ASSESSING THE ECONOMY-WIDE IMPACT OF GENDER GAP IN AGRICULTURAL PRODUCTIVITY IN NIGERIA: Evidence from CGE model

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ABSTRACT

The agriculture sector is a key sector of the Nigeria economy, as it contributes to GDP, employment and poverty reduction. However, while women account for a large proportion of agricultural labour, they often face constraints in terms of access to farm inputs, resources and credit. This study examines the impact of gender disparities in productivity in the Nigerian agriculture sector. We used a Computable General Equilibrium (CGE) model and Nigeria's updated social accounting matrix (SAM) for the analysis. The results show that gender disparities in productivity caused aggregate agricultural output to fall by 6.6%. The fall in agricultural output resulted in a decline in agricultural exports and an increase in agricultural imports. Also, agricultural prices increased. Lastly, the gender gap in productivity also led to a fall in real GDP by 2.4% and a rise in consumer price index by 6.6%. These results show the huge economic losses associated with the gender gap in agricultural productivity. Hence, it is recommended that policies to narrow the gender gap in the agricultural sector should be prioritized.

JEL: Q10; Q18; J43; C68; N57

Keywords: Agriculture**,** women in agriculture, food security, CGE model, Nigeria

1. Introduction

The agriculture sector is important for economic growth and development in developing countries, including Nigeria (Kalu, 2021). Investment in the sector improves productivity and employment opportunities, reduces poverty, and enhances sustainable development (World Bank, 2014). However, the performance of the sector in Nigeria has raised concerns about the ability to ensure food security and reach the poverty- and hunger-related targets of the Sustainable Development Goals (SDGs). Nigeria was ranked 93rd of 117 countries on the 2019 Global Hunger Index and 158th out of 189 countries on the 2018 UNDP Human Development Index (HDI). Over 52% of the rural population lives under the poverty line compared to only 18% of the urban population. The high population growth rate relative to dwindling food production capacity increases the likelihood of a food crisis and insecurity (Chima, 2023). Nigeria's 2020 food security outlook report by the Famine Early Warning Systems Network painted a gloomy picture of the country's prospects (Famine Early Warning Systems Network, 2020). The increasing demand for food in the face of shrinking domestic supply has resulted in massive food importation and food price inflation.

A peculiar feature of the agriculture sector in Nigeria, however, is the gender gap in access to farm inputs and in productivity levels (Oseni et al., 2013; Mukasa & Salami, 2015). According to the Nigerian Federal Ministry of Agriculture and Rural Development (2019), women account for 60%-79% of the rural labour force but are five times less likely to own land than men. Wage disparities between male (₦1,454) and female (₦1,246) labour are evident in the sector (NBS and World Bank, 2019). There is also a marked difference in productivity, measured by crop yields (kg/hectares), between men and women plot managers in Nigeria.

Several studies have analysed the gender gap in Nigeria's agriculture sector (Oladeebo & Fajuyigbe, 2007; Oseni et al., 2013; Oseni et al. 2015; Mukasa & Salami, 2015). Their analyses are limited mainly either to determining the availability of the gender gap, estimating the extent of the gap, or exploring the causes and determinants of the gap. Mukasa & Salami (2015) estimated gender disparities in agricultural productivity in Nigeria at 18.6%, attributing the gap to the disadvantages women experience in gaining access to labour inputs, to large areas of land, and to good-quality land. This corroborates the earlier

conclusions of Oseni, et al. (2013), who found that gender gaps in agricultural earnings in Nigeria could be attributed to unequal access to land, labour physical inputs and tools, and information.

The impact of policy measures to improve the productivity of women farmers and close the gender gap has also been well researched (Karamba & Winters, 2015; Ngoma et al., 2021; Anderson et al., 2021), but CGE-model studies on economy-wide impacts of gender disparities in agricultural productivity are rare. One study by the United Nations Entity for Gender Equality and the Empowerment of Women (UN Women) et al. (2015) used a partial-equilibrium approach to estimate the welfare and GDP effects of closing the gender gap in agricultural productivity in Malawi, Tanzania, and Uganda. The study estimated the cost of the gap in the countries under study but failed to capture the feedback effects. For instance, the study assumed that increasing the productivity of women farmers does not affect the productivity of farming men or agricultural prices. The study however found that the inability to access men's labour constrained the productivity of women farmers.

Our analysis builds on the study by UN Women et al. (2015) by incorporating general equilibrium effects. CGE models have been used to analyse the economic impacts of public policy in Nigeria (Nkang et al., 2013; Odior, 2014; Montaud, et al., 2017; Bosello et al., 2018; Omoju et al., 2024). None of these CGE analyses, however, incorporated a gender analysis to capture the gendered effects of public policies. Fontana and Wood (2000), Fontana and Rodgers (2005), and Fontana (2014) noted the importance of incorporating gender into CGE frameworks while Fontana and Wood (2000) modelled gender by incorporating leisure and unpaid work.

Other means of incorporating gender into a CGE model include gender-disaggregated labour shares and household structures (Arndt & Tarp, 2000; Fontana, 2014). Following Oseni et al. (2015), we disaggregate gendered labour shares into whether they were provided by unpaid household labour or paid hired labour. This disaggregation is critical because of the unequal access of farming men and women to different labour types. It is also based on a key strand of the gender-in-agriculture literature, which argues that market inefficiencies, especially in the credit and labour markets, are key drivers of the productivity gap. Palacios-López and López (2015) estimated that 34% of the agricultural labour productivity gap in Malawi was the result of differences in

labour market access. Mukasa and Salami (2015) also noted that one source of the productivity gap in Nigeria is unequal access to labour inputs. In the Nigerian context, women are disproportionately employed as unpaid family labour in the agriculture sector, and women farmers also rely more on family labour than men farmers (Oseni et al., 2015), who have more resources to acquire hired labour.

This study contributes to the gender-in-agriculture literature in a number of ways. First, to the best of our knowledge, it is the first to estimate the economy-wide impacts of gender disparities in productivity in the Nigerian agriculture sector. Second, it contributes to the CGE model literature in Nigeria by modelling gender differences in the distribution of labour between household and hired labour. Thus, this study analyses the economy-wide impacts of the gender disparities in productivity in the agriculture sector.

2. Literature Review

The agriculture sector plays a vital role in reducing poverty and fuelling economic growth (Edafe et al., 2023). The performance of the sector globally is impeded by several factors, however, including the inability of women to access key resources, services, and markets (Food and Agriculture Organisation (FAO), 2011). The gender gap in the agriculture sector undermines productivity and overall socioeconomic development goals. According to the FAO report, women across developing regions face similar challenges in inputs, services, and assets such as labour, land, education, livestock, and extension and financial services.

