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Female participation in agriculture and economic development in 33 African Countries

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Romanus Osabohien[1,2], Isaiah Olurinola[1], Oluwatoyin Matthew[1,2], Dominic Azuh[1] and Busayo Aderounmu[1]

Department of Economics and Development Studies, Covenant University, Ota, Nigeria[1]; Centre for Economic Policy and Development Research (CEPDeR), Covenant University, Ota, Nigeria[2]

***For Correspondence:** Email: *romanus.osabohien@covenantuniversity.edu.ng*

Abstract

Women occupy a crucial position in the agricultural sector because; they participate in different forms, as entrepreneurs, labourers, and marketers among others. Despite the various responsibilities' women are involved in, such as family and child-care among others; they contribute up to 40% of agricultural GDP. Against this background, this study examined how female participation in agriculture contributes to economic development in selected African countries, which is in line with the United Nations (UN) 2030 Sustainable Development Goals (SDGs 5 & 8; to ensure gender equality, decent work and economic growth respectively). The study engaged a panel data of selected 33 African countries sourced from the World Development Indicators (WDI) and the Human Development Index (HDI) for the period of 2000 - 2018. The study applied the Pooled Ordinary Least Squares (POLS) and the fixed effects method based on Hausman specification result. Findings from the POLS and fixed effect were consistent across sub-regions, showing that, female participation in agriculture, though statistically significant, was negatively related to economic development. This means that a 1% increase in female participation in agriculture may reduce economic development by between 0.06% and 2.7%. On the other hand, across model, female education was found to be statistically significant and positively related to economic development. On the average, increased level of female education may increase economic development by 1.71%. The implication of this is that an increase in female participation in agriculture without the required level of education and training and access to agricultural materials may have a negative impact on economic development. Therefore, the study recommended that female education and training are required to improve economic development in Africa. *(Afr J Reprod Health 2021; 25[5s]: 107-115).*

Keywords: Agriculture, SGD 5 & 8, African women, Africa

Résumé

Les femmes occupent une position cruciale dans le secteur agricole parce que ; ils participent sous différentes formes, en tant qu'entrepreneurs, ouvriers et commerçants, entre autres. Malgré les diverses responsabilités dans lesquelles les femmes sont impliquées, telles que la famille et la garde des enfants, entre autres ; ils contribuent jusqu'à 40 % du PIB agricole. Dans ce contexte, cette étude a examiné comment la participation des femmes dans l'agriculture contribue au développement économique dans certains pays africains, ce qui est conforme aux objectifs de développement durable 2030 des Nations Unies (ONU) (ODD 5 et 8 ; assurer l'égalité des sexes, un travail décent et croissance économique respectivement). L'étude a utilisé un panel de données de 33 pays africains sélectionnés à partir des indicateurs de développement dans le monde (WDI) et de l'indice de développement humain (IDH) pour la période 2000 - 2018. L'étude a appliqué les moindres carrés ordinaires regroupés (POLS) et le méthode des effets basée sur le résultat de la spécification Hausman. Les résultats du POLS et de l'effet fixe étaient cohérents dans toutes les sous-régions, montrant que la participation des femmes dans l'agriculture, bien que statistiquement significative, était négativement liée au développement économique. Cela signifie qu'une augmentation de 1 % de la participation des femmes dans l'agriculture peut réduire le développement économique de 0,06 % à 2,7 %. D'un autre côté, dans tous les modèles, l'éducation des femmes s'est avérée statistiquement significative et positivement liée au développement économique. En moyenne, l'augmentation du niveau d'éducation des femmes peut augmenter le développement économique de 1,71 %. L'implication de ceci est qu'une augmentation de la participation des femmes dans l'agriculture sans le niveau requis d'éducation et de formation et l'accès aux matériaux agricoles peut avoir un impact négatif sur le développement économique. Par conséquent, l'étude a recommandé que l'éducation et la formation des femmes soient nécessaires pour améliorer le développement économique en Afrique. *(Afr J Reprod Health 2021; 25[5s]: 107-115).*

Mots-clés: Agriculture, SGD 5 & 8, Femmes africaines, Afrique

Introduction

Generally, women occupy an essential position in the agricultural sector[1]. This is because women engage in agricultural activities in different forms, as entrepreneurs, labourers, and marketers[1,2]. In Africa, irrespective of the various responsibilities women are involved in, such as family and child-care among others; they contribute up to 40% to agricultural Gross Domestic Products (GDP)[3]. The Food and Agricultural Organisation[4] estimated that, globally, the contribution of women to the production of food is more than 50%, this percentage constitutes about 80% of Africa's food production, Asia (60%), and South and North America (30% and 40%) respectively.

