PROBLEMY EKOROZWOJU – PROBLEMS OF SUSTAINABLE DEVELOPMENT
SUBMITTED: 15.09.22, ACCEPTED: 7.10.22, PUBLISHED ON-LINE: 1.07.23
2023, 18(2): 242-248
DOI: 10.35784/preko.4037

Investigating the Impact of Education and Women in Agriculture on Human Capital Outcomes in Africa: An Interaction Analysis

Badanie wpływu edukacji na kobiety pracujące w rolnictwie w aspekcie tworzenia się kapitału ludzkiego w Afryce. Analiza interakcji

Zhichao Yu* and Romanus Osabohien*

**Yunnan Normal University, Pan-Asia Business School, Kunming, 650092, China*
***Covenant University, Department of Economics and Development Studies, Ota, Nigeria*
*E-mails (Corresponding Authors): *yuzhichao2023@sina.com; **romik247@gmail.com*

Abstract

Agriculture plays a crucial role in Africa's economy, and women constitute a significant proportion of the agricultural workforce in the region. Impact of women's role in farming and women education in Africa is significant for the human capital development. Furthermore, women's engagement in agricultural activities has increased with time, leading to improved contributions to food security and livelihood. Against this background, this study investigates the impact of women's participation in agriculture and women education interaction on human capital in Africa with the data obtained from the World Development Indicators (WDI) of the World Bank and Human Development Index (HDI) covering 33 African countries for the time frame 2000 to 2018. To control endogeneity that may be present in fixed effects model, the study applied the Generalised Method of Moments (GMM). The results show that, across African sub-regions, while women's participation in agriculture has a significant negative effect, education has a significant positive impact on human capital outcomes. Additionally, the interaction between women participation in agriculture and education has a significant positive impact on human capital across sub-regions in Africa. The findings underscore the need for policies that promote gender equality, as this has the potential to significantly increase human capital formation and sustainable development. The study, through the the interaction between women's in agriculture and education highlights the contribution of these factors to various goals, such as no poverty (SDG 1), zero hunger (SDG 2), quality education (SDG 4), gender equality (SDG 5) and decent work and economic growth (SDG 8).

Key words: economic growth, food security, human capital outcomes, population dynamics, sustainable development

Streszczenie

Rolnictwo odgrywa kluczową rolę w gospodarce Afryki, a kobiety stanowią znaczną część siły roboczej w rolnictwie w regionie. Wpływ roli kobiet w rolnictwie i edukacji kobiet w Afryce jest istotny dla rozwoju kapitału ludzkiego. Ponadto zaangażowanie kobiet w działalność rolniczą wzrosło z czasem, co prowadzi do większego wkładu w bezpieczeństwo żywnościowe i zapewnienie środków do życia. Na tym tle w niniejszym artykule bada się wpływ interakcji kobiet w rolnictwie i edukacji kobiet na kapitał ludzki w Afryce na podstawie danych uzyskanych ze Światowych Wskaźników Rozwoju (WDI) Banku Światowego i Wskaźnika Rozwoju Społecznego (HDI) obejmujących 33 kraje afrykańskie w okresie od 2000 do 2018 r. Aby kontrolować problem endogeniczności, który może występować w modelu z efektami stałymi, w badaniu zastosowano uogólnioną metodę momentów (GMM). Wyniki pokazują, że w podregionach afrykańskich, gdy udział kobiet w rolnictwie ma znaczący negatywny wpływ, edukacja ma znaczący pozytywny wpływ na kapitał ludzki. Ponadto interakcja między udziałem kobiet w rolnictwie a edukacją ma znaczący pozytywny wpływ na kapitał ludzki w podregionach Afryki. Uzyskane wyniki podkreślają potrzebę prowadzenia polityki promującej równość płci, ponieważ ma to potencjał do znacznego zwiększenia tworzenia kapitału ludzkiego i zrównoważonego rozwoju. Badanie, poprzez interakcję między udziałem kobiet w rolnictwie i edukacji, podkreśla wkład tych czynników w różne Cele zrównoważonego rozwoju

(SDGs), takie jak brak ubóstwa (SDG 1), brak głodu (SDG 2), wysokiej jakości edukacja (SDG 4), równouprawnienie płci (SDG 5) oraz godnej pracy i wzrostu gospodarczego (SDG 8).