The gender gap in the agriculture sector in Nigeria has attracted significant interest in the academic literature. The first strand of the literature examines the availability and causes of gender disparities in productivity. Folarin et al., (2021) compared the employment and productivity of males and females in Nigeria's agriculture sector. Yeo et al. (2024) showed that women have fewer opportunities to own agricultural assets than men. Obayelu et al. (2020) confirmed that domestic activities undermine female labour participation in agriculture. Edoka et al. (2025) observed that gender division of agricultural activities is a major factor containing food security in Nigeria; and current policies and technologies fail to recognize the different needs of men and

women in the sector. Ragasa et al. (2023) also confirmed that women in Nigeria face deep-seated gender inequalities that restrict their participation, access to resources, and productivity in the agriculture sector.

However, Adeleke et al. (2008) found no significant differences between the productivity of men and women who farmed maize in Nigeria, after accounting for agricultural input use. This result corroborated earlier findings by Oladeebo and Fajuyigbe (2007), who found, in their study of rice farmers in Osun State of Nigeria, that women rice farmers were more technically efficient than their male counterparts, when years of education and age were considered. Akighir et al. (2021) also found that gender played no role in who benefits from Nigeria's anchor borrower's programme.

On the contrary, other studies established evidence of gender disparities in productivity. Peterman et al. (2010), for example, found a productivity gap between plots managed by men and those managed by women as well as between households headed by men and those headed by women in Nigeria and Uganda, even after accounting for agricultural inputs, a range of socioeconomic variables, and crop choices. They noted that gender differences in productivity depend on gender indicators, crop-specific samples, bio-physical characteristics, and agro-ecological zones. Oseni et al. (2015) employed data from the General Household Survey Panel 2010-2011 and the Oaxaca-Blinder decomposition method to analyse gender differences in agricultural productivity among plot managers in Nigeria, finding that gender gaps in productivity and the causes of such gaps varied across locations. Women from the north were 28% less efficient than men after controlling for observed factors of production, while there were no significant gender differences in productivity in the south. The study further revealed that structural factors were more important than endowment factors in explaining the gap in the north, indicating that, if women farmers in the north were given the same level of resources as men, they would still be less efficient. The reverse was the case in the south where endowment factors were more important than structural factors in explaining the productivity gap. With the same level of farm inputs, women farmers in the south performed as well as men farmers. Like Oseni et al. (2015), Ekerebi and Adeola (2017) found a gender-harvest-value gap across the northern and southern parts of Nigeria. They attributed the disparity partly to differences in wealth, education, and

access to irrigation because the north is predominantly Muslim, women are more constrained in hiring male labour and accessing markets. In another study, the World Bank (2023) found that women farmers in Nigeria produce 30% less than their male counterparts, due to their adoption of fewer inputs and limited participation in extension services, specializing in less-valuable crops, and hiring less productive labour.

Another strand of the literature evaluates the impact of policy measures aimed at improving the productivity of women farmers and closing the gender gap. As noted by Anderson et al. (2021) in their systematic review, evidence of the significant economic benefits of closing the gender gap exists, but studies that have estimated these economic benefits are rare. Karamba and Winters (2015) investigated the impact of the farm-input subsidy programme on agricultural productivity (value of output per hectare) in Malawi using nationally representative, plot-level data. Using spatial fixed effects and propensity score methods, they found that the programme increased the productivity of both men and women farmers but did not disproportionately increase the productivity of women farmers relative to counterpart farming men. This is similar to the findings of Ngoma et al. (2021) for Zambia. Contrary to Karamba and Winters (2015), however, Fisher and Kandiwa (2014) found that Malawi's farm input subsidy programme helped close the gender gap in modern maize adoption. The programme, which consisted of both maize seeds and fertilizer coupons, had a positive impact on modern maize adoption for women farmers while there were no effects on their male counterparts. The World Bank (2022) observed that doubling the quantities of herbicide and fertilizer may increase agricultural productivity by 18% and 6% respectively.

While gender differences in productivity in the agriculture sector have been noted, empirical analysis of the economy-wide effects of these disparities in Nigeria or of the economic benefits of narrowing them are rare. The report by UN Women (2015) estimated that the gender gap in the agriculture sector in Malawi, Tanzania, and Uganda cost those countries $100 million, $105 million, and $67 million in annual GDP respectively. Closing the gap would increase annual crop output by 7.3%, 2.1%, and 2.8% respectively, in those three countries. Mukasa and Salami (2015) estimated that resolving gender disparities in agricultural productivity in Nigeria would increase production by 2.8%, increase monthly consumption per adult equivalent by 2.9%, and reduce

poverty among households managed by women by 1.2%. This analysis was based on micro-level data, however, and did not capture macro-level or inter-sectoral linkages and effects. This paper, in contrast, used a CGE model to analyse the economy-wide impacts of gender disparities in productivity in the Nigerian context.

Numerous studies have modelled gender issues within a CGE framework (Fontana, 2014). Fontana and Wood (2000) modelled gender in a CGE framework by incorporating leisure and unpaid work. Arndt and Tarp (2000) investigated the interactions between agricultural technology improvements, risk-reducing behaviour and gender roles in agricultural production in Mozambique using a CGE model. Acknowledging that availability of labour is a major constraint on cassava production, a key female-intensive crop, and the critical role of women's labour in cassava production, they modelled the gender effects through gender-disaggregated labour shares. Our study, following Mukasa and Salami's (2015) analysis that access to labour is a driver of gender disparities in productivity in Nigeria, toes the path of Arndt and Tarp (2000) in the modelling of gender through labour shares. However, we went further to disaggregate these gendered labour shares into whether they are provided by unpaid household labour or paid hired labour. Women are disproportionately employed as unpaid household labour in the agriculture sector in Nigeria, and women farmers also rely more on family labour than their male counterparts, who have more resources to acquire hired labour.

While several studies have been conducted on gender issues in agriculture as shown in the review, studies on the economy-wide impacts of the gender gap in agriculture are rare. This is the gap in the literature this study fills.

3. Methodology

3.1 CGE model: PEP 1-1 model

The study is built on the Women in Development theory. The theory provides contexts for integrating women into economic and social development and aims to correct the gender blindness of economic and development policies (Boserup, 1970). The theory posits that women are key factors in development and should be valued as key untapped economic resources to increase productivity and promote inclusive development. In the context of agriculture,

it notes that providing access to credit, technology and other key resources is critical for economic development.

We used a CGE model to assess the impact of gender disparities in productivity in the agricultural sector. Computable General Equilibrium models are employed to investigate the economy-wide, distributional, and welfare impacts of public policies (Wing, 2004). It is presumed that consumers seek to maximize utility given budget constraints, while producers aim to minimize production costs. Among other applications, CGE models have been used widely to evaluate the impact of agricultural policies (Shikur, 2020). They have been used to analyse public policies on issues in Nigeria, ranging from agriculture, climate change, energy, and government expenditure to trade liberalization (Nkang et al., 2013; Odior, 2014; Montaud, et al., 2017; Bosello et al., 2018; Omoju et al., 2024), though they have not captured gender.

