

AN ASSESSMENT OF WATER FOOTPRINT IN SMALL-SCALE POULTRY SLAUGHTER AND MEAT PROCESSING PLANTS IN SOME KANO METROPOLITAN LOCAL GOVERNMENTS AREAS

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ABSTRACT: The study assessed the water footprint of small-scale poultry meat processing plants in five Kano metropolitan local government areas (LGAs). Data were collected through structured questionnaires from 100 poultry processors and physical observations across Fagge, Kano Municipal, Kumbotso, Tarauni, and Ungoggo LGAs. The results revealed that poultry processing is dominated by men (100%), with majority (64%) aged between 20–40 years and married (54%). Most respondents (91%) slaughtered multiple species, and 66% of them slaughtered over 100 birds daily. Their primary water sources were vendors (75%), with 54% of poultry processors spending more than ₦1000 to purchase water from vendors daily. General cleaning consumed the highest volume of water (2.4 L/kg bird, 63% of total use), followed by scalding (800 mL/kg, 21%). Majority (58%) of respondents discharge their effluent into municipal drainage systems, while 28% dispose of wastewater in open areas without recycling practices. It was concluded that poultry processing in Kano Metropolitan is a young able men dominated practices with limited formal education. General cleaning and scalding consumed the highest amount of water while, most processors relied on vended water with inadequate wastewater disposal methods. It is recommended that piped-borne water and subsidised boreholes should be provided.

Keywords: Kano Metropolis, Poultry Processing, Small-scale, Slaughter, Water footprint

INTRODUCTION

Water is an indispensable resource for sustaining life, supporting socio-economic development and maintaining healthy ecosystems. However, the growing global population and increasing industrialisation have placed immense pressure on freshwater resources, leading to concerns over water scarcity and sustainability (Hoekstra and Mekonnen, 2012). The concept of water footprint (WF) has emerged as a key indicator of water use in relation to consumer goods, particularly in the food production sector. Agriculture, principally livestock production, is one of the most water-intensive sectors, accounting for approximately 92% of global freshwater consumption (Mekonnen and Hoekstra, 2011). Within this sector, animal products, including poultry, are significant contributors to humanity's water footprint, with 27% of global freshwater use linked to their production (Mekonnen and Hoekstra, 2011).

The poultry industry has experienced rapid growth due to its relatively low production costs, high demand for meat and eggs, and shorter production cycles compared to other livestock sectors (Gonzalez-Garcia *et al.*, 2014). However, poultry processing is highly water-intensive, with substantial volumes of water required for slaughtering, scalding, evisceration, and cleaning (Formentini *et al.*, 2010). For instance, according to the North Carolina Division of Environment and Natural Resources, NCDENR (2010), poultry processing accounts for 76% of the water used, approximately 13% is used in clean-up and 12% is used during downtime. Despite its importance, water management

in small-scale poultry processing plants, particularly in developing countries, remains poorly understood and often inefficient.

The global population is projected to reach 9.7 billion by 2050, further exacerbating the demand for food and water resources (UNDP, 2019). In Nigeria, the poultry industry is a critical component of the agricultural sector, contributing significantly to food security and employment. However, small-scale poultry processing plants, which dominate the industry in many regions, often operate with limited resources and outdated technologies. This results in inefficient water use, high levels of water wastage, and inadequate wastewater management practices (Zorrilla-Ortega *et al.*, 2018).

Water scarcity is a growing concern in many parts of Nigeria, including Kano State, where rapid urbanisation and population growth have strained existing water infrastructure (Bello and Tuna, 2014). The lack of reliable water sources and poor water management practices in small-scale poultry processing plants further exacerbate this challenge. Without significant improvements in water use efficiency and recycling, the sustainability of the poultry industry in Nigeria is at risk.

Understanding the water footprint of small-scale poultry processing is essential for developing sustainable water management strategies. Efficient water use not only reduces operational costs for processors but also minimises environmental impacts, such as water pollution and depletion of freshwater resources (Mekonnen and Hoekstra, 2012). Moreover, improving water management practices in poultry processing can enhance food safety and hygiene, which are critical for public health (Russell, 2008).

Despite the importance of this issue, there is limited research on water use in small-scale poultry processing plants, particularly in sub-Saharan Africa. Most existing studies focus on large-scale operations in developed countries, where advanced technologies and regulatory frameworks are in place (Wojdalski *et al.*, 2009; Formentini *et al.*, 2010). This study addresses this gap by examining water consumption patterns and management practices in small-scale poultry processing plants in Kano Metropolitan Local Governments, Nigeria.