Słowa kluczowe: wzrost gospodarczy, bezpieczeństwo żywnościowe, rozwój kapitału ludzkiego, dynamika demograficzna, zrównoważony rozwój

1. Introduction

Agriculture remains a crucial sector in many African countries, providing employment and food security for millions of people (Edafe et al., 2023; Osabohien, 2023). Despite the pivotal role played by women in agriculture, their participation and empowerment in the sector have often been limited due to cultural norms, policies, and inadequate resources (Osabohien el., 2021). This issue has been compounded by a significant gender gap in education, which limits women's ability to contribute fully to the agricultural sector. Recent research shows that education has a positive relationship with the growth of agriculture and can have a profound impact on human capital development. However, there is a dearth of studies that examine the interaction between education, women's participation in agriculture, and human capital development in Africa, which forms the basis of this study, to expand the frontiers of knowledge.

Furthermore, by 2030, to realise the United Nations (UN) Sustainable Development Goals, particularly, end poverty (SDG 1), food and nutrition security (SDG 2), gender equality (SDG 5) and decent work and economic growth (SDG 8), there should equitable access to land, credit and other productive agricultural resources, train women to acquire requisite skills and knowledge on how to adapt to various agricultural shocks. 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 (Drucza and Peveri, 2018; Karakara et al., 2021).

Therefore, against this background, the study impact of education and women's participation in agriculture interaction on human capital in African. Specifically, this research examines the effect of education, women's participation in agriculture as well as their interaction impact and other key variable such as women education on human capital outcomes. The study made use of the data from the World Development Indicators (WDI) and Human Development Index (HDI) covering 33 African countries. To control for endogeneity that may weaken fixed effect model, the study engaged the generalised method of moments (GMM). The study through its findings underscore the need for policies that promote gender equality, as this has the potential to significantly increase human capital formation and sustainable development. Also, the study, through the interaction between women's participation in agriculture and education highlights the contribution of these factors to various goals, such as no poverty (SDG 1), zero hunger (SDG 2), quality education (SDG 4), gender equality (SDG 5) and decent work and economic growth (SDG 8). This study is structured as follows; after this introductory section is the review of literature, section three is the methodology, results are presented and interpreted in section four, while section five is summary and conclusion.

2. Literature Review

As mentioned previously, to realise the sustainable development goals of no poverty (SGD 1), zero hunger (SDG 2), gender equality (SDG 5) and decent work and economic growth (SDG 8), it is essential to support women, promote new conceptual and developmental frameworks 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.

Drucza and Peverib (2018) examined gender differential in agriculture in Pakistan, emphasised on the wheat sector of agricultural productivity. The study applies descriptive and exploratory methods. Results from the study showed that irrespective of women involvement in the production of wheat in Pakistan, they are still looked down upon when compared with the male counterparts. Also, Osabohien et al. (2021) using the fixed effect regression model found that women participation I agriculture has a negative impact on human capital development. Similar to this, Matthew et al., (2022) found that women in agriculture supported by agricultural education may significantly drive human capital in Africa.

In another study, Akter et al. (2017) 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. Findings from Akter et al. (2017) showed that 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. Edafe et al. (2023) used a mixed-method, both qualitative and quantitative analysis and found that among others things, that female-headed households spent more time on off-farm business despite the fact that they earn less compared with their male counterparts. The study concludes by recommending that the possible adverse employment effects of large scale land investment could be reduced by optimising its positive impact. It also 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. (2017). With respect to education as one of the most significant components of human capital as noted by Abrahman et al. (2015), In another study, Oluwatobi et al. (2016) 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 generalized system method of moments, and found that human capital, as well as an enabling institutional environment, influence human capital development in SSA.