We employed an extended PEP 1-1 model (Decaluwé et al., 2009) for this analysis. The PEP 1-1 model is a single-country static model. The choice of a static model is the simplicity and lower data requirement, and the need to evaluate the short-run and immediate impact of gender differences in the agriculture sector.

In the model, output (XST) is composed of intermediate consumption (CI) and value added (VA), and both are a fixed proportion of output. The outputs of each sector are either sold locally (DS) or exported to the rest of the world (EXD). The disaggregation of output into local supply and export is governed by a constant elasticity of transformation (CET) function. Similarly, total consumption is made up of commodities produced locally (DD) and those imported (IM). It is assumed that locally produced commodities and imported commodities are imperfect substitutes, and this relationship is expressed by a CES function following the Armington Hypothesis (Armington, 1969).

We made some adjustments to the standard PEP 1-1 model to adapt it to our research questions. First, we separated agricultural output from non-agricultural output and segmented the labour market according to gender, following such workers as Arndt and Tarp (2000) and Fontana (2014). But our study went further to disaggregate these gendered labour shares into unpaid household labour or paid hired labour. According to Oseni et al. (2015), Nigerian women farmers are constrained by their inability to acquire hired men as labourers and mostly depend on family labour for production. Also, women

are likely to work as unpaid family labour in the agriculture sector rather than as hired/paid labourers. Thus, following the pattern of employment in the agricultural labour market in Nigeria (according to the Living Standards Measurement Study-Integrated Surveys on Agriculture), agricultural labour in the model is segmented into family and hired labour. Hence, agricultural value added is made up of agricultural labour, capital, and land while non-agricultural labour is made up of non-agricultural labour and capital. These relationships are expressed by a constant elasticity of substitution (CES) function.

Once we had separated agricultural labour from non-agricultural labour, we further disaggregated non-agricultural labour across sectors by gender, using data from the Women and Men Report in Nigeria. Similarly, agricultural labour was initially decomposed into family labour and hired labour using data from the Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA). Thereafter, both family labour and hired labour were further disaggregated into men's and women's labour. At the end of the disaggregation, agricultural labour was decomposed into family or hired labour, as was the proportion of men's and women's labour in each category. We implemented this in the model using a CES function as shown in the following equations. The relative demand functions of each labour category are correspondingly computed.

$$AGLAB_j = B_j^{AGLAB}[\beta_j^{AGLAB} HHL_j^{-\rho_j^{AGLAB}} + (1-\beta_j^{AGLAB}) HRL_j^{-\rho_j^{AGLAB}}]^{\frac{1}{\rho_j^{AGLAB}}} \quad (1)$$

Equation (1) shows a CES reflecting the relationship between family labour (HHL) and hired labour (HRL).

$$AGHHL_j = B_j^{AGHHL}[\beta_j^{AGHHL} HHLM_j^{-\rho_j^{AGHHL}} + (1-\beta_j^{AGHHL}) HHLF_j^{-\rho_j^{AGHHL}}]^{\frac{1}{\rho_j^{AGHHL}}} \quad (2)$$

Equation 2 depicts the relationship between men's (HHLM) and women's family labour (HHLF).

$$AGHRL_j = B_j^{AGHHL}[\beta_j^{AGHHL} HRLM_j^{-\rho_j^{AGHHL}} + (1-\beta_j^{AGHHL}) HRLF_j^{-\rho_j^{AGHHL}}]^{\frac{1}{\rho_j^{AGHHL}}} \quad (3)$$

Lastly, Equation 3 reflects the relationship between men's (HRLM) and women's hired labour (HRLF).

The extension of the PEP 1-1 model is shown in Figure 1.

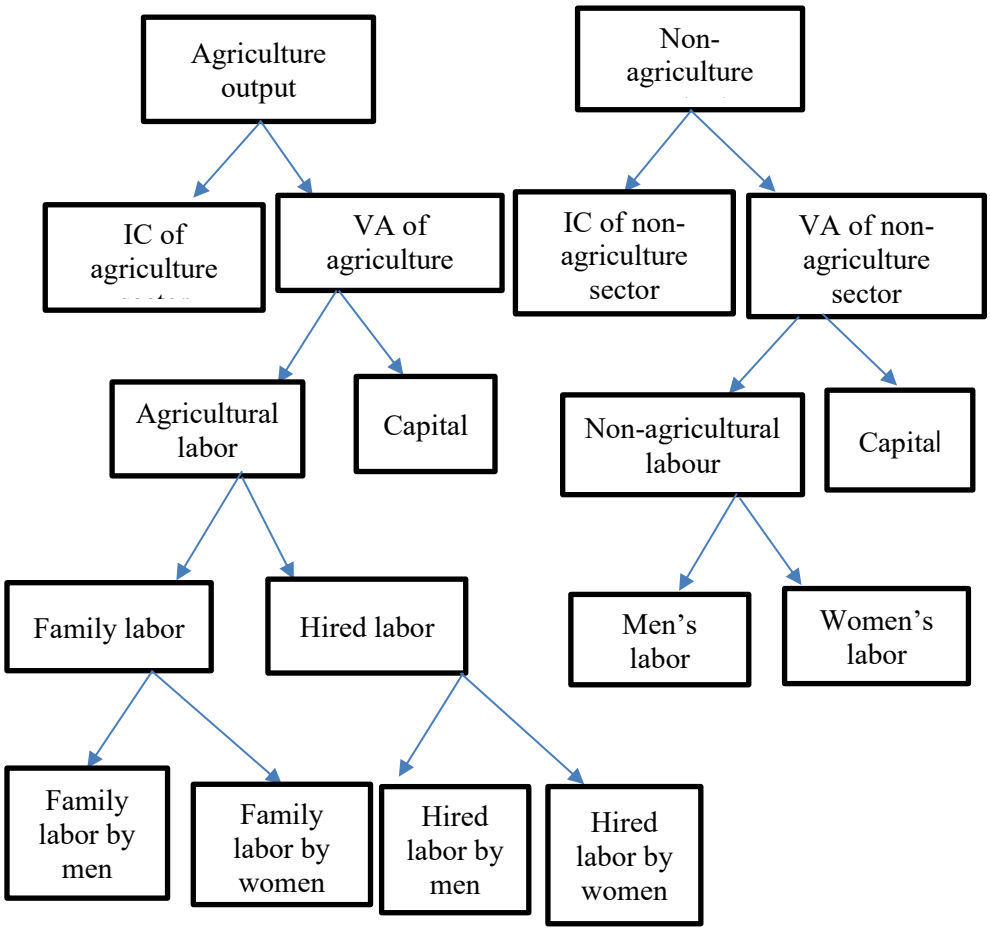

Figure 1: Schema of Adjusted PEP 1-1 Model

Source: Authors' compilation

There are no specific elasticity parameters for the CES functions for Nigeria. Hence, we adopted elasticities from Decaluwé et al. (2001). The supply of household labour is constrained, while that of hired labour is variable (subject to wages). Land and capital are sector-specific in the model. The closure rules for the model are labour supply, current account balance, government savings, and world prices; and stock variation are fixed. The nominal exchange rate is the numeraire.