Besides, women are seen as the primary drivers of the development of national economies and local communities. This is because; women constitute more than 40% of the global share of the labour force in agriculture[1,4]. In SSA, rural households who are small scale farmers contribute more than 75% to the agricultural production. This contribution is as a result of the fact that women constitute the most significant proportion of the share of the labour force in agriculture[5]. To achieve the United Nations (UN) Sustainable Development Goals 5 and 8 by 2030, there should be an equal access to land, credit, skill acquisition and other productive agricultural resources for women and men[5]. One of the main drawbacks of the agricultural sector is found in the production, disposal and preservation, processing as well as the marketing of agricultural products.

Supporting women is a way of breaking the vicious cycle that leads to rural poverty and to the expansion of slums in the cities[1,6]. In the same vein, to achieve the UN SGDs 5 & 8, developmental strategies should consider women as a critical factor, by paying particular attention to their social skills both within and outside the agricultural sector. In this wise, policies established for the benefit of women should be tested and reassessed by the beneficiaries, using them as social learning [6-8]. In the particular case of agriculture, most studies establish that the education and skills of farmers are important elements in explaining the inter-farm and inter-country disparities in agricultural productivity, along with the more conservative reasons such as availabilities of land and water resources, inputs, credit, and so on. Against this backdrop, this study has taken a new direction, by examining how female participation in agriculture contribute to economic development in Africa.

Literature review

To achieve SDGs 5 & 8 by 2030, it is highly imperative to support women, promote new conceptual and developmental programmes that could contribute to the implementation of new ideas by women with a view to diversifying income-generating activities and the provision of other services. Women produce over 40% of the world's food [4] and about 40% of the agricultural labour force across the globe[9]. Additionally, women invest as much as ten times more of their earnings than men in their family's well-being, including child health, education and nutrition[10-12]. Therefore, empowering women for skills development has a direct impact on agricultural productivity and household food security[13-15], and as a result, it remains at the core of agricultural research in developing countries[16].

Donor agencies, local governments and NGOs are increasingly targeting women as priority clients and strengthening their investments to empower them and reduce inequity[16,17]. Furthermore, it has been observed from the literature that in Africa, women own fewer assets (including farmlands) than men[1]. In most cases, the assets women are allowed to own are non-income-producing assets such as pans, cups, brooms and hoes. In some cases, women own animals, but their ownership is typically restricted to small ruminants and relatively low value as compared to men. For example, in rural areas, while men own drought and dairy cows, women own small cattle, pigs, poultry, and so on. Even if women own dairy cattle, these are generally in smaller numbers as compared to men[18-21].

In the same vein, irrespective of the improved awareness in the agricultural sector as an engine room for growth and development and greater recognition of the importance of women in agriculture, existing tools for measuring the impact of agricultural interventions for women's empowerment is limited[21]. Without such tools, the impacts of programmes on women empowerment and development are likely to be less satisfactory in their outcomes. Therefore, there is a need for measures of empowerment that are robust,

inclusive and comparable over time and space, multidimensional, as well as able to measure and monitor the impact of agricultural interventions on women's empowerment[2].

Drucza and Peverib[7] examined gender differential in agriculture in Pakistan with emphasis on the wheat sector of agricultural productivity. The study applied descriptive and exploratory methods. The results from the study showed that irrespective of women's involvement in the production of wheat in Pakistan, they were still looked down upon when compared with the male counterparts. In another study, Akter *et al*.[15] employed the framework recommended by the Women's Empowerment in Agriculture Index (WEAI), 37 focus group discussions were conducted among 290 women farmers across Myanmar, Thailand, Indonesia and the Philippines. The results contradict the conventional notion of gender inequality. In all four countries, women appear to have equal access to productive resources such as land and inputs, and greater control over household income than men. In Nigeria, different findings were obtained by Obayelu *et al*[1] who examined decision making of male and female households in Nigeria, using a survey of 1,747 farmers across 141 farming communities in Nigeria, using a multi-stage sampling technique. Findings showed that on average, the male had more educational qualification than the female. In the same vein, male-headed households owned more productive assets than female and earned a higher income. Also, female households spent more time taking care of children, cooking and schooling than the male. It can, therefore, be concluded that a gender gap exists in agricultural labour participation, with the male playing dominant roles than the female, which is against the findings by Akter et al.[15].