2. Methodology

Our paper follows the study of Edafe et al., (2023), Matthew et al., (2022) and Osabohien et al., (2021) that seek to understand factors influencing women in agriculture and how it drive food security, human capital., welfare, income and livelihood. In this wise, this study investigates the interaction impact of education and women's participation in agriculture on human capital. The baseline model is given in equation (1)

$$Y_{it} = f(WIA_{it}, FE_{it}, WIA_{it} * FE_{it}, PF_{it}) \quad (1)$$

Where Y_{it} represents the dependent variable (human capital outcomes), for country i at time t. Similarly, WIA_{it} and FE_{it} are women involvement or participation in agriculture and women's education, respectively. On the other hand, $WIA_{it} * FE_{it}$ is the interaction between women's involvement in agriculture and their level of education, while PF_{it} population of the female individuals.

The explicit form of the model, in double-log form is given in equation (2). However, to control for the weakness of the pooled OLS, and fixed and random effects, such as endogeneigty (Arellano & Bond 1991)., we enaged the generalised method of moments (GMM) and the model for that is presented in equation (3)

$$lnY_{it} = \beta_0 + \beta_1 lnWIA_{it} + \beta_2 lnFE_{it} + \beta_3(WIA_{it} * FE_{it}) + \beta_5 lnPF_{it} + \varepsilon_{it} \quad (2)$$

$$lnY_{it} = \beta_0 + \psi lnY_{it-1} + \beta_1 lnWIA_{it} + \beta_2 lnFE_{it} + \beta_3(WIA_{it} * FE_{it}) + \beta_4 lnPF_{it} + \varepsilon_{it} \quad (3)$$

From the model, Y is the dependent variable (human capital outcomes) proxied by human development index (a scale of 0 – 1, the higher the better), ψY_{it-1} means first lag of the depenedent variable, WIP represents women's involvement in agriculture (measured by employment of women in agriculture, % of total employment), FE captures female education (female education attainment, at least completed primary, % of female population). Furthermore, $WIA_{it} * FE_{it}$ captures the interaction between women's involvement or participation in agriculture and PF means population of the female (% of total population). Additionally, ln means nautral logarithm of the variable, it means entity and time, and ε captures the stochastic term, representing other variables not included in the model.

The *a priori* expectation is that the involvement of women in agriculture and their level of education is expected to be significant and positively related to human capital outcomes, while the population is expected to be significant and negatively related to human capital outcomes. Also, the interaction of these two factors (education of women and their involvement in agriculture) is expected to positively influence their level of human capital. In this study, we made use of a panel data of selected 33 countries in Africa based on data availability. The variables are obtained from the Human Development Index (HDI) and the World Development Indicators (WDI) of the World Bank for the period of 2000 to 2018[1].

The study employed the Pooled Ordinary Lease 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. 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. However, the fixed effects may be weakened by endogeneity. To control for the possible issues of endogeneity, we engaged the Generalised Method of Moments (GMM).

4. Results Presentation

4.1. Descriptive Statistics and Correlation Results

This study was motivated to examine how female participation in agricultural, their level of education and the interaction of both influence human capital outcomes in Africa. This section presents the results obtained from the

[1] Though, authors would have extended the sample period, the choice for the sample size (2000-2018) is based on the fact that HDI data started in the year 2000.

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, human capital index has a mean value of 0.24, which means that, on average, the select African countries have about 42% rate of human capital outcomes. 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 human capital development rages from 40 to 46%, Central and West Africa (42%), East Africa (41%), North Africa (46%) and Southern Africa (43%).

4.2. Pooled Ordinary Least Squares and Fixed 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 human capital 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). Results are consistent across sub-regions as female participation in agriculture tend to be negative in all the sub-regions, with West Africa the largest.

Table 1. Descriptive Statistics, source: own elaboration

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

Note: SD means standard deviation, Max means maximum, and Min means minimum.