3.2 Data: Social accounting matrix (SAM)

The baseline data for a CGE model is the social accounting matrix (SAM). The SAM describes both the structure of the economy and the interdependence of sectors and economic agents within the economy. We used the Nigerian SAM developed by Nwafor et al. (2010). We used the cross-entropy method developed by Lemelin et al. (2013) to update the SAM to current economic data. Data used for updating the SAM were obtained from the database of the Central Bank of Nigeria and included the proportion of trade, revenue, gross fixed capital formation, and sector-based output in GDP.

The SAM included 27 crop sectors and commodities, 10 livestock sectors and commodities, 1 fishery sector and commodity, 1 forestry sector and commodity, 22 non-agricultural sectors, and 23 non-agricultural commodities. According to the Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) (National Bureau of Statistics and the World Bank, 2019), the most important crops in Nigeria include rice, maize, sorghum, millet, cassava, yams, beans, groundnut, and oil/benniseed. These are also the crops in which women play an important role.

We retained nine crop sectors and commodities and merged the remaining crop sectors and commodities as "other crops," resulting in a total of ten crop sectors: rice, maize, sorghum, millet, cassava, yams, beans, groundnut, oil/benniseed, and other crops. Crop sectors were further disaggregated into those managed by women and those managed by men based on data from the LSMS-ISA. After all adjustments, there were forty-one sectors and thirty-two commodities in the final SAM.

We separated the labour account in the SAM into agricultural and non-agricultural labour. Agricultural labour is used only in the agriculture sector

and comes either from family/household or hired labour. The proportion of family and hired labour we used to disaggregate the SAM, and the further disaggregation of labour by gender, were all based on data from the LSMS-ISA. After the disaggregation, we were left with men's family labour, women's family labour, men's hired labour, and women's hired labour.

Non-agricultural labour is also used in non-agricultural sectors. Using women's and men's employment data from the 2011 National Bureau of Statistics' "Women and Men in Nigeria" report (National Bureau of Statistics, 2013), we disaggregated non-agricultural labour into men's and women's labour. Agricultural and non-agricultural labour are supplied by rural and urban households, and labour is mobile across agricultural and non-agricultural sectors.

The SAM included two household categories (rural and urban), firms, government, and the rest of the world. Because of the lack of reliable data, we did not categorize households by gender. Households obtain income from production-factor income and transfers from firms and the government. Households use their incomes to pay direct taxes, purchase goods and services, and savings. Firms earn income from capital factors. Firms' expenditures include payment of direct taxes, transfers to households, and savings. The government module in the SAM reflects public revenue and expenditure. Government revenue comes from taxes, capital income, and income from abroad. Tax income mainly consists of direct taxes (individual income tax and corporate income tax), indirect taxes, and import taxes. Government expenditures include government consumption of commodities, transfers to households in the form of social security, transfers to other agents, and government savings.

The rest of the world is an external agent that depicts the international trade relationship between Nigeria and other countries. The relationship between export and import in the SAM is depicted by the current account balance. Other parts of the SAM include savings-investment, stock variations, transaction costs, and the total column and rows.

3.3 Overview of the Nigerian agriculture sector based on the updated/adjusted SAM

Only three production factors – land, labour, and capital – are employed in the agriculture sector, and their intensity varies according to each crop. However, as Table 1 makes clear, labour and land are the most dominant production factors in the sector. This is because of the small-scale nature of Nigerian agriculture and the lack of commercial and mechanized farming. All crops also use varying proportions of different types of labour. Household labour, however, accounts for the highest proportion of labour used in the agriculture sector. Within the household labour supply, men's labour supply is proportionally higher.

The labour supply of hired women is the lowest in all crop sectors (Table 1). This suggests that women largely participate in the agricultural labour market as family labourers.

Table 1: Factor Intensity of the Agriculture Sector (%)

Sectors	Household labour supplied by men	Household labour supplied by women	Hired labourers: men	Hired labourers: women	Capital	Land
Rice	22.75	15.81	13.50	7.27	0.91	39.76
Maize	24.16	21.42	9.77	6.25	1.08	37.33
Sorghum	25.89	13.34	12.94	7.28	0.58	39.97
Millet	25.45	11.97	15.08	10.92	0.49	36.09
Cassava	21.91	31.53	3.03	3.57	0.70	39.25
Yams	21.67	31.17	2.63	0.74	0.77	43.02
Beans	21.96	15.90	7.30	8.92	0.99	44.93
Groundnut	23.54	14.43	7.51	10.37	0.97	43.19
Oil/benniseed	24.59	19.32	9.26	6.98	2.59	37.25
Other crops	22.47	17.66	8.46	6.38	2.11	42.90

Source: Authors' calculations

Very few women receive wages for services rendered in the agriculture sector; only 7.3% of labour in the rice crop sector are hired women who receive wages compared to family labour, which constitutes 15.8%. Similarly, the supply of hired women's labour in the yam crop sector is only 0.7% compared to 31.2% of women's labour supplied by the family. Of all the crop sectors,

millet and groundnut have the highest proportions of hired women labourers at 10.9% and 10.4% respectively. In summary, the data characterize the agriculture sector in Nigeria as labour-intensive, with most of the labour supplied by families relative to hired labour. Also, the proportion of hired women labourers is comparatively low, suggesting most women work in the agriculture sector as family labourers without wages.

Capital and labour are the only factors of production used in the non-agricultural sectors (Figure 2). Compared to capital, more labour is used in all sectors except for oil, gas, and mining (OMIN), construction (CONS), and other manufacturing sectors (OMFC), which are capital-intensive by up to 99%, 97%, and 80% respectively. Labour accounts for about 90% of the value added of the education, health, public administration, trade, hotel, real estate, and other services sectors. Livestock, fisheries, forestry, and food and beverages also employ a large proportion of labour relative to capital. In terms of the gender composition of labour, men's labour accounts for a higher proportion of labour supply in the non-agriculture sectors: 45.9%, 42.3%, and 46.6% of value added in the livestock, fishery and forestry sectors respectively, compared to women's labour, which accounts for 26.4%, 27.2%, and 26.8% respectively.