The study by Abraham *et al*.[5] examined female labour force participation and their employment choice between the formal and informal sectors after several institutional and social reforms. The study made use of data from Ghana's 2010 population and housing census, and applied the multinomial logit regression technique. Results showed that female labour force participation has declined; and education, a development component remains as one of the most important factors predicting women's participation in the formal sector. Interventions such as encouraging female education and retraining to enhance the development are required[5]. With respect to education as one of the most significant components of development as noted by Abraham *et al*.[5], in another study, Oluwatobi et al.[22] examined the impact of human capital and institutions on innovation in sub-Saharan Africa (SSA). Clearly, they highlighted the relevance of the human factor in determining productive and developmental outcomes in the SSA. The study applied the generalised system method of moments, and found that human capital, as well as an enabling institutional environment, influence development in SSA.

Methods

Following the empirical work by Dao[8] and Oluwatobi *et al*.[22], the baseline model for this study is specified implicitly as shown in equation [1]

$$ED_{it} = f(FPA_{it}, FPOP_{it}, FEDU_{it}) \quad [1]$$

The explicit (non-linear) form of the model is specified in equation [2]

$$ED_{it} = A * FPA_{it}^{\phi_1} * FPOP_{it}^{\phi_2} * FEDU_{it}^{\phi_3} * e_{it} \quad [2]$$

given the fact that equation [2] is a non-linear form, which may not be easy to analyse, therefore, it is linearised using the natural logarithm as donated by ln, presented in equation [3]

$$\ln ED_{it} = \ln A + \phi_1 \ln FPA_{it} + \phi_2 \ln FPOP_{it} + \phi_3 \ln FEDU_{it} + e_{it} \quad [3]$$

from equation [3], let $A = \phi_0$, the model to be estimated is shown in equation [4]

$$\ln ED_{it} = \phi_0 + \phi_1 \ln FPA_{it} + \phi_2 \ln FPOP_{it} + \phi_3 \ln FEDU_{it} + e_{it} \quad [4]$$

Where; ED economic development (dependent variable), in percentage, FPA means female participation in agriculture measured as female employment in agriculture (percentage of total employment), FPOP means female population (percentage of the total population), FEDU means female education (female primary school enrolment, percentage of total enrolment),e is the error term which captures other explanatory variables that are not included in the model[23]. Also, in the model, ϕ_0 is the constant term, ϕ_1, ϕ_2, ϕ_3, are the coefficients of the explanatory variables, while

'*i*' and '*t*' represents entities and time respectively. The '*apriori*' expectation is that female participation in agriculture and education of female is expected to be significant and positively related to economic development, while the population is expected to be significant and negatively related to economic development. The study engaged a panel data of 33 African countries, which are selected across five regions viz; Central Africa: Angola and Cameroun, Central Africa Republic, Chad, Comoros and Eritrea. East Africa: Burundi, Congo Democratic Republic, Ethiopia, Rwanda, South Sudan, Tanzania, Uganda and Zimbabwe. North Africa: Mauritania and Sudan. Southern Africa; Lesotho, Madagascar, Malawi and Mozambique. West Africa: Benin, Burkina Faso, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo. The justification for selecting these countries is that they are considered as low-income and upper-middle income countries, of which the required data is available.

The data are sourced from the Human Development Index (HDI) and the World Development Indicators (WDI) of the World Bank for the period of 2000 to 2018. Human Development Index comprises of four components: (a) life expectancy at birth (to assess a long and healthy life); (b) adult literacy (percentage of the population aged over 15 years who can read and write); (c) educational enrolment rates (percentage of the population in the relevant age cohort enrolled in primary, secondary, and tertiary education); (d) gross domestic product (GDP) per capita (to assess the standard of living). The study employed the Pooled Ordinary Least Squares (POLS), and the fixed effect methods based on 'Hausman' specification. To determine the suitability of the fixed effects or the random-effects model, the 'Hausman' test was conducted where the null hypothesis is that the preferred model is fixed effects[24]. The significant advantage of the fixed effects model is that the fixed-effects model controls for time-invariant between the individuals, so the estimated coefficients of the fixed-effects models are not biased as a result of the omitted time-invariant characteristics. Another critical assumption of the fixed effect model is that those time-invariant characteristics are unique to the individual and are not correlated with other individual characteristics[24].