Table 2. Pearson Correlation Coefficients, source: own elaboration

	Full Sample				**Central Africa**				**East Africa**			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Human capital	1.00				1.00				1.00			
Women in agriculture	-0.31	1.00			-0.55	1.00			-0.06	1.00		
Population (female)	-0.02	-0.01	1.00		0.39	-0.77	1.00		0.11	0.55	1.00	
Education (female)	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**			
	(13)	(14)	(150	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
Human capital	1.00				1.00				1.00			
Women in agriculture	0.26	1.00			-0.40	1.00			-0.33	1.00		
Population (female)	-0.19	-0.55	1.00		-0.51	-0.45	1.00		-0.13	0.04	1.00	
Education (female)	0.08	0.38	-0.52	1.00	0.64	0.08	-0.72	1.00	0.47	-0.18	0.63	1.00

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 human capital outcomes. The implication of this is that increase in female population without proper harnessing may negatively affect human capital outcomes. On the contrary, female education was found to be significant and positive in explaining the level of human capital development, which is in line with the *'a priori'* 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 human capital 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 human capital 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.

Table 3. Estimates from the Pooled Ordinary Least Squares Analysis, source: own elaboration

	Full Sample	**Central Africa**	**East Africa**	**North Africa**	**Southern Africa**	**West Africa**
Variable	[1]	[2]	[3]	[4]	[5]	[6]
Constant	4.772* (0.629) [7.58]	100.321* (18.421) [5.45]	9.398 (9.354) [1.00]	-0.166* (0.010) [-16.56]	24.316* (4.777) [5.09]	10.145* (2.493) [4.07]
Female participation in agriculture	-0.055* (0.003) [-17.56]	-0.389* (0.1138) [-3.42]	-0.238* (0.085) [-2.79]	-2.727** 0.968 [-2.82]	-0.228* (0.027) [-8.45]	-0.097* (0.019 [-5.04]
Female population	-1.246* (0.165) [-7.54]	-25.846* (4.640) [-5.57]	-2.913 (2.446) [-1.19]	0.447* (0.016) [27.23]	-6.391* (1.136) [-5.62]	-3.257* (0.636) [-5.12]
Female education	0.171* (0.07) [25.85]	0.336* 0.043 [7.77]	0.4712* (0.049) [9.63]	8.5964** (3.802) [2.26]	0.196* (0.065) [2.99]	0.483* (0.0240 [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

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, source: own elaboration

	Full Sample	**Central Africa**	**East Africa**	**North Africa**	**Southern Africa**	**West Africa**
Variable	[1]	[2]	[3]	[4]	[5]	[6]
Constant	13.152* (4.116) [3.20]	113.770* (20.053) [5.67]	62.445* (20.044) [3.12]	24.859* (3.357) [7.40]	70.672* (10.912) [6.48]	-7.015*** (4.091) [-1.71]
Women in agriculture	-0.065* (0.021) [-2.99]	-0.279 (0.326) [-0.86]	-0.089 (0.109) [-0.82]	-0.361* (0.029) [-12.11]	-0.011 (0.053) [-0.21]	-0.011 (0.021) [-0.03]
Female population	-4.005* (1.045) [-3.83]	-29.392* (5.158) [-5.70]	-16.566* (5.095) [-3.25]	-6.421* (0.807) [-7.95]	-18.442* (2.761) [-6.68]	1.078 (1.036) [1.04]
Female education	0.433* (0.020) [21.52]	0.323* (0.044) [7.37]	0.446* (0.037) [11.80]	0.200* (0.038) [5.22]	0.220* (0.061) [3.60]	0.437* (0.020) [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

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.

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 human capital

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.

4.3. Generalised Method of Moments Analysis

The results for the Generalised Method of Moments (GMM) where the interaction term is incorporated is presented in table 5. It is good to mention that GMM estimates are consistent with the Pooled OLS and fixed effect regression estimator presented in Table 3 and Table 4. From the GMM, across sub-regions, results show that the first lag (last year's) human capital outcomes has a significant positive impact on current year's human capital outcomes, which meets the *'a priori'* expectation. This is viewed from the angle that last year's human capital can act as a foundation for this year's human capital by sharing knowledge, leveraging experience, developing leadership, fostering engagement, and shaping organisational culture.

