

Income inequality and distribution patterns in the cassava value chain in the Oyo State, Nigeria: a gender perspective

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Abstract

Purpose – This study analyses income inequality and distribution patterns among key actors in the cassava value chain. The study also identifies factors that influence profit of key actors in the cassava value chain.

Design/methodology/approach – The study was conducted in Oyo State, Nigeria, using primary data from 620 actors, consisting of 400 farmers, 120 processors and 100 traders in the cassava value chain. The Gini coefficient was used to estimate income inequalities within and between actors. Multiple linear regression was applied to identify factors that influence the profit of the actors in the cassava value chain.

Findings – The result shows a gender pattern in the participation in the cassava value chain: men dominate in the production, whereas women mostly engage in processing and marketing of processed cassava products. We also find that incomes are unequally distributed among actors, favouring traders and processors more than farmers in the value chain. Women are better off in processing and trading of value-added products than in the raw cassava production. Spatial differences also contribute to income inequality among farmers in the cassava value chain. An increase in farmers and processors' incomes reduces inequality in the value chain while an increase in traders' income widens inequality. Age is significantly negatively correlated with actors' profit at 1%, while educational level significantly increases their profit at 5%. Processors and traders with large households have a higher profit. We also find that farm size, experience and labour input have significant positive effects on farmers' profit only at 5%. Membership in an association increases farmers and processors' profit at 1 and 10%, respectively.

Practical implications – The study recommends that agricultural policies that promote agrifood value chains should aim at minimizing income inequality by targeting vulnerable groups, particularly female farmers to achieve sustainable development in rural communities.

JEL Classification — Q00, Q10, Q16, Q19

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Originality/value – Existing studies recognise income inequality in agricultural value chains in sub-Saharan Africa. However, there are few rigorous quantitative studies that address this pressing issue. Our paper fills this knowledge gap and suggests ways to minimise income inequality in the agri-food value chain, using the example of the cassava value chain in Nigeria.

Keywords Agrifood value chain, Gini coefficient, Income inequality, Income gap, Cassava sector, Sustainable rural development, Gender inequality

Paper type Research paper

1. Introduction

Reducing inequality within and between countries is part of the Sustainable Development Goals (SDG 10) that many countries aim to achieve by 2030 (Kunawotor *et al.*, 2020; Nhamo, 2017). High inequality is an indication of persistent disadvantage for a group of people in society (Kunawotor *et al.*, 2020). This situation can lead to stunted economic growth, political instability and social unrest (Anyanwu *et al.*, 2016; Anyanwu, 2016). Economic literature recognizes that income inequality in the world has a serious impact on poverty (Naschold, 2002). Poverty refers to the rate of change in the mean income of a population and the change in the income distribution, suggesting that poverty stems from changes in average income or income distribution (World Bank, 2021). More than 27% of the world's population lives on less than US\$2 per day (World Bank, 2021). Most of these poor people are in Sub-Saharan Africa (SSA), where agriculture is the main source of livelihood. Nearly half of the poor people in SSA live in five countries, which include Nigeria (World Bank, 2021). Poverty rates are more pronounced among smallholder farmers, who constitute the majority of the labour force in the agricultural sector in SSA, particularly Nigeria (World Bank, 2021). About 45% of people in SSA are extremely poor and live in rural areas. In Nigeria, for example, about 60% of the population is poor and 45% is undernourished (National Bureau of Statistics (NBS), 2016). This problem has sparked debates on measures to alleviate poverty in SSA, especially among rural population. Researchers propose agrifood value chain development initiatives as a pro-poor strategy to minimize poverty levels and improve food security status in SSA including Nigeria (Reardon *et al.*, 2003, 2009, 2019; Reardon, 2015; Rutherford *et al.*, 2016; Memedovic and Sheperd, 2009).

Agrifood value chain refers to a set of value-adding activities required to move a food product from the initial input supply stage through various stages of production, processing and marketing to its final destination and post-disposal management (Kaplinsky and Morris, 2001). Agrifood chains, for example, the cassava value chain (CVC) has attracted the attention of governments, non-governmental agencies and private investors because it has numerous economic opportunities that contribute to economic growth and development in Nigeria. Cassava contributes greatly to the agricultural gross domestic product (GDP) of Nigeria (Ikuemonisan *et al.*, 2020; Donkor *et al.*, 2017). Nigeria is a leading producer of cassava tubers in the world, accounting for 26.40%. It also contributes to 46.70% to the cassava production in Africa (FAOSTAT, 2021). In addition, the CVC provides many employment opportunities for numerous stakeholders in Nigeria and other parts of Africa, where cassava is grown (Ikuemonisan *et al.*, 2020). Cassava also provides valuable raw materials such as starch, high-quality cassava flour, cassava chips and ethanol for the industrial sector (Uchechukwu-Agua *et al.*, 2015). The majority of the cassava tubers are consumed as food in various processed forms such as *gari*, *Lafun*, tapioca, bread, cake, fritters and croquette in Nigeria (James *et al.*, 2012; Ikuemonisan *et al.*, 2020). These demonstrate that the cassava industry is paramount to achieving sustainable food and nutritional security in Nigeria (Donkor *et al.*, 2017). These contributions of CVC to the economic development and their potential to minimize rural poverty and enhance food security in Nigeria.

It is important to ensure that the primary actors in the CVC benefit equitably from the opportunities in the sector. If only a few actors in the value chain make the highest profit, this is likely to contribute to high-income inequality. Hence, the need to understand how incomes are distributed among the actors in the chain, by also considering gender dynamics, which is how social norms define gender roles, in the chain. It is argued in the literature that agrifood chains including that of cassava is shaped by gender as men and women play different roles at different nodes of the chain (Fischer and Qaim, 2012). Evidence shows that men dominate the production node of the agrifood value chain especially for cash crops (Fischer and Qaim, 2012), like cassava in Nigeria. The reason is that men have control over productive resources such as land and finance and better access to extension services, agricultural innovations and markets, which enable them to venture into crop production (Fischer and Qaim, 2012). These factors also account for the high agricultural productivity associated with farms owned by men (Peterman *et al.*, 2011). In contrast, women have limited control and access to resources which limit them from engaging in commercial production (Fischer and Qaim, 2012; Quisumbing *et al.*, 2015, 2021). The limited resources and the burden of uncompensated domestic and reproductive roles such as caring for children, cooking and fetching of water contribute to their low-farm productivity and income in agriculture (Quisumbing *et al.*, 2021). Instead, they resort to processing and marketing of processed products to generate income. These gender dynamics are likely to manifest in the CVC and affect how incomes are distributed across actors in the chain. In addition, different factors are likely to affect incomes of the actors in the CVC. However, there is lack of evidence on these critical issues in the CVC and related agricultural value chains as demonstrated later in Section 2. Instead, the literature focused on analysing profitability (Donkor *et al.*, 2019; Obayelu *et al.*, 2013), adoption of improved cassava varieties (Afolami *et al.*, 2015; Wossen *et al.*, 2018) and marketing of cassava (Donkor *et al.*, 2018a). The growing literature analysing income inequality in SSA focuses on the macro-level (Sulemana *et al.*, 2019; Asongu and Odhiambo, 2019; Bigsten, 2016; Anyanwu *et al.*, 2016; Anyanwu, 2016), while existing microeconomic studies are mainly concerned with the impact of spatial differences and income sources on income inequality (Manero, 2016; Bayelu, 2014; Chiwuzulum *et al.*, 2010; Babatunde, 2009; Lay *et al.*, 2008).