MATERIALS AND METHODS

Study Location

The study was conducted in Kano Metropolitan Local Governments, Nigeria, which includes Fagge, Kano Municipal, Kumbotso, Tarauni, and Ungoggo. Kano State is located in northern Nigeria, between latitudes 11°59'59.57"N to 12°02'39.57"N and longitudes 8°31'19.69"E to 8°33'19.69"E. The metropolitan area covers approximately 499 km², with an estimated population of over 4.4 million people (NiMet, 2023). Kano is a major commercial and industrial hub in northern Nigeria, with a significant proportion of its workforce engaged in agriculture and related activities. The climate is semi-arid, with an average annual rainfall of 690 mm, most of which falls between June and September. The region faces significant water scarcity due to rapid urbanisation, population growth, and inadequate water infrastructure (NiMet, 2023).

Methodology

Cross-sectional survey was conducted to assess water use in small-scale poultry slaughter and meat processing plants. Based on the concentration of poultry processing activities, a total of 100 poultry processors were systematically selected across five local government areas (Fagge, Kano Municipal, Kumbotso, Tarauni, and Ungoggo), with 20 respondents representing each local government area. The study employed a combination of structured questionnaires and physical observations to collect data on water consumption, sources, and management practices.

The questionnaires were designed to gather information on the socio-economic characteristics of the processors, including age, gender, educational level, and household size. Additionally, data were collected on the types of birds processed, daily processing volumes, water sources, and water use during various processing stages (slaughtering, scalding, evisceration, washing and cleaning). Physical observations were conducted to estimate the volume of water used in each processing stage and to assess the types of water storage containers and wastewater disposal methods.

Data Analysis

The data collected were analysed using descriptive statistics with the Statistical Package for Social Sciences (SPSS) Version 20.0. Frequencies and percentages were used to summarise categorical variables, such as the socio-economic characteristics of the processors and water sources. Mean values were calculated for continuous variables, including water consumption during different processing stages.

RESULTS AND DISCUSSION

Table 1 presents the socio-economic profile of poultry processors in Kano Metropolitan local government areas. The results indicate that all processors (100%) were male, with the majority (64%) aged between 20 and 40 years. A smaller proportion (19%) were under 20 years old, while those aged between 41 to 60 years constituted the minority (11%). Marital status analysis revealed that 54% of respondents were married, 44% were single, and only 2% were divorced.

Table 1: Socio-economic Characteristics of Poultry Processors in Kano Metropolitan

PARAMETERS	FREQUENCY	PERCENTAGE (%)
<i>Gender</i>		
Male	100	100.0
Female	0	0.0
<i>Age (years)</i>		
< 20	19	19.0
21 – 40	64	64.0
41 – 60	11	11.0
> 60	6	6.0
<i>Marital Status</i>		
Single	44	44.0
Married	54	54.0
Divorced	2	2.0
<i>Educational Status</i>		
Qur'anic	18	18.0
Primary	22	22.0
Secondary	47	47.0
Tertiary	13	13.0
<i>Household Status</i>		
Head	54	54.0
Member	46	46.0
<i>Household Size</i>		
< 5	43	43.0
5 – 10	22	22.0
> 10	35	35.0

In terms of educational attainment, 47% had attended secondary school, 22% primary school, and merely 11% had pursued tertiary education. Regarding household status, 54% of processors were household heads, while 46% were household members. Household size varied, with 43% having fewer than 5 members, 35% more than 10, and 22% between 6 and 10 members.

The demographic profile of poultry processors in this study - predominantly male, married, and of productive age with varying educational levels, corresponds with findings from similar research contexts. The results align closely with Amaegberi and Onuche's (2024) study in Dekina, Kogi State, which reported an exclusively male workforce (100%), with 80.3% married, 42% having fewer than five family members, and 90% possessing some form of formal education. This pattern is further supported by Okpala *et al.* (2021), who documented an entirely male workforce (100%) at Nsukka slaughterhouse in Enugu State, with 94% having attained some level of education. The persistent male dominance in this sector likely reflects both the physically demanding nature of butchering activities and prevailing sociocultural norms regarding gender roles in occupational settings.

The educational profile of respondents is particularly noteworthy, with 80% having received formal education of varying degrees. This finding suggests significant potential for the adoption of improved processing techniques and technologies, as education has been shown to positively influence both management practices and technological adoption in agricultural enterprises (Aromolaran, 2000). The combination of formal education and practical experience among processors creates a favourable environment for implementing capacity-building initiatives and modernisation efforts in small-scale poultry processing.