The involvement of women in agriculture and the female population is significant and negative across sub-regions, while female education is significant and positive across sub-regions. Concerning female education, on average, all *things are constant*, the coefficients are significant and positive across sub-regions. It means that a proportionate increase in female education, *ceteris paribus*, will increase human capital outcomes by 0.02% (full sample), 0.01% in Central Africa, 0.04% in East Africa, 0.99% in North Africa, 0.36% in Southern Africa and 0.02% in West Africa.

The result shows that when women in agriculture and education are interacted, there is significant positive impact on human capital outcomes. It implies that on average, *a* proportionate increase in the interaction between female education and their participation in agriculture, *ceteris paribus*, will increase human capital outcomes by 0.32% (full sample), 0.02% in Central Africa, 0.48% in East Africa, 0.65% in North Africa, 0.08% in Southern Africa and 0.56% in West Africa. This result conforms with the *'a priori'* expectation and it means that Overall, the interaction between female education and women in agriculture positively influences human capital outcomes by enhancing skills, decision-making power, resource access, health and nutrition, and promoting gender equality and empowerment.

Table 5. Generalised Method of Moments Result, source: own elaboration

Variable	**Full Sample**	**Central Africa**	**East Africa**	**North Africa**	**Southern Africa**	**West Africa**
Constant	0.3124* (0.000)	0.3470* (0.000)	0.3706** (0.007)	0.0027** (0.010)	-0.0190** (0.0231)	0.33539** (0.0311)
Y_{it-1} (first lag of human caiptal outcome)	0.7228* (0.000)	0.0095* (0.006)	0.0798* (0.000)	0.0314** (0.048)	0.6947* (0.000)	0.0010** (0.068)
WIA (women in agriculture)	-0.0504 (0.173)	0.0522** (0.041)	-0.0644* (0.095)	-0.4916* (0.009)	0.1914* (0.091)	-0.0273** (0.046)
PF (population of female)	-0.1047** (0.028)	-0.0531 (0.164)	0.0472*** (0.008)	-0.662*** (0.051)	-0.2306 (0.137)	-0.0819*** (0.001)
WE (female education)	0.0194** (0.017)	0.0149 (0.395)	0.0407** (0.017)	0.991* (0.000)	0.3556** (0.034)	0.0198** (0.021)
Interaction term	0.3229* 0.000	0.0211* (0.000)	0.4821* (0.000)	0.6480* (0.000)	0.0779* (0.004)	0.5551*** (0.067)
AR (1)	-9.20*** (0.000)	-4.87*** (0.000)	-6.01*** (0.000)	-8.201*** (0.000)	-3.26*** (0.001)	-4.42*** (0.000)
AR (2)	-1.43 (0.153)	0.32 (0.751)	0.82 (0.411)	0.24 (0.141)	-1.10 (0.271)	-0.86 (0.392)

Note: Variables are their logarithm form; *, **, *** means significant at 1%, 5% and 10%, respectively.

From the result, it can be deduced that while female participation in agriculture and the female population are significant but negative in explaining the level of human capital outcomes 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 human capital outcomes 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 human capital developmental progress.

The interaction between the two key variables, women in agriculture and their level of education significantly and positively influences human capital outcomes. It shows that female education is capable of providing women with the necessary skills and knowledge to actively participate in agricultural activities. By receiving formal education, women can gain technical expertise, understand modern farming techniques, and acquire problem-solving abilities. This enhances their productivity and efficiency in agricultural practices, leading to improved human capital outcomes.

The findings are in line with the findings by Matthew et al. (2022) and Drucza and Peverib (2018), but against the findings by Akter et al. (2017). Drucza and Peverib (2018) used the descriptive statistics and found that despite

the role of women involvement in the production of wheat in Pakistan, they are constrained by access to credit, skills and knowledge that are capable of increasing human capital development. Similarly, Edafe et al. (2023) 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 human capital development.

Also, akin to the findings by Osabohien et al. (2021), education as a human capital 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 of human capital are required.

5. Summary and Conclusion

This study aims to contribute to the extant literature by examining how female participating in agriculture affect human capital development in Africa. The study engaged a panel data of selected 33 African countries sourced from the Human Development Index (HDI) and World Development Indications (WDI) for the period 2000-2018, using the POLS and Fixed effects based on Hausman specification.