In this study, we address the following research questions: How are incomes distributed within (and between) the actors in the cassava food value chain in Nigeria? Does gender play a role in income inequality in the value chain? What factors that influence the incomes of main actors in the CVC?

By answering these research questions, our paper makes an important contribution to the literature on agrifood value chains by improving our understanding of the distribution of incomes among (and between) key actors (primarily farmers, processors and traders) in the CVC in Nigeria using the Gini coefficient. This paper also contributes to filling the knowledge gap by analysing gender inequality in terms of incomes in the agrifood value chain using the case of the CVC in Nigeria. The study also provides insights into factors that influence incomes of actors in the agrifood value chain. The findings from our study have policy implications for sustainable rural development through reducing income inequality, minimising poverty and ensuring sustainable food security rural areas in Nigeria.

2. Cassava value chain in Nigeria

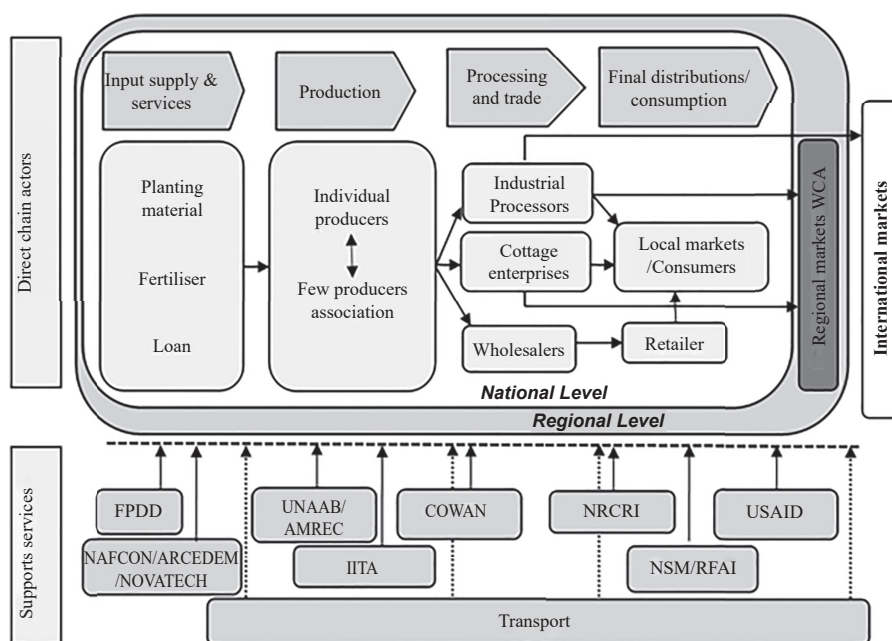
The CVC can be defined as all the value-adding activities required to bring cassava products from the farm to the final consumers (McNulty and Oparinde, 2015). Value addition processes include input supply, production, processing, distribution and

marketing. The CVC also includes vertical and horizontal relationships between the different actors in the chain as the products move from the field to the end markets (McNulty and Oparinde, 2015). The vertical relationship refers to the interaction between the various actors at different nodes of the value chain and vice versa to the horizontal relationship. The CVC is characterised by long chains of actors that generate relatively low value added (Coulibaly *et al.*, 2014). The Nigerian CVC can be described as a traditional food value chain, as the chain is dominated by small-scale producers and processors who add little value to cassava tubers through processing. Farmers usually sell their cassava tubers to middlemen or processors without any value addition (Donkor *et al.*, 2018b). The financial constraint and the lack of innovativeness limit the farmers' capacity to increase their value addition (Donkor *et al.*, 2018b).

The general overview of the CVC in Nigeria is shown in Figure 1. Existing literature classifies CVC actors in Nigeria into direct actors and support services (Coulibaly *et al.*, 2014). Direct actors are those who directly carry out activities in the CVC. Direct actors are input suppliers, producers, processors, traders and marketers. Each of these actors play different roles such as production, bulking, processing, storing, wholesaling, refining, packaging, retailing, marketing and financing. Support services help direct actors to work efficiently in the CVC. The support services include governmental and non-governmental organisations.

2.1 Input supply and provision of support services

Input suppliers provide farmers and other stakeholders with inputs such as fertilisers, improved planting materials, agrochemicals, farm implements and processing equipment (Coulibaly *et al.*, 2014). Input dealers in the CVC depend on wholesalers and importers as



Source(s): Coulibaly *et al.* (2014)

Figure 1.
Cassava value chain in
Nigeria

sources of supply for their inputs. Support service supporting direct actors in the CVC include financial and research institutions, transporters, extension agents, non-governmental organisations and policy makers. Each of these service providers support actors at different nodes in the value chain. The CVC in the Nigeria is supported by many institutions. The Federal Government of Nigeria through the Ministry of Agriculture and Natural Resources (state and local) develops appropriate policies to promote production, processing, and export, disseminate and train producers on use of improved varieties (McNulty and Oparinde, 2015; Oparinde *et al.*, 2016).

2.2 Cassava production trend

Nigeria is currently the largest cassava producers in the world (FAOSTAT, 2021). It contributed 26.40% of global cassava production and 46.70% of African cassava production in 2020 (FAOSTAT, 2021). This suggests that Nigeria plays a key role in cassava production in Africa and globally. However, cassava yields in Nigeria are lower compared to cassava producing countries in Asia and other African countries (Ikuemonisan *et al.*, 2020). Trend analysis by Ikuemonisan *et al.* (2020) shows that Nigerian cassava production has been on an upward trend in Nigeria's cassava production since 1970. Cassava output increased from 9.3 million tonnes in 1970 to 60 million tonnes in 2020 (FAOSTAT, 2021). This upward trend is mainly due to the expansion of cultivated areas rather than an increase in yields (Ikuemonisan *et al.*, 2020). Cassava production is dominated by individuals who are small-scale producers and by a few large-scale producers. Farmers also organise themselves into associations to help each other.