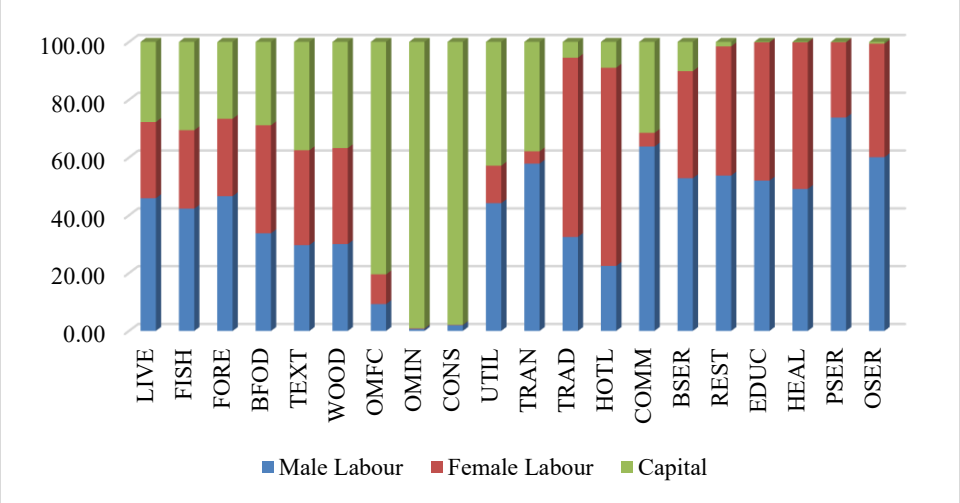

Figure 2: Factor Intensity in Non-agriculture Sectors

Source: Authors' calculations

The contribution of women's labour to total value added is higher than men's in a few sectors: beverages and processed food, textiles, wood and furniture, other manufacturing, wholesale and retail trade, hotel and restaurants, and health. Women's labour accounts for the largest component of value added in the wholesale and retail trade, and hotel and restaurant sectors at 62.0% and 68.6% respectively. In contrast, the contribution of women's labour to total value added in the transportation, communications, public administration, and other services sectors are 4.3%, 4.7%, 26.1%, and 39.3% respectively, lower than the contribution of men's labour, which stands at 57.9%, 63.8%, 73.8%, and 60.1% respectively.

The crop sector is a major priority area of intervention. The share of the value added of individual crop sectors to total agricultural value added is presented in Figure 3a. The highest share of agricultural value added is observed in the growing of cassava, yams, and "other crops," while oil/benniseed, rice, and beans account for the lowest. Nigeria produces about 20% of the world's cassava, and the sector is largely dominated by women farmers who are mostly smallholders on small plots for family consumption and local sale.

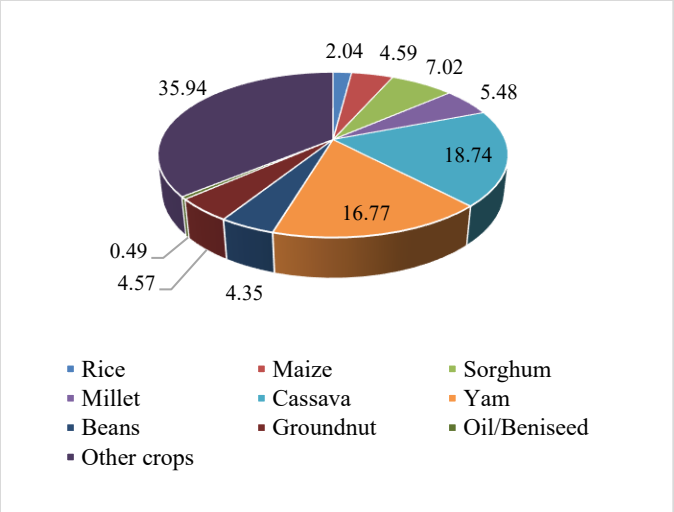

Figure 3a: Crop Sector Value Added as % of Total Agricultural Value Added (%)
Source: Authors' calculations

The gender intensity of crop activities is presented in Figure 3b. Only the cassava sector has a higher intensity of women, where women farmers account for 53% of activities. In the other crop sectors, women's intensity is lower than men's, but the gap is generally small, except in the sorghum and beans sectors in which the gender-intensity gap is wide; women account for only 32% and 34%, respectively.

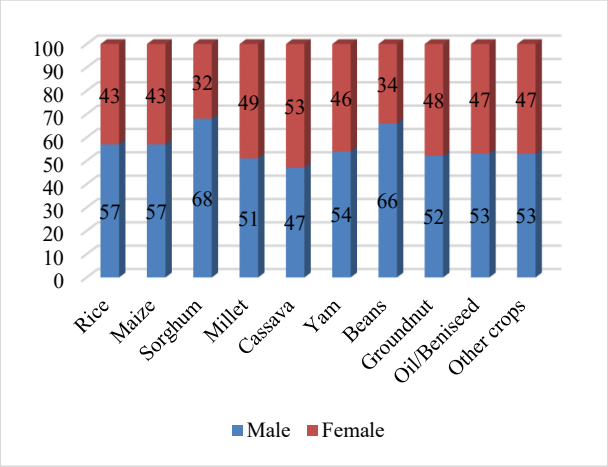

Figure 3b: Gender Intensity of Crop Sector Activities (%)
Source: Authors' calculations

4. Results and Discussion

The objective was to examine the economy-wide effects of gender disparities in productivity in the agriculture sector. We simulated the impact of changes in the scale parameters of crop sectors managed by men or by women using data from the National Bureau of Statistics (NBS).

The results show that overall agriculture output was 6.6% lower relative to a scenario in which no gender disparities existed in productivity (Figure 4). This means that the overall output of the agriculture sector declined by 6.6% because of the gender disparity in productivity level. This result aligns with existing findings on the subject, which indicate that lack of access to agricultural inputs for women is a major challenge for agricultural productivity (World Bank, 2023). Given that women are actively involved in the agriculture sector in Nigeria, their lack of access to key inputs and resources such as

fertilizers, seedlings, extension services, credits and grants, etc. creates a huge gap in agricultural productivity.

For individual crops, the outputs of beans, groundnut, maize, millet, oil/benniseed, rice, sorghum, yams, and other crops were 16.9%, 3.7%, 11.3%, 3.0, 27.2%, 12.9%, 14.1%, 6.2%, and 8.9% lower respectively, compared to a scenario without gender disparities. The only crop for which the productivity of women farmers was higher than that of farming men was cassava, which showed a 5.2% higher output. These results suggest that higher levels of gender disparities in productivity results in lower levels of aggregate agricultural output.

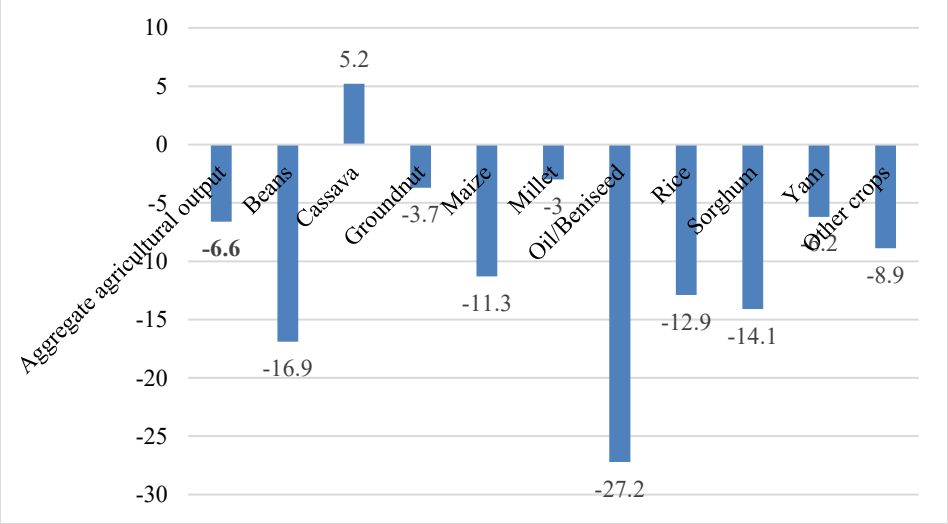

Figure 4: Impact of gender gap on agricultural output (%)

Source: Simulation results

Similarly, the results in Figures 5a and 5b show that gender disparities in productivity in the agriculture sector have led to lower exports and higher imports of agricultural commodities. Lower agriculture output, itself the result of gender disparities in productivity, led to reductions in agricultural exports and increases in imports. The lower exports are primarily due to the reduction in productivity, most of which are consumed locally with little left for exportation. Also, imports increase to complement the shortfall in production.