Results are consistent full the sample and across sub-regions analysis using the POLS, fixed effects and GMM. It showed that women in agriculture in agriculture and population is statistically significant but negative in explaining the level of human capital outcomes in Africa, while education is significant and positive in explaining the level of human capital outcomes. Similarly, the interaction with women in agriculture and education showed a significant influence on human capital outcomes. It shows that education empowers women by providing them with the confidence and knowledge to participate in decision-making processes.

It is recommended that skills of women should be improved through education and training to drive human capital outcomes. This is essential because when women are involved in agricultural decision-making, they can contribute unique perspectives and insights that can lead to more effective and sustainable farming practices. This involvement enhances human capital outcomes by promoting innovation, adaptability, and better resource management.

Furthermore, education can help women overcome barriers to accessing resources such as land, credit, technology, and markets. With increased education, women are more likely to have the necessary skills and knowledge to access and effectively utilize these resources in agriculture. This access to resources improves productivity, income generation, and overall human capital outcomes. Overall, the interaction between female education and women in agriculture positively influences human capital outcomes by enhancing skills, decision-making power, resource access, health and nutrition, and promoting gender equality and empowerment.

However, this study is not without its limitations. The study did not account for impact of education and women in agriculture on human capital outcome at the country-level. Therefore, given data availability, the impact of education, population and women in agriculture on human capital at the country-level, is recommended for future research.

References

1. ABRAHAM A.Y., OHEMENG F.N.A., OHEMENG W., 2017, Female labour force participation: evidence from Ghana, *International Journal of Social Economics* 44(11): 1489-1505, DOI: 10.1108/IJSE-06-2015-0159.
2. AKTER S. RUTSAERT P., LUIS J., HTWE NM, SAN S.S., RAHARJO B., PUSTIKA A., 2017, Women's empowerment and gender equity in agriculture: A different perspective from Southeast Asia, *Food Policy* 69: 270-279
3. ARELLANO M., BOND S., 1991, Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations, *Rev. Econ. Stud.* 58, 277-297
4. DRUCZA K., PEVERIB V., 2018, The literature on gendered agriculture in Pakistan: Neglect of women's contributions, *Women's Studies International Forum* 69:180-189.
5. EDAFE O.D., OSABUOHIEN E., MATTHEW, O., OSABOHIEN R. AND KHATOON R., 2023, Large-scale agricultural investment and female employment in African communities: Quantitative and qualitative insights from Nigeria, *Land Use Policy*, 127, 106579, DOI: 10.1016/j.landusepol.2023.106579.
6. KARAKARA A.A., OSABUOHIEN E.S., NWACHUKWU J.C., OSABOHIEN R.A., 2021, Innovations in savings behaviour and agricultural business support for women: The Ghanaian 'Money-Box', *African Journal of Reproductive Health* 25(5s): 147-158, https://www.ajol.info/index.php/ajrh/article/view/221449.
7. MATTHEW O., OSABOHIEN R., LAKHANI K.H., ADEROUNMU B., OSADOLOR N.E., ADEDIRAN, O., MABINUORI, O., IGHARO A.E., 2022, Women engagement in agriculture and human capital development in developing countries: An African sub-regional analysis, *Plos One* 17(12), p.e0277519, DOI: 10.1371/journal.pone.0277519.
8. OLUWATOBI S., OLA-DAVID O., OLURINOLA I., ALEGE P., OGUNDIPE A., 2016, Human capital, institutions and innovation in Sub-Saharan Africa, *International Journal of Economics and Financial Issues* 6(4): 1507-1514.
9. OSABOHIEN R., (2023). ICT adoption and youth employment in Nigeria's agricultural sector, *African Journal of Economic and Management Studies*, DOI: 10.1108/AJEMS-03-2022-0111.
10. OSABOHIEN R., OLURINOLA I., MATTHEW O., AZUH D., ADEROUNMU B., 2021. Female participation in agriculture and economic development in 33 African Countries. *African Journal of Reproductive Health*, 25(5s), 107-115. DOI:10.29063/ajrh2021/v25i5s.10.