2.3 Processing and marketing of cassava products

Cassava tuber processing is a key component of the CVC (Kehinde and Aboaba, 2016). It provides business opportunities for rural entrepreneurs to generate income and thus contribute to the economic development in rural areas. In most rural areas where cassava is extensively produced, processing is one of the major activities for the rural people, especially women (Adebayo, 2005). Cassava tubers are highly perishable and begin to deteriorate three to four days after harvesting (Dada, 2016). Therefore, processing of cassava tubers is essential as it transforms cassava tubers into safer and more marketable products by reducing cyanide content, extending shelf life, reducing postharvest losses, avoiding contamination of products and environment, increasing nutritional and market values, and reducing transport costs (James *et al.*, 2012).

Cassava producers sell their cassava tubers to industrial processors, cottage enterprises and wholesalers who process cassava into various products. Industrial processors mainly process cassava into ethanol, high-quality cassava flour (HQCF), starch, sweeteners and chips (Uchechukwu-Agua *et al.*, 2015). However, there are few industrial processors operating in Nigeria. Instead, cassava producers rely mainly on cottage enterprises and wholesalers to purchase their cassava tubers. Cottage enterprises and wholesalers process cassava into local food products such as tapioca, *gari*, *lafun* and *fufu*. Tapioca is a granular product made from gelatinized cassava starch. *Gari* is a dry, crispy, creamy-white and granular flake (James *et al.*, 2012). *Lafun* is a flour made from fermented-dried cassava that is later made into a stiff paste. It is eaten with a sauce or soup. There are wet and instant *fufu* flour. Wet *fufu* is a fermented wet paste made from cassava that is widely consumed in eastern and southwestern Nigeria and other parts of West Africa (Sanni *et al.*, 2009). Wet *fufu* is highly perishable with a shelf life of 7 days, so the product needs to reach the final consumers after processing (Adebayo, 2005). Instant *fufu* flour has a longer shelf life, is convenient to store and has compact size. About 90% of the cassava tubers produced in Nigeria are processed into food products and the remaining 10% into industrial products

(Uchechukwu-Agua *et al.*, 2015). This shows that cassava is an important staple crop that contributes greatly to sustainable food security in Nigeria. The local food products are mostly sold domestically while a few quantities, mainly gari are exported to neighbouring African countries, Europe and America (International Institute of Tropical Agriculture (IITA), 2005).

3. Literature review

The CVC has attracted the attention of researchers and policy makers to explore ways to develop the chain in Nigeria. Most studies on the CVC focus on the production node, with only a few studies considering activities at the processing and market nodes of the chain. At the production node, studies address issues related to adoption of improved cassava varieties (Opata *et al.*, 2021; Afolami *et al.*, 2015; Wossen *et al.*, 2018), choices of marketing channels (Donkor *et al.*, 2018a), value addition (Donkor *et al.*, 2018b) and profitability of cassava production (Obayelu *et al.*, 2013; Omotayo and Oladejo, 2017; Ojiako *et al.*, 2018; Donkor *et al.*, 2019; Rahman and Chima, 2016).

Afolami *et al.* (2015) found that the adoption of improved cassava varieties increased the annual income and consumption expenditure of farming households in southwestern Nigeria. Wossen *et al.* (2018) showed that the adoption improved cassava varieties reduced poverty by 4.6%. Donkor *et al.* (2018a) found that human capital, physical capital, social capital and market conditions significantly influenced farmers' decision to participate in the direct marketing channel in Oyo State of Nigeria. Donkor *et al.* (2018b) showed that membership in a farmer association, access to extension services, access to credit, access to electricity, ownership of radio and television sets increased the value-added capacity of cassava farmers in Oyo State of Nigeria. Obayelu *et al.* (2013) showed that cassava production was profitable in Ogun and Oyo States of Nigeria. They also found that the use of herbicides increased the profitability of small-scale farmers, that cassava cuttings increased the profitability of medium-scale producers, and that labour and farm size positively influenced the profitability of large-scale producers in Ogun and Oyo State, respectively. Rahman found that farm size negatively influenced cassava farmers' profit while experience in farming showed a negative relationship with profit in Ebonyi and Anambra States, Nigeria. Omotayo and Oladejo (2017) showed that cassava production was profitable in Oyo State of Nigeria and that farmers' net returns were positively correlated with fertiliser use, price per cassava truck and total revenue. Ojiako *et al.* (2018) reported that cassava production was viable enterprise in southern Nigeria and that adoption and complementary use of the recommended package of practices would provide farmers with higher yield, profitability and return on investment. Donkor *et al.* (2019) found that adoption of mineral fertiliser resulted in higher yields and net revenues for cassava farmers in Oyo State, Nigeria.

At the processing node, Ehinmowo *et al.* (2015) found that compared to Ondo and Ogun States, cassava processing was more profitable in Oyo State. Education, experience, access to extension services, household size positively influenced the profitability of cassava processing in the three States. Oladejo (2017) also revealed that cassava processing by women was profitable in Oyo State and that education and experience in processing positively correlated with the marketing efficiency of women processors. Obayelu *et al.* (2018) showed that cassava processing was a profitable venture in Ogun State and that processors preferred fufu more than gari and Lafun.

In summary, the literature shows that cassava production and processing are profitable enterprises in Southern Nigeria. However, there are no empirical studies that analyse the income distribution and inequality among actors at the different nodes of the CVC. This shows the need to intensify research to understand income and gender inequalities in the CVC.

4. Methodology

The study derives its theoretical basis from the economic theory of income distribution, which is based on the theory of marginal productivity proposed by [Ricardo \(1815\)](#). The theory states that the factor of production sold in a perfectly competitive factor market is paid according to its value of marginal product ([Ricardo, 1815](#)). Applying this principle to the present study, we conceptualize that profit margins are distributed among the main actors in the CVC, based on their respective values of marginal productivity. A participant in the value chain is likely to receive a higher income if his/her contribution to marginal value is relatively high. Based on this notion, we hypothesise that smallholder farmers tend to earn low returns due to their limited capacity to add value. We also expect smallholder farmers to contribute the smallest share to the total income and overall income inequality in the CVC. In this section, we present the analytical methods needed to estimate and interpret the distribution of incomes among (and between) the principal actors, comprising smallholders, medium-scale farmers, processors and traders of processed cassava food product in the CVC.