Results

Descriptive statistics and correlation results

This study was motivated to examine how female participation in agricultural influences economic development in Africa. This section presents the results obtained from the descriptive statistics of variables and correlation analysis. The results obtained from the descriptive statistics are presented in Table 1, while the correlation result is presented in Table 2. To ensure that selected variables exhibit no high incidence of multicollinearity, they were subjected to a test for multicollinearity using the Pearson correlation matrix, presented in Table 2. From the result presented in Table 2, it can be concluded that there exists no high degree of high multicollinearity.

From the descriptive statistics (presented in Table 1) for the full sample, economic development has a mean value of 0.24, which means that, on average, the select African countries have about 42% rate of economic development. Given the fact that there exists some heterogeneity across countries, it is necessary to run regional analysis to observe this regional difference. This percentage for the full sample is quite similar across the sub-regional analysis. This is based on the fact that across sub-regions, the mean of economic development ranges from 40% to 46%, Central and West Africa (42%), East Africa (41%), North Africa (46%) and Southern Africa (43%).

POLS and random effects analysis

Table 3 presents the estimates obtained from the POLS for the full sample and sub-regional analysis. Three variables were engaged in the analysis, which is female participation in agriculture, female population and female education. Using the POLS, the result showed that, across sub-regions, female participation in agriculture is statistically significant, but negative in explaining the level of economic development. From the result, female participation showed a negative sign of 0.06 (full sample), 0.39 (Central Africa), 0.23 (East and Southern Africa), 0.27 (North Africa) and 0.10 (West Africa). This implies that a 1% increase in female participation in agriculture may have a negative effect of 0.06% (full sample), 0.39% (Central Africa), 0.23% (East and Southern Africa), 0.27% (North Africa) and 0.10% (West Africa) on

Table 1: Descriptive statistics

	Full Sample		**Central Africa**		**East Africa**		**North Africa**		**Southern Africa**		**West Africa**	
	Mean (SD)	Min (Max)	Mean (SD)	Min (Max)	Mean (SD)	Min (Max)	Mean (SD)	Min (Max)	Mean (SD)	Min (Max)	Mean (SD)	Min (SD)
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
HCD	0.42	0.26	0.42	0.28	0.41	0.27	0.46	0.40	43.33	0.30	0.42	0.26
	(0.06)	(0.58)	(0.07)	(0.53)	(0.62)	(0.53)	(0.31)	(0.51)	(0.56)	(0.51)	(0.66)	(0.5)
FPA	65.52	8.70	66.36	8.70	77.43	41.40	48.83	23.40)	70.77	28.20	59.63	14.60
	(20.53)	(96.0)	(24.24)	(83.90)	(13.20)	(96.0)	(18.82)	(72.30)	(20.71)	(86.3)	(18.22)	(87.90)
FPOP	50.35	48.40	50.03	49.21	50.57	49.90	49.90	49.62	51.00	50.14	50.22	48.40
	(0.62)	(52.03)	(0.57)	(51.14)	(0.42)	(51.34)	(0.14)	(50.12)	(0.65)	(52.03)	(0.58)	(51.17)
FEDU	90.05	26.57	77.67	45.07	101.13	37.60	78.67	(53.26	118.23	63.40	81.00	26.56
	(26.90)	(148.87)	(19.94)	(110.71)	(27.97)	(147.55)	(17.55)	(104.99)	(21.44)	(148.87)	(22.00)	(129.78)

Source: Authors' Computation, 2020. **Note:** SD means standard deviation, Max means maximum, and Min means minimum.

Table 2: Pearson correlation coefficients

	Full Sample				**Central Africa**				**East Africa**			
	HCD	FPA	FPOP	FEDU	HCD	FPA	FPOP	FEDU	HCD	FPA	FPOP	FEDU
ED	1.00				1.00				1.00			
FPA	-0.31	1.00			-0.55	1.00			-0.06	1.00		
FPOP	-0.02	-0.01	1.00		0.39	-0.77	1.00		0.11	0.55	1.00	
EDU	0.56	0.07	0.33	1.00	0.73	-0.41	0.39	1.00	0.53	0.49	0.51	1.00
	North Africa				**Southern Africa**				**West Africa**			
	HCD	FPA	FPOP	FEDU	HCD	FPA	FPOP	FEDU	HCD	FPA	FPOP	FEDU
ED	1.00				1.00				1.00			
Female	0.26	1.00			-0.40	1.00			-0.33	1.00		
FPOP	-0.19	-0.55	1.00		-0.51	-0.45	1.00		-0.13	0.04	1.00	
FEDU	0.08	0.38	-0.52	1.00	0.64	0.08	-0.72	1.00	0.47	-0.18	0.63	1.00

Source: Authors' Computation, 2020.