The predominance of married respondents (54%) with established family structures may have important implications for business sustainability. As Onwuna *et al.* (2024) observed, married individuals often demonstrate greater commitment to income-generating activities due to domestic responsibilities. Furthermore, the presence of family members can provide both immediate labour support and long-term business continuity, as noted by Adebayo (2012). Family-based operations may benefit from inherent stability, with multiple generations potentially viewing the enterprise as a valuable household asset rather than merely temporary employment. This dynamic could facilitate knowledge transfer across generations and encourage investment in business improvements.

Figure 1 illustrates the poultry species processed in the study area. The majority of processors (91%) slaughtered multiple species, including chickens, turkeys, geese, and guinea fowl, while a minority specialised in chickens (4%), guinea fowl (3%), or geese (2%). This aligns with Adzitey and Huda (2012) who noted that multi-species slaughtering is common in West African informal markets due to diverse consumer demand and seasonal availability of birds.

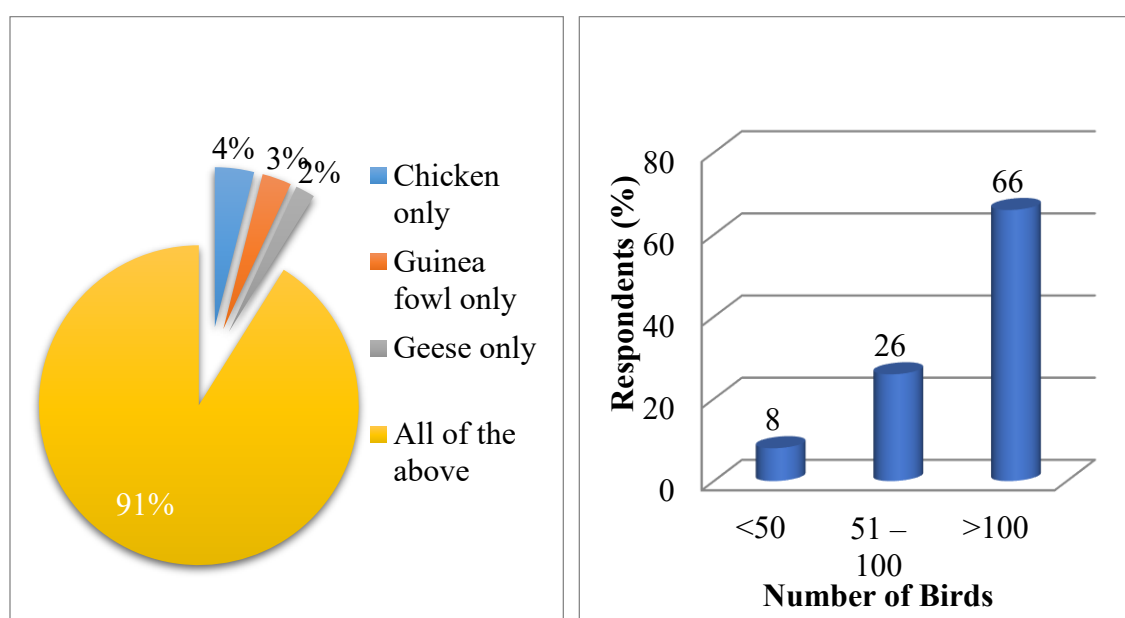


Figure 1: Type of Birds processed

Figure 2: Number of Birds processed/day

As shown in Figure 2, majority (66%) of respondents slaughtered over 100 birds daily, 26% processed 51–100 birds, and only 8% handled fewer than 50 birds. High-throughput slaughter rates are typical of urban slaughterhouses, as observed by Garba *et al.* (2022) in Kano metropolitan abattoir, where high demand drives large-scale operations. Kano metropolis is the second highest populous city with an estimated human population of 4, 910, 000 million people (Balogun, 2025).

Figure 3 highlights that vendors were the primary water source (75%), followed by wells (19%), tap water (5%), and boreholes (1%). In concurrence with this findings, Garba *et al.* (2022), documented inadequate water supply in Kano main abattoir facilities, with processing water being procured through informal distribution systems from unverified sources. This practice of relying on potentially unsafe water for carcass washing operations likely represented a significant hygiene compromise and contamination vector. These findings concur with the work of Abdulkadir *et al.* (2019), who reported that approximately 70% of residents in Zango, Rimin Kebe (Ungoggo Local Government) relied

on water vendors—a practice associated with significant hygiene concerns. In addition, Nura *et al.* (2020), recorded that 57.4% of the Unguwa Uku residents in the Tarauni Local Government Area patronized the services of water vendors. This situation mirrors observations by Nura and Ibrahim (2014) in Kano Metropolis, where inadequate access to piped water and the high cost of borehole construction, exacerbated by economic constraints, limited safe water availability. Furthermore, domestic wells proved unreliable, as they typically recharge only during the rainy season and deplete in drier months, rendering them an unsustainable year-round solution. Nura and Ibrahim (2014) documented a significant water supply deficit in Kano Metropolis, with daily water demand estimated at 550 million litres far exceeding the state's treatment capacity of just 200 million litres per day.