4.1 Distribution of profit among the value chain actors

Different measures have been developed and applied to estimate income inequality in empirical economic studies. These measures include range, relative mean deviation, variance, coefficient of variation and Gini coefficient ([Sen, 1997](#); [Cowell, 1995](#)). However, it is argued that the use of inequality measures such as range, relative mean deviation, variance and coefficient of variation are less robust ([Litchfield, 1999](#)). For example, range has the limitation that it ignores the distribution between the extreme values of the distribution ([Litchfield, 1999](#)). Relative mean has been shown to be insensitive to transfers between households that are on the same side of the mean income, violating the Pigou–Dalton transfer principle ([Cowell, 1995](#)). This principle requires that an income transfer from a poorer person to a richer person should lead to an increase (or at least not a fall) in inequality and an income transfer from a richer to a poorer person should lead to a decrease (or at least not as in increase) ([Litchfield, 1999](#)). Although variance satisfies the Pigou–Dalton transfer principle, it is dependent on the mean income, and a distribution may have a greater relative variation but lower variance if it has a smaller mean ([Cowell, 1995](#)). Variance relies on the income scale, assuming all incomes are doubled, the variances quadruple ([Cowell, 1995](#); [Litchfield, 1999](#)). This contradicts the axiom of income-scale independence, which requires that the inequality measure be invariant to equal proportional changes, i.e. if each individual's income changes by the same proportion, inequality should not change ([Litchfield, 1999](#)). In contrast, the Gini coefficient fulfils both the Pigou–Dalton transfer principle and income scale independence ([Litchfield, 1999](#)). It is easier to identify the sources of income inequality with the Gini coefficient compared to other measures such as range, relative mean deviation, variance and coefficient variation. Due to the aforementioned strength of the Gini coefficient, we apply it to analyse income distribution patterns among (and between) the main actors in the CVC. Following [López-Feldman \(2006\)](#), the Gini coefficient for the estimating total income inequality is expressed as follows:

$$T = \sum_{k=1}^K S_k G_k R_k \quad (1)$$

$k = 1$ (small – scale farmers), 2 (medium – scale farmers), 3 (processors), 4 (traders)

where T is the Gini coefficient for total income inequality, S_k indicates the share of each actor k in the total income, G_k represents the Gini of the respective income distribution of each actor and R_k is the Gini correlation, which indicates the correlation between income of each actor and total income. R_k is computed as in (2):

$$R_k = \text{Cov}\{y_k, \Omega(y)\} / \text{Cov}\{y_k, \Omega(y_k)\} \quad (2)$$

where y_k is the income of each actor. $\Omega(y)$ is the cumulative distribution of total income whereas $\Omega(y_k)$ is the cumulative distribution of income from each actor k . Stark *et al.* (1986) indicate that the effect of each income component on total income inequality depends on: (1) importance of an actor's income in relation to total income (S_k), (2) how equally or unequally distributed an actor's income is (G_k) and (3) degree of correlation between each actors' income k and total income (R_k). If an actor's income accounts for a large share of total income, it can have a large impact on inequality (López-Feldman, 2006). For example, if income is equally distributed ($G_k = 0$), it cannot affect total income inequality (T). However, if the actor's income is large and unequally distributed (S_k and G_k are large), it can either increase or decrease income inequality (López-Feldman, 2006). If the actor's income is unequally distributed and flows disproportionately in favour of those at the top of the income distribution (R_k is positive and large), its contribution to overall inequality would be positive. If it is unequally distributed but targeted at poor households (individuals), then income source may have an equalising effect on the income distribution (López-Feldman, 2006).

Holding the incomes from all other sources, constant, the effect of small changes in a specific income source on inequality can be estimated. The partial derivative (E_k) of the overall Gini coefficient with respect to a percentage change in income (y_k) of actor k is equal to as in (4) (López-Feldman, 2006):

$$\frac{\partial T}{\partial y_k} = S_k(G_k R_k - T) \quad (3)$$

where T is the Gini coefficient of total income inequality prior to the income change, and y_k is the income of each actor k . The percentage change in inequality resulting from a small percentage change in the income from actor k equals the original contribution of source actor to income inequality minus actor k 's share of total income (López-Feldman, 2006):

$$\frac{\partial T / \partial y_k}{T} = \frac{S_k G_k R_k}{T} - S_k \quad (4)$$

The incomes used to estimate income inequality represent the annual profits earned by the main actors in the value chain. A written command in Stata called *descogini* is used to estimate the Gini coefficient and share of each actor. The command allows the estimation of the marginal effects that each actor has on inequality (López-Feldman, 2006). This command is used with *bootstrap* to estimate standard errors and confidence intervals.

We also analyse factors that influence incomes of the actors using multiple linear regression model. The reason for using this linear regression model is that the dependent variables (income) are continuous variable. Actors' incomes are expressed as a linear function of different factors such as socioeconomic and institutional variables. We empirically specify the reduced form of the multiple linear regression model for the actors as:

$$\begin{aligned} \Pi_{ik} &= \alpha_k + \sum_{j=1}^M \gamma_{jk} \text{Socioeconomic}_{ijk} + \sum_{j=m}^T \lambda_{jk} \text{Institutional}_{ij} + \xi_{ik}, k \\ &= 1(\text{farmers}), 2(\text{processors}), 3(\text{traders}) \end{aligned} \quad (5)$$

where Π_{ik} is incomes reflecting the annual profits of the actors, which are computed as the differences between total revenues and total cost of production. The annual income for farmers reflects the profit generated in the cassava production cycle, which is about 12 months depending on the variety grown. During the data collection, which took place in

2016, the 2016 production cycle had not yet ended and farmers had not harvested their cassava tubers. Hence, we used 2015 production cycle as a reference year. For the processors and traders, they processed and sell cassava products throughout the year. Hence, we estimated their production costs and revenues on monthly basis and projected their profits for the year. The cost items for the farmers include farm inputs (fertiliser, herbicide, insecticide and labour). The total production cost was computed by multiplying the quantity of farm inputs used in 2015 production cycle by their respective unit prices and summed all of them. The total revenue was computed by multiplying the quantity of cassava tubers sold by the unit price. For the processors, the cost items include cassava tubers, transport, water, diesel, peeling of cassava tubers, pressing, sieving, firewood, roasting and milling of sieved gari. We summed all the costs related to these items to generate the total production cost. The revenue was calculated as the quantity of processed cassava tubers (gari) multiplied by unit price. In the case of traders, the cost items were processed cassava products (gari, lafun), labour, transport and monthly market toll. The total production or operation cost was computed as summation of all the costs related to the items. The total revenue was computed as the sum of the revenues from the sales of gari and Lafun. Processors and traders operate throughout the year. To obtain their annual estimates, we computed their average monthly profit and projected it for the year.

k represents different actors, namely farmers, processors and traders. $Socioeconomic_{ijk}$ represents a set of human capital variables of the actors. In the farmers' equation, we include socioeconomic variables such as age, household size, gender, education, experience, farm size, off-farm activities, record keeping, labour, location-dummies, while membership of association, access to credit and extension services are the institutional variables. For traders, the socioeconomic variables are age, household size, education, experience, record keeping, location-dummies, whereas membership of association, extension and credit access are the institutional variables. With the exception of gender, record keeping, labour and extension, all the variables included in the processors' model are the explanatory variables for traders' equation. To minimize skewness and kurtosis of the profit variable, we transform the dependent variable and all the continuous variables into natural logarithms. Therefore, the coefficients are interpreted as partial elasticities. The parameters, α_k , γ_{jk} , λ_{jk} , are estimated with the ordinary least squares method. ξ_{ik} represents the error terms.

