01$). No significant differences exist between motorcycles and donkeys, or between buses and taxis ($p = 1.000$ in both cases), indicating these pairs perform similarly; bicycles consistently transport the smallest volumes, with 87.3% carrying less than 1 bag. These results demonstrate that transport mode significantly affects the volume of produce moved, and the rejection of H_0 confirms that motorised vehicles (lorries, buses, taxis) transport substantially larger quantities than non-motorised modes (bicycles, motorcycles, donkeys), highlighting the need for investment in rural transport infrastructure and affordable access to larger vehicles in Makarfi LGA.

5. Conclusion and Recommendations

This study concludes that road transportation plays an important role in agricultural produce marketing in Makarfi LGA. Motorcycles and bicycles dominate as means of transport because of poor road conditions and limited access to motorised vehicles, and the volume and type of produce transported are determined by the means of transportation available, with lorries handling bulk produce and bicycles handling smaller quantities. Transportation costs are generally high, imposing a significant burden on farmers and marketers, and the most pressing challenges are poor road conditions and high transportation costs, leading to produce damage, reduced quality, and decreased incomes. Accessibility in the area is generally poor, especially to farms, and this constrains agricultural marketing efficiency; the Kruskal-Wallis H test confirmed a statistically significant difference in the volume of agricultural produce transported by different modes ($H = 163.35$, $df = 5$, $p < .001$, $\epsilon^2 = 0.698$), with motorised vehicles such as lorries and buses enabling bulk movement, while non-motorised modes such as bicycles, motorcycles, and donkeys are limited to small quantities.

Based on these findings, seven recommendations are made. First, because poor road condition was the most pressing challenge (35% overall, affecting 68% of vehicle operators), the Federal, State, and Local Governments should construct and regularly maintain roads, connecting inaccessible areas to facilitate produce movement and reduce transport costs. Second, because 43% of farmers and 34% of marketers reported produce damage, the Makarfi Local Government Authority should provide storage facilities to prevent losses. Third, given the congestion implied by the area's reliance on a narrow road network, parking spaces for trailers, canters, pick-ups, vans, buses, and taxis should be provided to ease loading and offloading on market days. Fourth, because 37% of respondents cited high transport costs as a burden, the National Union of Road Transport Workers should enact a standard, distance-based price for moving produce in Makarfi LGA. Fifth, law enforcement agencies' roles along transport routes should be clearly defined to prevent extortion and service delays. Sixth, given that only 15% of produce currently reaches industrial buyers, government tiers should collaborate on reliable power supply to motivate agro-allied activity. Finally, given that 55% of respondents reported their farm road is not motorable, government and farmer organisations should facilitate cooperative ownership or leasing of tractors and small trucks for farm-to-market transport.

6. Limitations and Direction for Future Research

This study is subject to several limitations. First, its cross-sectional design captures conditions at a single period, limiting conclusions about change since data collection; future research could adopt a longitudinal design or update the study with fresh fieldwork. Second, the study was restricted to Makarfi LGA, which may limit generalisability to settlements with different road networks, crop mixes, and market structures; a comparative, multi-LGA design across Kaduna State or other northern states would help. Third, the study relied on self-reported interview data, including retrospective cost and challenge reporting, subject to recall bias; future work could triangulate this with transporters' logbooks or direct observation. Finally, because the dataset was collected and analysed in 2025, monetary figures (such as transport costs in naira) reflect conditions at that time, not current costs, given subsequent fuel-price and currency changes; future research should update these figures before using them for present-day policy costing.

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