Lower agricultural production accompanied by higher imports poses a threat to food security (Afrexim Bank Research & University of Waterloo, 2024; Xu et al., 2026).

Exports of oil/benniseed and other crops were lower by 29.6% and 19.9% respectively. In contrast, the import of agricultural commodities increased. Imports of beans, other crops, and maize increased by 27.8%, 28.2%, and 19.0% respectively, while fertilizer imports fell by 9.1%. Because fertilizer is used only in the agriculture sector, the drop in fertilizer imports was directly correlated to the drop in agricultural production.

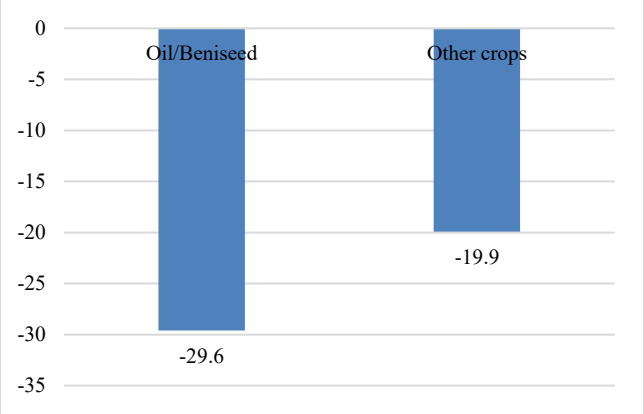

Figure 5a: Agricultural Exports (%)

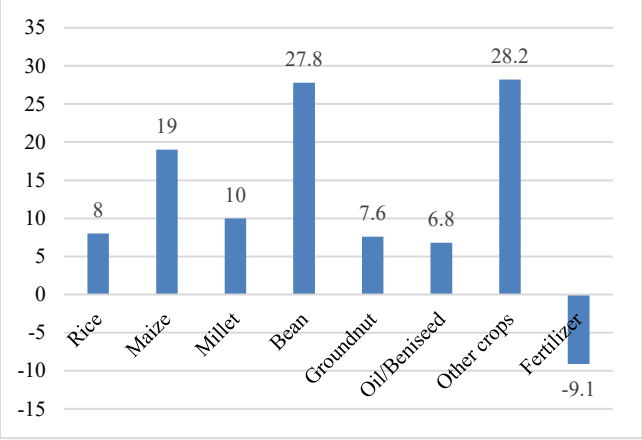

Figure 5b: Agricultural Imports (%)

Source: Simulation results

Furthermore, a reduction in agriculture output in the context of demand resulted in an increase in price. As Figure 6 shows, the price of major agricultural commodities (except cassava) increased, ranging from the price of groundnut (which increased by 5.8%) to the price of sorghum (which increased by 39.6%). The increase in prices because of the decline in agricultural productivity corroborates with earlier studies such as Mbah et al. (2022), which finds lower agricultural productivity is translated to food inflation in the long run. Increases in the price of agricultural commodities undermine food security.

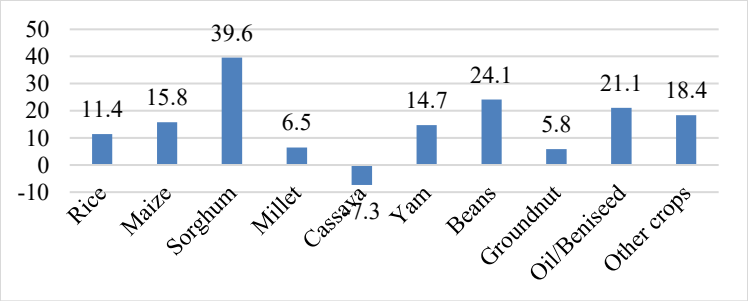

Figure 6: Agricultural prices (%)

Source: Simulation results

Figure 7 also shows that real GDP was lower by 2.4% and the consumer price index (CPI) was higher by 5.6% because of gender disparities in productivity in the agriculture sector. The significant effect on real GDP is due to the contribution of the agriculture sector to GDP. Currently, the sector contributes over 20% of the GDP, and shocks and interventions to the sector will have direct impact on the GDP. As the agriculture sector faces output losses because of the gender gap, the effect on the overall economy is significant due to the share of the sector in the economy.

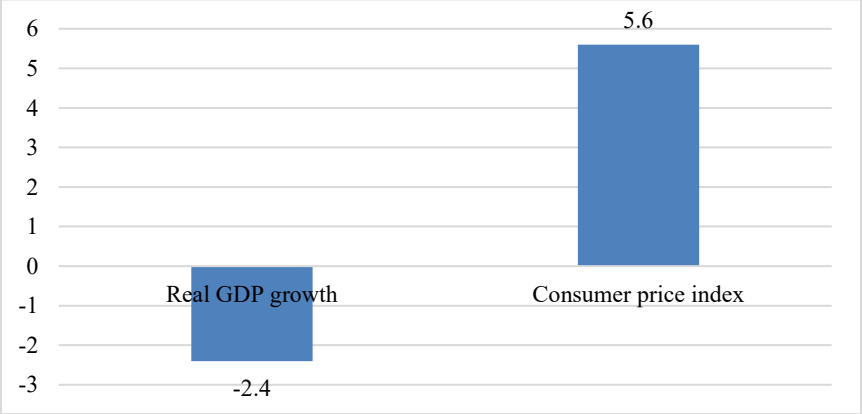

Figure 7: Impact on real GDP and CPI (%)

Source: Simulation results

5. Conclusion and Policy Implications

Using an extended CGE model and updated SAM for Nigeria, we analysed the economy-wide impacts of gender disparities in agriculture productivity. Overall, we found that gender disparities in productivity resulted in agriculture output declining by 6.6% compared to a baseline scenario in which no gender-productivity gap existed. The effect of individual agricultural crops varied. For instance, the output of agricultural commodities like beans, groundnut, maize, millet, oil/benniseed, rice, sorghum, yams, and other crops reduced by a range of 3.0%-27.2%, indicating the heterogenous effects of gender disparities across different agriculture sectors. The significant decline in agricultural output resulted in a decline in exports and increase in imports. As production reduces, there is a need to import more agriculture commodities to fill the shortfall, while available production is allocated to the local market, limiting exports. Specifically, exports of agricultural commodities were lower by 19.9%-29.6% while imports increased by 19.0%-28.2%. Importation of fertilizer, a key input in agricultural production also fell by 9.1%. This is expected as lower overall agricultural production means lower demand for agricultural inputs. Lower agricultural production and higher food imports create a food security risk.