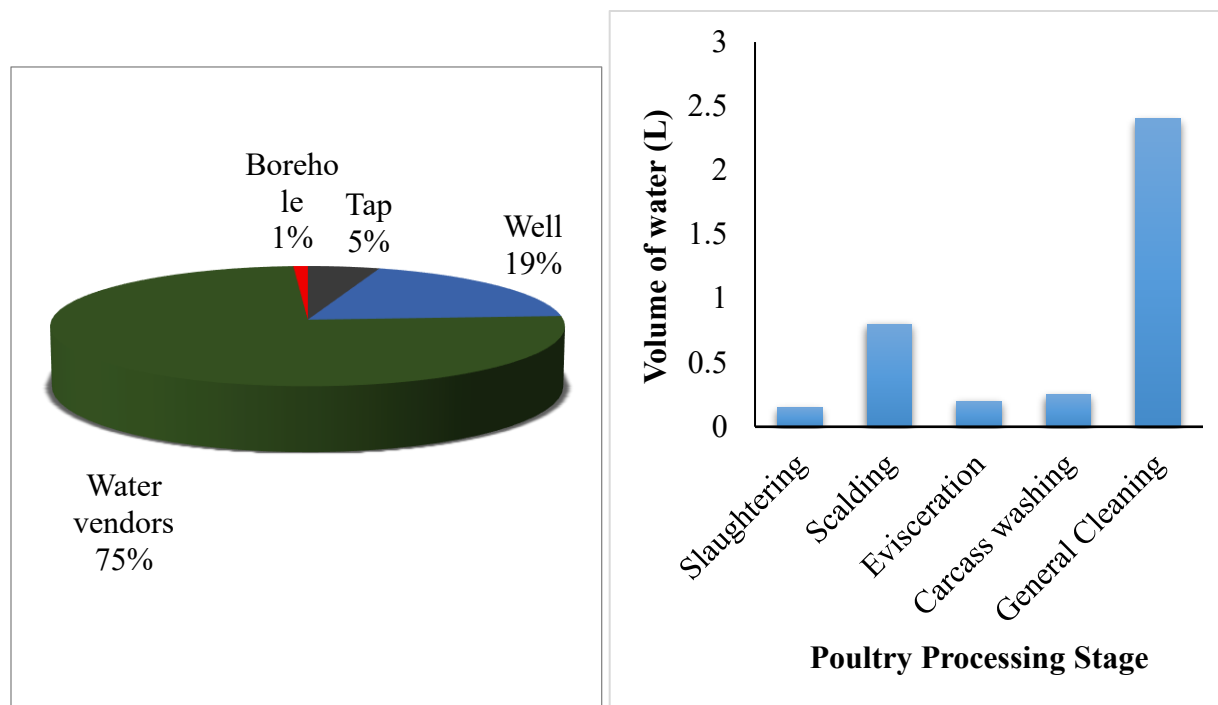


Figure 3: Sources of Water

Figure 4: Volume of Water used

Figure 4 details water use: general cleaning consumed the most water (2.4 L/kg bird, 63% of total use), followed by scalding (800 mL/kg, 21%), carcass washing (250 mL/kg), evisceration (200 mL/kg), and slaughtering (150 mL/kg). These findings concur with earlier studies, who identified cleaning and scalding as the most water-intensive stages in poultry processing. Comparative data from industrial poultry processing facilities demonstrate significant water usage across different stages of operation. The North Carolina Division of Environment and Natural Resources (2010) reported water consumption rates of 0.95 L/bird for scalding and 1.9 L/bird for chilling, with this water subsequently being repurposed for waste transportation. Their findings indicated that processing accounts for the majority of water use (76%), while clean-up and downtime operations utilise approximately 13% and 12% respectively. These observations were supported by Huezo *et al.* (2007), who documented that immersion chilling requires an initial 2.6 L/bird to fill the chill tank, followed by an additional overflow of 1.9 L/bird during operation.

Further evidence from Formentini *et al.* (2010) in a Brazilian processing plant revealed that slaughtering and cleaning processes constitute the most water-intensive stages, accounting for 71% and 15% of total water consumption, respectively. These comparative figures highlight the substantial water demands of commercial poultry processing operations across different geographical contexts.