Table 3: Estimates from the pooled ordinary least squares

	Full Sample	Central Africa	East Africa	North Africa	Southern Africa	West Africa
Variable	[1]	[2]	[3]	[4]	[5]	[6]
Constant	4.772*	100.321*	9.398	-0.166*	24.316*	10.145*
	(0.629)	(18.421)	(9.354)	(0.010)	(4.777) [5.09]	(2.493)
	[7.58]	[5.45]	[1.00]	[-16.56]		[4.07]
Female participation in agriculture	-0.055*	-0.389*	-0.238*	-2.727**	-0.228*	-0.097*
	(0.003)	(0.1138)	(0.085)	0.968	(0.027)	(0.019
	[-17.56]	[-3.42]	[-2.79]	[-2.82]	[-8.45]	[-5.04]
Female population	-1.246*	-25.846*	-2.913	0.447* (0.016	-6.391*	-3.257*
	(0.165)	(4.640)	(2.446)	[27.23]	(1.136)	(0.636) [-
	[-7.54]	[-5.57]	[-1.19]		[-5.62]	5.12]
Female education	0.171*	0.336*	0.4712*	8.5964**	0.196*	0.483*
	(0.07)	0.043	(0.049)	(3.802)	(0.065)	(0.0240
	[25.85]	[7.77]	[9.63]	[2.26]	[2.99]	[20.38]
Obs.	407	58	92	29	62	166
R-sq.	0.6228	0.7352	0.5155	0.9714	0.7619	0.7416
F-stat	608.06	134.53	31.21	282.96	61.87	154.96

Source: Authors' Computation, 2020. **Note:** The standard errors and the t-statistic are in parentis ( ) and [ ] respectively. Also, *, and ** means that the coefficient is statistically significant at 1% and 5% respectively.

Table 4: Fixed effect estimates

	Full Sample	Central Africa	East Africa	North Africa	Southern Africa	West Africa
Variable	[1]	[2]	[3]	[4]	[5]	[6]
Constant	13.152*	113.770*	62.445*	24.859*	70.672*	-7.015***
	(4.116)	(20.053)	(20.044)	(3.357)	(10.912)	(4.091)
	[3.20]	[5.67]	[3.12]	[7.40]	[6.48]	[-1.71]
Female participation in agriculture	-0.065*	-0.279	-0.089	-0.361*	-0.011	-0.011
	(0.021)	(0.326)	(0.109)	(0.029)	(0.053)	(0.021)
	[-2.99]	[-0.86]	[-0.82]	[-12.11]	[-0.21]	[-0.03]
Female population	-4.005*	-29.392*	-16.566*	-6.421*	-18.442*	1.078
	(1.045)	(5.158)	(5.095)	(0.807)	(2.761)	(1.036)
	[-3.83]	[-5.70]	[-3.25]	[-7.95]	[-6.68]	[1.04]
Female education	0.433*	0.323*	0.446*	0.200*	0.220*	0.437*
	(0.020)	(0.044)	(0.037)	(0.038)	(0.061)	(0.020)
	[21.52]	[7.37]	[11.80]	[5.22]	[3.60]	[21.50]
Observation	407	58	92	29	62	166
R-squared	0.6703	0.7377	0.6725	0.9853	0.7855	0.7628
F-stat	252.11	45.94	56.13	535.19	67.14	160.76
Hausman	0.0315	0.0000	0.089	0.0001	0.0000	0.0000

Source: Authors' Computation, 2020. **Note:** The standard errors and the t-stat are in parentis () and [] respectively. Also, *, ** and *** means that the coefficient is statistically significant at 1%, 5% and 10% respectively.

economic development. Results are consistent across sub-regions as female participation in agriculture tends to be negative in all the sub-regions, with West Africa the largest.

Similar result is obtained for female population across sub-regions, except in North Africa, where female population is significant but negative in explaining the level of development. The implication of this is that increase in female population without proper harnessing may negatively affect economic development. On the contrary, female education was found to be significant and positive in explaining the level of economic development, which is in line with the '*apriori*' expectation. The result showed that with respect to female education, a 1% increase in female education will lead to about 0.17% (full sample), 0.34% (Central Africa), 0.47% (East Africa), 8.6% (North Africa), 0.20% (Southern Africa and 0.48% (West Africa), increase in economic development. For the full sample and across sub-regions, the F-statistic shows that female

participation in agriculture, female education and female population are jointly significant in explaining the level of development in Africa, and R-squared of above 0.5 shows that the model is well-fitted (See Table 3).