4.2 Survey data

The data was collected from farmers, processors and traders of cassava in 2016 in Oyo State in Nigeria. Oyo State is one of the major cassava-producing states in Nigeria, Oyo State. For agricultural purposes, these local government areas have been grouped into four major agricultural development zones, namely Ibadan/Ibarapa, Saki, Ogbomosho and Oyo. Ibadan/Ibarapa has the largest number of local government areas (14), including Ibarapa East, Ibarapa North, Ibarapa Central, Egbeda, Ibadan North, Akinleye, Ibadan North East, Ibadan North West, Ibadan South East, Ibadan South West, Ido, Lagelu, Oluyole and Ona-Ara. Saki Agricultural Development Zone has ten local government areas namely, Atisbo, Oorelope, Iseyin, Itesiwaju, Kajola, Irepo, Olorunsogo, Iwajowa and Saki East and Saki West. Ogbomosho North, Ogbomosho South, Surulere, Oriire and Ogo-Oluwa are classified under Ogbomosho agricultural development zone. Lastly, Oyo agricultural development zone has the least local governments, which include Afijio, Atiba, Oyo East and Oyo West as shown in Figure 2.

The population of the study comprised small- and medium-scale cassava producers, gari processors and traders. The sample size was 620 respondents consisting of 231 small-scale cassava farmers, 169 medium-scale cassava farmers, 120 gari processors and 100 traders. A multi-stage cluster sampling technique was used in selecting the farmers from the study area.

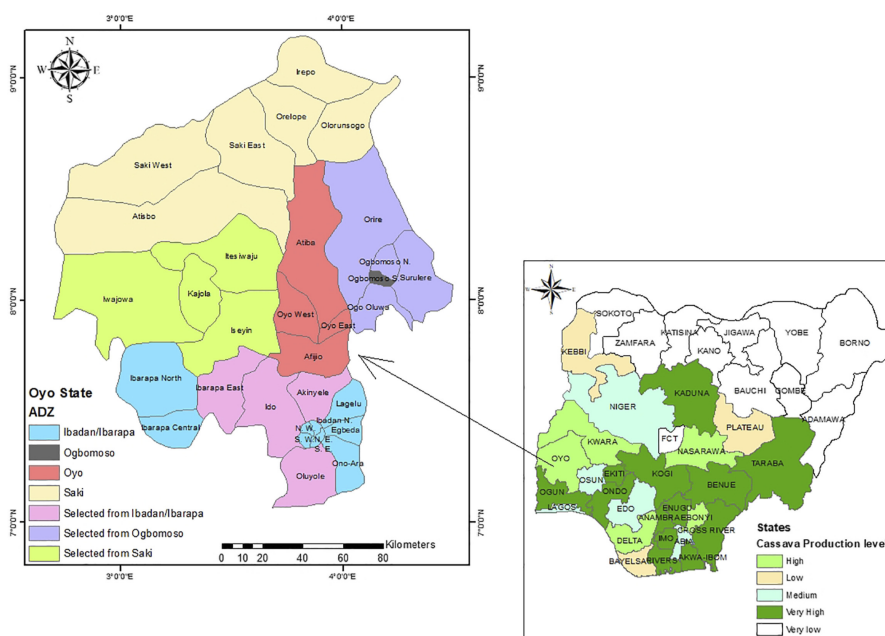


Figure 2.
Map of Nigeria

Source(s): Authors' design

This sampling procedure involved three main steps. Oyo state is divided into four main strata (agricultural development zones), namely Ibadan/Ibarapa, Ogbomoso, Oyo and Saki. The first stage involved a random selection of four local government areas from each stratum. The selected local government areas from Ibadan/Ibarapa include Ido, Akinleye, Ibarapa east and Oluwole. Oyo West and East, Afijo, and Atiba LGA were selected from Oyo ADZ. For Ogbomoso, the LGA chosen were North Ogbomoso, Ogo-Oluwa, Oriire and Surulere, while Iseyin, Itesiwaju, Kajola and Iwajowa were chosen from Saki ADZ. In the second stage, one community known for cassava production was purposively selected from each local government area. This suggests that four cassava-producing communities were selected from each ADZ. The last stage involved a random selection of 25 cassava farmers from each community with the assistance of sample frame (a list of registered cassava farmers in the community) from the agricultural development directorate in the state. In total, 100 cassava farmers were selected from each stratum (ADZ). This gave a total sample size of 400 cassava farmers, comprising 231 small- and 169 medium-scale farmers.

We used the farmer sampling procedure to select cassava processors who were mainly gari processors. First, we purposively chose three LGA out of the four selected LGA for the farmers known for processing of cassava into gari. One community known for gari processing was purposively selected from each LGA. Thirty gari processors (10) were selected from each community. The gari processors were clustered at one place in each community, but they were operating independently in sheds. The owners of the shed were interviewed. A total sample of 120 gari processors were chosen for the study.

Hundred traders of cassava-related products, specifically, gari and lafun were selected with the purpose sampling technique. Twenty-five traders were purposively selected from each ADZ. In Ibadan ADZ, three major markets noted for the trading of agricultural commodities were selected. The markets included Bodija (Ibadan North), Oje (Akinleye LGA)

and Apete (Ido LGA). Eight traders were selected from each market. Two notable markets, namely, Odooba (Ogbomosho North) and Aaradaa (Ogbomosho South), were selected from Ogbomosho ADZ. Thirteen traders were selected from Odooba Market, whereas twelve traders were chosen from Aaradaa Market. In Oyo ADZ, Sabo (Atiba), Akeesan (Oyo East) and Jobele (Afijio) were selected and eight traders were chosen from each market. In Saki ADZ, all the twenty-five traders were selected from Sango Market in Iseyin LGA. This was because the Sango Market is a major market noted for the trading of cassava products in the ADZ.

The sampling techniques for the farmers and processors are summarised in [Tables A1](#) and [A2](#) in [Appendix](#).