Agricultural prices also increased due to reduced production. Reduction in production vis-à-vis demand raised prices by between 5.8%-39.6%. Overall, the consumer price index, a key measure of inflation, increased by 5.6%. A

combination of lower agriculture production and higher prices led to a fall in GDP by 2.4%.

Based on these findings, we observe that lack of access to basic agricultural resources has a negative impact on the economy, agriculture output, and food security. Hence, efforts to bridge the gender gap in the sector should be prioritized as a measure to improve the performance of the sector in terms of output, price and net trade, as well as the overall economy. Policies to enhance women's access to productivity-enhancing agricultural resources should be pursued.

Much remains to be done to adapt a CGE model to an understanding of the rural economy in Nigeria and of gender issues in the agricultural sector. This work should include, among other things, comprehensive data collection on intra-household decision making and resource allocation and household consumption of their own production. Further studies should also attempt to capture regional differences in women's roles in agriculture in Nigeria.

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References

Adeleke, O.A., Adesiyan, O.I., Olaniyi, O.A., Adelalu, K.O., & Matanmi, H.M. (2008). Gender differentials in the productivity of cereal crop farmers: A case study of maize farmers in Oluyole Local Government Area of Oyo State. *Agricultural Journal*, *3*(3), 193-198. https://www.cabidigitallibrary.org/doi/full/10.5555/20093214341

Afrexim Bank Research and University of Waterloo (2024). *Food imports and food security in Africa: Addressing the challenges.* https://media.afreximbank.com/afrexim/Food-Imports-and-Food-Security-Addressing-the-Challenges.pdf

Akighir, D.T., Akegh, E. & Emmanuel, E. (2021). Anchor borrowers' programme and poverty level among smallholder farmers in Benue State, Nigeria: Implications for Economic Recovery and Growth Plan. *Nigerian Journal of Economic and Social Studies*, *63*(2), 241-269.

Anderson, C.L, Reynolds, T.W., Biscaye, P., Patwardhan, V. & Schmidt, C. (2021). Economic benefits of empowering women in agriculture: Assumptions and evidence. *The Journal of Development Studies*, *57*(2), 193-208. https://doi.org/10.1080/00220388.2020.1769071

Armington, P. (1969). A theory of demand for products distinguished by place of production. *IMF Staff Papers*, *16*, 159-178. Washington, DC: International Monetary Fund. https://doi.org/10.2307/3866403.

Arndt, C. & Tarp, F. (2000). Agricultural technology, risk, and gender: A CGE analysis of Mozambique. *World Development*, *28*(7), 1307-1326. https://doi.org/10.1016/S0305-750X(00)00017-6.

Bosello, F., Campagnolo, L., Cervigni, R., & Eboli, F. (2018). Climate change and adaptation: The case of Nigerian agriculture. *Environmental and Resource Economics, 69*(4), 787-810. https://doi.org/10.1007/s10640-016-0105-4.

Boserup, E. (1970). *Women's role in economic development*. St. Martinís Press, New York.

Chima, C.I. (2023). Effect of insecurity on agricultural productivity in Nigeria. *Nigerian Journal of Economic and Social Studies*, *65*(3), 467 - 491.

Decaluwé, B., Lemelin, A., Maisonnave, H., & Rochibud, V. (2009). PEP-1-1: The PEP standard computable general equilibrium model, single-country, static version. Partnership for Economic Policy (PEP), MPIA Research Network. https://www. pep-net. org/methods/macro-modeling/cge-models.

Decaluwé, B., Materns, A., & Savard, L. (2001). *La Politique Économique du Développment et les Modèles d'Équilibre Général Calculable*. University of Montreal Press, Montreal, Canada.

Edafe, O.D., Osabuohien, E., Matthew, O., Osabohien, R., & Khatoon, R. (2023). Large-scale agricultural investment and female employment in African communities: Quantitative and qualitative insights from Nigeria. *Land Use Policy, 127*, 106579. https://doi.org/10.1016/j.landusepol.2023.106579

Edoka, M.H., Ojih, J.T., Ebenehi, O., & Shirama, L. (2025). Gender issues and agricultural productivity in Nigeria. *International Journal of Global Affairs, Research and Development*, *3*(1), 17–30. https://ijgard.com/index.php/ijgard/article/view/75

Ekerebi, E., & Adeola, O.O.O. (2017). Estimation of the difference in agricultural yield between male and female farmers in Nigeria. *Feed the Future Innovation Lab for Food Security Policy Research Briefs 28*. https://ageconsearch.umn.edu/record/260420

Famine Early Warning Systems Network (2020). Persisting and escalating conflicts in the Northeast and other Northern areas increasing assistance needs: Nigeria food security https://reliefweb.int/report/nigeria/nigeria-food-security-outlook-february-september-2020

Federal Ministry of Agriculture and Rural Development (2019). National Gender Policy in Agriculture. Abuja, Nigeria. https://fmard.gov.ng/national-gender-policy-in-agriculture/

Fisher, M. & Kandiwa, V. (2014). Can agricultural input subsidies reduce the gender gap in modern maize adoption? Evidence from Malawi. *Food Policy, 45*, 101-111. https://doi.org/10.1016/j.foodpol.2014.01.007

Food and Agriculture Organization (2011). *The state of food and agriculture: Women in agriculture - Closing the gender gap for development, food and agriculture.* Rome, Italy: FAO.

Folarin, E.M., Osabuohien, E.S., Okodua, H., Onabote, A., & Osabohien, R. (2021). Male and female employment in agriculture and agricultural productivity in Nigeria. *IOP Conference Series: Earth and Environmental Science*, *665*(1), doi: 10.1088/1755-1315/665/1/012066.

Fontana, M. (2014). Adding gender dimensions to bio-economic modelling: Insights from the literature. Washington, DC: International Food Policy Research Institute (IFPRI). https://hdl.handle.net/10568/150932

Fontana, M. & Wood, A. (2000). Modeling the effects of trade liberalisation on women, at work and at home, *World Development*, *28*(7), 1173-1190.

Fontana, M., & Van Der Meulen Rodgers, Y. (2005). Gender dimensions in the analysis of macro-poverty linkages. *Development Policy Review, 23*(3), 333-349.

Kalu, U. D. (2021). Infrastructural development and value addition in agricultural output in Nigeria. *The Nigerian Journal of Economic and Social Studies, 63*(2), 209-238

Karamba, R.W. & Winters, P.C. (2015). Gender and agricultural productivity: Implications of the farm input subsidy program in Malawi, *Agricultural Economics*, *46*(3), 357-374.