Figure 5 present the summary of the cost incur by the respondents to obtain water from vendors. The analysis of water procurement expenditures reveals that 54% of poultry processors incurred over ₦1000 daily to purchase water from vendors, while the remaining 46% spent between ₦500-₦1000. These findings compare favourably with that of Abdulkadir *et al.* (2019), who reported vendor pricing of ₦20.00-₦25.00 per 20-litre Jerry can for household deliveries pre-subsidy removal rates. The elimination of fuel subsidies in 2023 led to a sharp increase in petrol prices (from

₦189/litre to over ₦800/litre), directly raising operational costs for private borehole owners and water vendors who rely on fuel-powered vehicles to transport water.

Figure 6 presents the wastewater disposal methods employed by poultry slaughter plants in Kano metropolis. The data reveal that 58% of facilities discharge their effluent into municipal drainage systems, while 28% dispose of wastewater in open areas, and the remaining 14% utilise alternative disposal methods. These findings are in line with Adesokan and Sulaimon (2014) who documented similar disposal patterns in Yobe, Kwara and Plateau representing the northern part; and Oyo, Lagos and Osun States for the southwestern region, noting that only few facilities had proper treatment systems. The high prevalence of open disposal (28%) exceeds the amount reported in these states, suggesting Kano may face particular challenges in waste management enforcement.

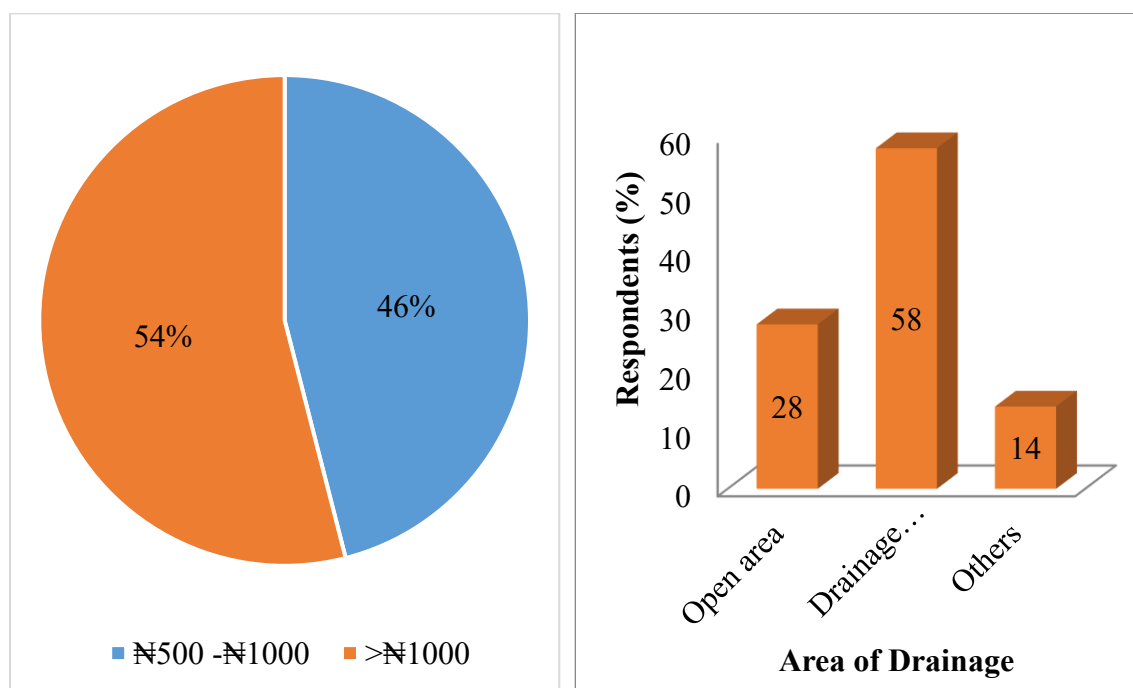


Figure 5: Amount (₦) spent on Water daily **Figure 6:** Where Wastewater is drained

CONCLUSION

Based on the findings of this study, it was concluded that poultry processing in Kano Metropolis is a predominantly taken by young, able-bodied men with limited formal education. General cleaning and scalding accounted for the highest water consumption while, most processors relied on vended water and inadequate wastewater disposal methods, highlighting the significant challenges in water access and sanitation. Furthermore, the high daily expenditure on water (₦500–₦1000) underscores the financial burden imposed by unreliable water infrastructure.

Recommendations

It is recommended that Municipal authorities should prioritise expanding piped water networks to reduce dependence on costly vended water. Subsidised borehole schemes could provide interim relief, particularly for high-water-use activities like scalding and cleaning. Vocational training programmes should address gaps in food safety and sustainable water use.

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