5. Results and discussion

5.1 Descriptive results

[Table 1](#) shows the summary characteristics of the main actors in the CVC in Nigeria. Cassava tuber producers are older than processors and traders of processed cassava tubers. The mean age of processors and traders is similar. In general, the actors have large households, which is an important source of cheap labour for carrying out various activities in the value chain. Men dominate in the production of cassava tubers, whereas women are more involved in the processing and trading of the processed cassava products ([Table 1](#)). This finding shows gender difference in the various activities in the CVC in Nigeria. This is consistent with gender and agriculture literature that agrifood value chains in SSA are gendered ([Quisumbing et al., 2021](#); [Peterman et al., 2011](#); [Mnimbo et al., 2017](#)). In particular, women are more actively engaged in cassava value addition. In Nigeria, occupations such as food processing and trading are constructed as female vocations, whereas farming is seen as a male vocation. We find that most of the value chain actors have at least primary education.

Variables	Farmers (N = 400)	Processors (N = 120)	Traders (N = 100)
<i>Socioeconomic variable</i>			
Age	48 (13)	43 (11)	43 (12)
Household size	7 (4)	7 (4)	7 (4)
Gender (males)	0.768 (0.423)	0	0
No formal education	0.203 (0.402)	0.175 (0.381)	0.170 (0.377)
Primary	0.305 (0.461)	0.492 (0.502)	0.310 (0.465)
Secondary	0.360 (0.481)	0.300 (0.460)	0.470 (0.501)
Tertiary	0.133 (0.339)	0.033 (0.180)	0.050 (0.219)
Experience	21 (13)	14 (9)	15 (10)
Farm size	2.522 (1.883)		
Off-farm activities	0.643 (0.479)		
Labour	39.66 (27.271)		
<i>Institutional variable</i>			
Membership association	0.598 (0.491)	0.625 (0.486)	0.640 (0.482)
Extension	0.300 (0.458)	0.158 (0.366)	
Credit	0.133 (0.339)	0.083 (0.277)	0.110 (0.314)

Profitability

Total production cost	138,098.87 (198,433.60)	1,986,706.37 (2,209,239.24)	9,140,785 (818,128.57)
Total revenue	432,800.04 (206,898.81)	3,223,133.81 (3,816,472.57)	11,643,665 (3,738,682.83)
Profit	294,701.17 (202,666.21)	1,236,427.44 (1,607,233.33)	2,431,133 (2,797,393.26)

Source(s): Authors' computations based on authors' primary survey data, 2016

Table 1.
Summary statistics of
the actors

However, more traders are educated than farmers and processors. On average, farmers are more experienced in their businesses than processors and traders. Table 1 also shows that most farmers engage in off-farm activities to earn an additional income to support their families. Most of the actors, notably traders are member of an association. These associations are important social capital for the value chain actors, enabling them to access to certain economic resources such as training, credit, innovations and relevant market information (Bizikova *et al.*, 2020; Manda *et al.*, 2020; Olagunju *et al.*, 2021). The value chain actors have limited access to credit, which hampers their business growth. Although access to extension services is low for the actors, more farmers have access to extension services compared to processors and traders. In the study area, we observe that extension agents do not extend their services to traders in the market.

Trade in cassava products has the highest annual total costs followed by cassava processing and cassava production with the lowest cost. This indicates that the trade in cassava products is a more capital-intensive venture. The result also shows that processors and traders earn higher profits than cassava producers (Table 1). In general, cassava product trading is more profitable, followed by processing. Cassava production is the least profitable enterprise in the CVC in Oyo State, Nigeria. This result is consistent with the previous study that value-added cassava product sales fetch higher prices in Nigeria (Donkor *et al.*, 2018b).

5.2 Income distribution patterns among (between) the principal actors in the cassava food value chain

Table 2 shows the empirical results of income distribution patterns among (between) farmers (i.e. small and medium-scale), processors, and traders of processed food products (namely gari and Lafun). The result shows that cassava farmers contribute the least to total income while traders contribute the most. The result also shows that the estimated Gini coefficients of small-scale cassava farmers, cassava medium-scale farmers, gari processors, and traders are 0.44, 0.57, 0.79, and 0.73, respectively (Table 2). This empirical finding implies that income inequality is relatively more pronounced among processors and traders, who are mainly women. We find the correlations between total income and the incomes of processors and traders are the highest, whereas the correlation between total income and small-scale farmers' income is the lowest.

Actor	Income share (S_k)	Gini coefficient (G_k)			Correlation with total income distribution (R_k)	Percentage contribution to total income inequality [$D_k = (S_k G_k R_k / G)$]	Source of elasticity of total inequality [$E_k = (S_k G_k R_k / G) \cdot S_k$]
		Gini	SE	t -value ¹			
Small	0.07	0.44	0.021	20.948***	0.11	1.00	-0.060
Medium	0.16	0.57	0.024	23.933***	0.60	9.30	-0.067
Processor	0.30	0.79	0.017	47.485***	0.90	21.00	-0.090
Trader	0.47	0.73	0.024	30.827***	0.93	54.08	0.071
Total	1.00	0.59			1.00		

Note(s): *** denotes the 1% statistical significance. ¹The computed t -values are used to test whether the estimated respective Gini coefficients of the actors are statistically different from zero; thus, $H_0: G_k$ equals zero versus G_k is not equal to zero. S_k is the income share of each actor k and it indicates the contribution share of each actor to total income. G_k denotes the computed Gini coefficient of each actor k , and it measures the income inequality among actor k . R_k is the Gini correlation which represents the correlation between the income of each actor k and total income. D_k indicates the percentage contribution of each actor k to total income inequality. E_k is the partial derivative of the overall Gini coefficient with respect to a percentage change in income (y_k) of actor k . Source: Authors' computations based on authors' primary survey data, 2016

Table 2.
Income distribution
patterns among
(between) the principal
actors in the cassava-
food value chain

Moreover, small-scale farmers contribute 1% to total income inequality, medium-scale farmers account for 9.30%, while the contributions of processors and traders to total income inequality are 21 and 54.08%, respectively (Table 2). These empirical results imply that traders who sell processed cassava products are major contributors to total income inequality in the CVC in Nigeria. The relative source elasticities show that a 10% increase in the income of small- and medium-scale farmers reduces overall inequality by 0.60 and 0.67%, respectively, whereas a 10% increase in processors' income decrease overall inequality by 0.90%. However, a 10% in traders' income increases overall inequality by 0.71%. These results show that small- and medium-scale cassava production and cassava processing have decreasing effects on overall income inequality in the CVC in Nigeria. The results of the Gini coefficients confirm our initial hypothesis that incomes are unequally distributed in CVC, while small-scale farmers tend to receive a smaller share of the profit margin. The Gini estimates from this study are higher than the national Gini index (0.30) by the World Bank (2014).