Lemelin, A., Fofana, I., & Cockburn, J. (2013). B*alancing a social accounting matrix: Theory and application* (revised edition). Available at SSRN 2439868. https://dx.doi.org/10.2139/ssrn.2439868.

Mbah, C.C., Orjime, S.M., & Mgbemena, E.M. (2022). Agricultural productivity, food prices and inflation in Nigeria. *Journal of Management, Economics, and Industrial Organization, 6*(3), 113-126. http://doi.org/10.31039/jomeino.2022.6.3.8

Montaud, J.M., Pecastaing, N., & Tankari, M. (2017). Potential socio-economic implications of future climate change and variability for Nigerien agriculture: A countrywide dynamic CGE-Microsimulation analysis. *Economic Modelling, 63*, 128-142. https://doi.org/10.1016/j.econmod.2017.02.005

Mukasa, A.N., & Salami, A.O. (2015). *Gender productivity differentials among smallholder farmers in Africa: A cross-country comparison.* (Working Paper No. 231). African Development Bank, Abidjan, Côte d'Ivoire.

National Bureau of Statistics. (2013). *Women and men in Nigeria 2011*. Abuja, Nigeria: National Bureau of Statistics.

National Bureau of Statistics & World Bank. (2019). *LSMS Integrated Surveys on Agriculture: Nigeria General Household Survey, Panel (Wave 4)*. Abuja, Nigeria: National Bureau of Statistics.

Ngoma, H., Machina, H., & Kuteya, A. N. (2021). Can agricultural subsidies reduce gendered productivity gaps? Panel data evidence from Zambia. *Development Policy Review, 39*(2), 303-323. https://doi.org/10.1111/dpr.12483

Nkang, N. M., Omonona, B. T., Yusuf, S. A. & Oni, O. A. (2013). Simulating the impact of exogenous food price shock on agriculture and the poor in Nigeria: Results from a computable general equilibrium model. *Economic Analysis and Policy, 43*(1), 79-94. doi:10.5539/sar.v1n2p141.

Nwafor, M., Diao, X., & Alpuerto, V. (2010). *A 2006 social accounting matrix for Nigeria: Methodology and results* (NSSP Report 7). Abuja, Nigeria: International Food Policy Research Institute (IFPRI). https://hdl.handle.net/10568/154936.

Obayelu, A.E., Ogbe, A.O., & Edewor S.E. (2020), Gender gaps and female labour participation in agriculture in Nigeria. *African Journal of Economic and Management Studies*, *11*(2), 285–300, doi: https://doi.org/10.1108/AJEMS-03-2019-0128

Odior, E.S.O. (2014). Government expenditure on education and poverty reduction: Implications for achieving the MDGS in Nigeria – A computable general equilibrium micro-simulation analysis. *Asian Economic and Financial Review, 4*(2), 150-172. http://aessweb.com/journal-detail.php?id=5002

Oladeebo, J. O. and Fajuyigbe, A. A. (2007). Technical efficiency of men and women upland rice farmers in Osun State, Nigeria. *Journal of Human Ecology, 22*(2), 93-100.

Omoju, O.E., Beyene, L.M., Ikhide, E.E., Dimnwobi, K.C., & Ehimare, O.A. (2024). Being green and prudent: Economy-wide and environmental impacts of renewable energy production subsidy in Nigeria. *Journal of Developing Areas, 58*(3), 47-66.

Oseni, G., Corral, P., Goldstein, M., & Winters, P. (2015). Explaining gender differentials in agricultural production in Nigeria. *Agricultural Economics, 46*, 285-310. https://doi.org/10.1111/agec.12166

Oseni, G., Goldstein, M., & Utah, A. (2013). Gender dimensions in Nigerian agriculture. *African Region Gender Practice Policy Brief*, 6, 1-4. Washington, DC: The World Bank. https://documents1.worldbank.org/curated/en/958181468334145779/pdf/861830BRI0ARGP00Box382165B00PUBLIC0.pdf

Palacios-López A., & López, R. (2015). The gender gap in agricultural productivity: The role of market imperfections. *The Journal of Development Studies*, *51*(9), 1175-1192. https://doi.org/10.1080/00220388.2015.1028539

Peterman, A., Quisumbing, A., Behrman, J., & Nkonya, E. (2010). *Understanding gender differences in agricultural productivity in Uganda and Nigeria.* (Discussion Paper Series No. 01003). Washington, DC: International Food Policy Research Institute.

Ragasa, C., Kyle, J., Onoja, A. O., Achike, A. I., Adejoh, S. O., Onyenekwe, C. S., Koledoye, G. F., Ujor, G. C. & Nwali, P. N. (2023). *Women's empowerment in agrifood governance*

(WEAGov) assessment framework: A pilot study in Nigeria (IFPRI Discussion Paper 02222). International Food Policy Research Institute, Washington, DC.

Shikur, Z. H. (2020). Agricultural policies, agricultural production and rural households' welfare in Ethiopia. *Journal of Economic Structures*, *9*(50), 1-21. https://link.springer.com/article/10.1186/s40008-020-00228-y

United Nations Entity for Gender Equality and the Empowerment of Women, the United Nations Development Programme, United Nations Environment Programme, Poverty-Environment Initiative Africa, and the World Bank. (2015). *The cost of the gender gap in agricultural productivity in Malawi, Tanzania, and Uganda.* Washington, DC: The World Bank Group.

Wing, I. S. (2004). *Computable general equilibrium models and their use in economy-wide policy analysis* (MIT Joint Program on the Science and Policy of Global Change Technical Note 6). Cambridge, MA: Massachusetts Institute of Technology.

World Bank (2014). *Nigeria agriculture and rural poverty: A policy note.* Washington, DC. The World Bank Group.

World Bank. (2022). *Closing gaps, increasing opportunities: a diagnostic on women's economic empowerment in Nigeria*. World Bank, Washington, DC. http://hdl.handle.net/10986/37225.

World Bank. (2023). *Gender gaps in agriculture productivity and public spending in Nigeria*. Nigeria Gender Innovation Lab, World Bank, Washington, DC. http://hdl.handle.net/10986/40392

Xu, Z., Wu, T., Hu, T., Liu, Y., & Peng, J. (2026). International food trade increased the food security gap between high and low economic development groups. *Geography and Sustainability*, *7*(1), 1-13, https://doi.org/10.1016/j.geosus.2025.100402

Yeo, P.A., Arouna, A., Mujawariya, G.M., Yergo, W.G., Aboudou, R., & Gbede, T.R. (2024). Quantitative Study on women and youth empowerment in the agricultural sector in Nigeria. Report of the TAFS-WCA, CGIAR/AfricaRice. https://cgspace.cgiar.org/server/api/core/bitstreams/291eaee4-d30f-476d-ab56-fcaedcf7e127/content