The results for the full sub-sample and sub-regions using the fixed effect regression estimator are presented in Table 4, which is consistent with the POLS result presented in Table 3. Findings show that female participation in agriculture and the female population is significant and negative across sub-regions, while female education is significant and positive across sub-regions. It shows that the output elasticity for female participation in agriculture shows the largest for North Africa (0.36%) followed Central Africa (0.28%), with Southern and West Africa having the lowest percentage decline (0.01%). Concerning female education, on average, all things being equal, the coefficients are significant and positive across sub-regions. It means that a proportionate increase in female education, *ceteris paribus*, will increase development by 0.43% (full sample), 0.32% in Central Africa, 0.45% in East Africa, 0.20% in North Africa, 0.22% in Southern Africa and 0.44% in West Africa.

Estimates from both the POLS and the fixed effects are consistent for the full sample and across sub-regions. From the result, it can be deduced that while female participation in agriculture and the female population is significant but negative in explaining the level of development in Africa, education is significant and positive. This implies that increase female population and participation in agriculture without the required education and training may have a negative impact on economic development in Africa. Though the result obtained for the female participation in agriculture is not in line with the '*a priori*' expectation, but that of female education and population conforms to the 'a priori' expectation. The justification for the result is that female knowledge and skills through education, can facilitate development progress.

The findings are in line with the findings by Obayelu *et al*[1], Drucza and Peverib[7] and Oluwatobi *et al*.[22], but against the findings by Akter *et al*[15]. Drucza and Peverib[7] used descriptive statistics and found that despite the role of women involvement in the production of wheat in Pakistan, they were constrained by access to credit, skills and knowledge that are capable of increasing economic development. Similarly, Obayalu *et al*.[1] found that on average, in Nigeria, the male has more educational opportunities and qualification than female. In the same vein, male-headed households own more productive assets than female and earned higher income, showing that gender inequality exists in agriculture. In this wise, as found in this study, increase female population and participation in agriculture, without education and training opportunities and skills development may have a negative effect on economic development. Against this finding, Akter *et al*.[15] found that in Asia, especially, in Indonesia, Myanmar, Philippines, and Thailand, women appear to have equal access to productive resources such as land and inputs, and greater control over household income than men.

Also, akin to the findings by Abraham *et al*.[5], education as a development component remains as one of the most important factors predicting women's participation in the formal sector. Interventions such as encouraging female education and retraining to enhance the level of development are required [5]. With respect to education as one of the most significant components of development as noted by Abraham *et al*.[5], in another study, Oluwatobi *et al*.[22] found that institutions as well as an enabling institutional environment influence economic development Africa. Similar findings were obtained by Folarin *et al*[2]. Edafe *et al*[26] and Osabuohien *et al*[27] proving that female participation in agriculture is significant to the development of an economy.

Conclusion

This study aims to contribute to the extant literature by examining how female participation in agriculture affects economic development in Africa. The study engaged a panel data of 33 selected African countries sourced from the Human Development Index (HDI) and World Development Indications (WDI) for the period 2000 to 2018, using the POLS and Fixed effects based on Hausman specification. Results are consistent full the sample and across sub-regions analysis using the POLS and fixed effects, which showed that female participation in agriculture and population is statistically significant but negative in explaining the level of economic development in Africa, while education is significant and positive in explaining

the level of development. This implies that an increase in female population and participation in agriculture without the required education and training may have a negative impact on economic development in Africa.

In conclusion, the production and dissemination of technology and management capabilities for more intensive and modernised agriculture and supporting services is imperative. This can only be achieved through the upgrading of the quality of human resources employed in agriculture. However, this study is not without its limitations. Due to short-time dynamics of the data, the study could not account for endogeneity and thus, the use of other methods such as the Generalised Method of Moments that could account for endogeneity is recommended for future research.

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Conflict of interests

The authors have declared no conflict of interest.

Contribution of authors

The first author conceived the idea, supervised by the second author. The third and fifth authors wrote the introduction. Data was gathered by third and fifth authors. Analysis and interpretation were done by first and second authors. All the authors read and approved the paper for submission.

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