Table 3 presents the distribution patterns of farmers' income according to their location and gender. In cassava production, men generate 56.7% of total income while women contribute 43.2%, indicating that men have the largest share of total income (Table 3). Men tend to have better access to support services (credit, extension services, training) and productive inputs (improve crop varieties, agro-inputs, fertile lands and mechanisation) (Peterman *et al.*, 2011; Adegbite and Machethe, 2020), which enable them to increase their farm yields and consequently raise farm incomes. In addition, men are less burdened by reproductive and domestic roles compared to women (Quisumbing *et al.*, 2021; Obayelu *et al.*, 2019). Consequently, they have higher labour productivity than women (Obayelu *et al.*, 2019). Gini coefficients for men and women are 0.541 and 0.537, respectively. These results indicate that income inequality is higher for men than women. The overall Gini (0.406) is lower than that of men and women. Table 3 further shows that men contribute 61.1% of total income inequality but women account for 38.9%. Moreover, a 10% increase in women's income decreases income inequality by 0.43%. In contrast, a 10% increase in men's income tends to increase income inequality by 0.44% (Table 3). These results suggest that an improvement in farm incomes of women tends to reduce overall income inequality in rural Nigeria.

Table 3 further shows that the Gini score of cassava farmers in Oyo State of Nigeria is 0.304, indicating lower income inequality. Cassava farmers in Ogbomosho are associated

Table 3.
Spatial and gender
effects on income
distribution of cassava
farmers

		Gini coefficient (G_k)			Correlation with total income distribution (R_k)	Percentage contribution to total income inequality ($S_k G_k R_k / G$)	Source of elasticity of total inequality ($S_k G_k R_k / G \cdot S_k$)
Variable	Income share (S_k)	Gini	SE	t -value			
<i>Gender</i>							
Female	0.432	0.537	0.026	20.65***	0.680	0.389	-0.043
Male	0.567	0.541	0.029	18.66***	0.809	0.611	0.044
Total		0.406					
<i>Location</i>							
Ibadan	0.152	0.511	0.0353	14.46***	0.157	0.040	-0.112
Ogbomosho	0.247	0.521	0.0393	13.25***	0.073	0.031	-0.216
Saki	0.330	0.504	0.0245	20.56***	0.081	0.044	-0.286
Oyo	0.271	0.498	0.0275	18.11***	0.710	0.315	0.044
Total		0.304					

Note(s): *** denotes the 1% statistical significance

Source(s): Authors' computations based on authors' primary survey data, 2016

with the highest income inequality of 0.521. The Gini coefficients for cassava farmers in Ibadan, Saki and Oyo are 0.511, 0.504 and 0.498, respectively. Cassava farmers from Saki have the largest share (33%) of total income. On the other hand, cassava farmers in Oyo, Ogbomosho and Ibadan contribute 27.1%, 24.7% and 15.2%, respectively, to the total income. These empirical findings indicate a spatial disparity in farmers' income in Oyo State. Cassava farmers in Ibadan, Ogbomosho and Saki tend to have decreasing effects on overall income inequality, while those in Oyo show an increasing effect on overall income inequality. Farmers in Saki have the greatest decreasing impact on overall income inequality. Farmers in Oyo contribute 31.50% to overall income inequality, whereas the contributions of farmers in Ibadan, Ogbomosho and Saki are 4%, 3.1% and 4.4%, respectively (Table 3). We observe from these results that farmers in Oyo contribute largely to the overall income inequality, whereas farmers in Ogbomosho contribute the least to the overall income inequality. The World Bank (2014) estimated the Gini coefficient of farmers located in Southeast of Nigeria (where Oyo State is located) to be 0.36, which is consistent with the estimate of 0.304 in this study. The implication of this result is that overall income inequality among farmers in the Southwest of Nigeria is low. A 10% increase in farmers' income in Ibadan, Ogbomosho and Saki tends to reduce total income inequality by 1.12%, 2.16 and 2.86% respectively (Table 3). In contrast, a 10% increase in farmers' income in Oyo leads to a 0.44% increase in total income inequality.

5.3 Factors influencing profits of actors in the cassava value chain

In this section, we present the results of factors affecting farmers, processors and traders' profits in the CVC in Oyo State, Nigeria. We have transformed the dependent variables and explanatory variables, which are continuous, into natural logarithms. Therefore, the estimated coefficients are interpreted as partial elasticities. The diagnostic statistics show that explanatory variables included in the linear regression models are not collinear, as suggested by mean variance inflation factors of 1.53, 1.45 and 1.73 (Table 4). We performed heteroskedasticity test using Breusch–Pagan/Cook–Weisberg. The result shows that heteroskedasticity is not a problem in the models of farmers and traders but is present in the model of processors. We address this heteroskedastic problem by estimating the standard errors using the robust approach. The *F*-statistics for the three models show statistical significance at 1% level, indicating that the explanatory variables included in the models jointly affect the profitability of the actors.

5.3.1 Socioeconomic variables. Our empirical results in Table 4 show that age exerts a significant negative effect on the profitability of the actors. This result indicates that an increase in the age of farmers, processors and traders reduce their profits by 2.555%, 2.711% and 3.477%, respectively. In general, the value-adding activities from cassava production to trade in cassava products are labour intensive and require more energy; therefore, as actors advance in age, they become less active and their labour productivity tends to reduce. The low labour productivity leads to reduction in their total output and profit. The observation of the study is consistent with the existing empirical study by Donkor *et al.* (2019) showing that age of cassava farmers reduced their profits in Oyo State, Nigeria. We find that household size does not affect farmers' profit, but it exerts a significant positive effect on the profit of processors and traders. Cassava processing and trading are family business; therefore, a large household provides a cheap labour force that minimises operating costs and thus increases profits. Our empirical finding shows that all education variables exert varying degrees of significant positive effects on actors' profits. Education, especially at the secondary and tertiary levels, is an important human capital that enhances managerial and cognitive skills to manage their business efficiently and increase profit margins.

Table 4.
Determinants of
profitability of the
actors in the cassava
food value chain

Variables	Farmers (N = 400)	Processors (N = 120)	Traders (N = 100)
<i>Socioeconomic variable</i>			
Age	−2.555*** (0.183)	−2.711*** (0.223)	−3.477*** (0.197)
Household size	0.010 (0.142)	0.883*** (0.316)	0.495* (0.252)
Gender	−0.036 (0.147)		
Primary	0.666*** (0.173)	0.861*** (0.315)	0.677** (0.339)
Secondary	1.073*** (0.199)	1.268*** (0.436)	1.206*** (0.349)
Tertiary	0.697*** (0.230)	1.492** (0.671)	1.194** (0.567)
Experience	0.290** (0.125)	0.137 (0.190)	−0.253 (0.168)
Farm size	1.273*** (0.112)		
Off-farm activities	−0.060 (0.132)		
Record keeping	0.198 (0.176)		0.223 (0.240)
Labour	0.461*** (0.121)		
Ogbomoshos	0.213 (0.199)	1.813*** (0.387)	0.291 (0.308)
Saki	0.198 (0.199)	1.251*** (0.420)	0.522* (0.279)
Oyo	0.034 (0.218)	0.878** (0.391)	0.522 (0.279)
<i>Institutional variables</i>			
Membership association	0.350*** (0.132)	0.538* (0.297)	0.298 (0.237)
Extension	−0.205 (0.165)	−0.695 (0.456)	
Credit	0.128 (0.193)	0.777 (0.506)	−0.409 (0.382)
<i>Diagnostic statistics</i>			
Joint effect	3069.65***	1377.02***	1612.49***
F-statistics			
VIF	1.53	1.45	1.73
Breusch–Pagan/Cook–Weisberg test for heteroscedasticity	2.17	4.04**	0.15

Note(s): *, **, and *** represent 10%, 5% and 1% statistical significance, respectively. Values in parentheses are standard errors. Source: Authors' computations based on authors' primary survey data, 2016

However, a finding from [Rahman and Chima \(2016\)](#) showed that education had no significant influence on cassava farmers' profit in Ebonyi and Anambra State, Nigeria. Experience shows a significant positive effect on farmers' profit but no significant effect on processors and traders' profits. The descriptive statistics in [Table 3](#) show that farmers are more experienced in their business. Experience is another important human capital. Most people develop business skills over time through experience. Therefore, farmers use the knowledge gained through experience to improve their productivity and profit. However, our finding is inconsistent with the finding of [Donkor et al. \(2019\)](#) that showed that labour had no significant effect on profit of cassava farmers in Oyo State, Nigeria. In contrast, [Rahman and Chima \(2016\)](#) showed that farming experience negatively influenced cassava farmers' profit in Ebonyi and Anambra States, Nigeria. We observe the farm size exerts a positive significant effect on farmers' profit. This result is consistent with [Obayelu et al. \(2013\)](#) that farm size was positively related to farm profit of cassava farmers in Ogun and Oyo States, Nigeria. It is known that increasing farm size is the main contributor to higher cassava output ([Ikueomonisan et al., 2020](#)). *Ceteris paribus*, a higher output can be translated into higher profits. Labour input shows a significant positive relationship with farmers' profit, indicating that increasing labour input tends to increase their profitability in cassava farming. Cassava production is labour intensive; therefore, availability of labour enables farmers to carry out productive various activities such as land clearing, planting, weeding, harvesting and transporting cassava tubers to markets. Our result is consistent with the results of [Donkor et al. \(2019\)](#) indicating that labour increased profit of non-adopters of fertiliser in

cassava production in Oyo State, Nigeria. Similarly, [Obayelu et al. \(2013\)](#) found that labour positively influenced profit of large-scale cassava producers in Ogun State, Nigeria. Location variables show significant positive effects on processors' profit but exerts no significant effect on profit of farmers. For traders, we observe that only Oyo is statistically significant.

5.3.2 Institutional variables. The results show that only membership in an association has a significant positive relationship with farmers and processors' profits. Membership in an association enables the actors to receive support in the form of training on innovations and finance from the government and non-governmental organisations. In addition, association members share information on available markets, prices and innovations that enhance their productivity and profit. Collective action by cooperatives reduces transaction costs and enables actors access to better markets. The result is consistent with evidence by [Donkor et al. \(2019\)](#) that showed that membership in an association increased cassava farmers' profit in Oyo State, Nigeria.

6. Conclusion and policy implications

We have provided better insights into understanding income distribution patterns among actors in the agrifood value chain in SSA using an evidence from the cassava sector in Nigeria. We also analysed how actors' socioeconomic and institutional factors influence their profits in the CVC. The study finds a gender pattern in the CVC. Notably, men operate at the production node of the chain, whereas women are involved in processing and marketing of processed cassava products. The results show large income disparities among actors in the CVC, implying that incomes are unequally distributed in the agrifood value chain. In particular, traders of processed cassava products have the highest share of total income and contribute strongly to overall income inequality in the agrifood value chain. As expected, smallholder farmers, especially women remain disadvantaged in the value chain as they are unable to process to their raw cassava tubers. The results show gender income inequality, in favour of men in cassava production but women in processing and trading of processed cassava products. This suggests that women involved in processing and trading are far better off than those in cassava production. The results also show that spatial differences contribute to income inequality among cassava farmers. In particular, farmers in Saki account for the largest of income but income inequality is higher among farmers in Ogbomosho.

We conclude that agrifood value chain development should aim at reducing income inequality to achieve sustainable development of the rural economy. We also conclude that increasing farmers and processors' profits is necessary to minimise income inequality to reduce poverty and food insecurity among actors in the agrifood value chain. This suggests that any agri-food policy that aims to increase the incomes of farmers and processors in the food chain has the potential to contribute to achieving sustainable development with reduced inequality. Based on the empirical findings, we propose the following policy implications. First, agrifood policies should be inclusive and gender-sensitive. The gender disparity in incomes at the production level can be addressed by empowering women to add value to their raw cassava tubers through processing to increase their profit margins. Agricultural policies should also focus on encouraging the youth to engage in cassava production while empowering the ageing population with adequate human capacity development. Human capacity development can be ensured by training farmers in better farm management practices through adult education programmes. Another recommendation is that agricultural policy initiative must promote the formation of associations, especially among farmers and processors, and strengthening of existing associations so that they become active and support members in their business activities. We also recommend that more research on income and gender equality across actors for different agricultural value chains in Nigeria and other SSA countries.

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Appendix

Agricultural development zones (ADZ)	Number of local government areas (LGA) randomly selected per ADZ	Number of communities purposively selected per LGA	Farmers per community
Ibadan/Ibarapa	4	1	25
Ogbomosho	4	1	25
Oyo	4	1	25
Saki	4	1	25
Total sample			400

Table A1.
Sampling of farmers

Agricultural development zones (ADZ)	Number of local government areas (LGA) purposively selected per ADZ	Number of communities purposively selected per LGA	Processors per community
Ibadan/Ibarapa	3	1	10
Ogbomosho	3	1	10
Oyo	3	1	10
Saki	3	1	10
Total sample			120

Table A2.
Sampling of processors

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