International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2026, 16(2), 1097-1104.

Arable Land, Climate Change and Female Employment in Agriculture in the Sahel Region

Misery Mpuzu Sikwela, Timothy Ayomitunde Aderemi*, Nqobile Natasha Mpala

Department of Public Administration and Economics, Mangosuthu University of Technology, Durban, South Africa.
*Email: aderemi.timothy@gmail.com

Received: 27 November 2025 **Accepted:** 24 January 2026 **DOI:** https://doi.org/10.32479/ijeep.22907

ABSTRACT

This study provides an empirical investigation of the nexus among arable land, climate change and female employment in agriculture within the Sahel region. The strategic importance of this study in the Sahel region lies in the fact that this sub-region of Africa is in a dire state of rainfall variability, land degradation, desertification, decline in food security, global warming and gender inequality, and thus the Sahel region is under pressure to meet the Sustainable Development Goals (SDGs 5, 13, 14 and 15) in particular within the timeline of 2030, and the African Union Agenda 2063 in general. As such, the policy implications of this study emphasize that, for the SDGs 13, 14 and 15 to be achieved within the Sahel, there is an urgent need for the policymakers in this sub-region to mitigate emission of greenhouse gas and degeneration of arable land through policies and programmes that would foster anti-grazing, sustainable agricultural practices, afforestation and sustainable extractive industries. In the same vein, since climate change induces reduction in female employment in agriculture in the Sahel, any time the policymakers in this sub-region want to achieve the SDGs 5, the policies that foster climate resilience environment should be embarked upon. Also, gender equality should be encouraged and considered when allocating arable land for agricultural purposes.

Keywords: Greenhouse Gas, Rainfall, Gender, Agricultural Employment, SDGs 5 and 13, Agenda 2063
JEL Classifications: H11, H51

1. INTRODUCTION

Productive land is an inevitable input for food production, employment enhancing projects and other activities that support ecosystems (Nkonya et al., 2016; Sikwela et al., 2025a). In recent times, degradation of land has become a critical issue to the scholars and the policymakers since about 30% of the total global land area is currently affected, in which Sub-Saharan Africa accounted for over 22% of the global land degradation (Nkonya et al., 2016). Meanwhile, climate change induced activities such as overgrazing, unsustainable agricultural practices, deforestation, extractive industries, overexploitation of wood cover and among others represent the biggest monsters confronting livelihoods in the Sahel region presently (IPCC, 2019; Sikwela et al., 2025b; Sikwela and Aderemi, 2025). The aftermath effects of climate change have resulted into an astronomical rise in the number of hot days and heat wave frequency, persistent flood episodes, food crisis, displacement of about 7000 settlements with approximately 4.1 million Sahel residents respectively (Fiorillo et al., 2017).

Consequently, one of the major livelihood support systems for the residents of the Sahel region is agricultural crop production (Anser et al., 2024). This is because the majority of the people in this sub region of Africa heavily depend on agricultural activities to ensure the creation of job opportunities, generation of income and other socio-economic needs. More importantly, food economy contributes approximately 80% of total employment in the Sahel region over time. Whereas the female population in this region overwhelmingly depend on the agricultural and food economies, having 40% contribution to agricultural production, 80%

contribution to agricultural processing, and 70% contribution to the region`s agricultural labour (FAO, 2020). This shows that women participation in agricultural activities in the Sahel region cannot be undermined. Therefore, arable land, climate change and its spillovers on female employment in agriculture have become the priorities of both the researchers and policymakers in countries in the Sahel region because of land degradation, global warming and gender inequality are a global problem that particularly impacts inhabitants of Sub-Saharan Africa in general, and the Sahel region in particular. Against this backdrop, this study embarks on an empirical investigation of the nexus among arable land, climate change and female employment in agriculture within the Sahel region. The strategic importance of this study in the Sahel region lies in the fact that this sub-region of Africa is in a dire state of rainfall variability, land degradation, desertification, decline in food security, global warming and gender inequality, and thus the Sahel region is under pressure to meet the Sustainable Development Goals (SDGs 5, 13, 14 and 15) in particular within the timeline of 2030, and the African Union Agenda 2063 in general. In addition, this study is also novel in terms of estimation techniques - Panel ARDL and Pairwise Dumitrescu Hurlin Panel Causality Tests utilized to address the studys objective in one hand, then, on the other hand, the choice of the principal variables which are agricultural land as percentage of land area, greenhouse gas emission, change in rainfall pattern and women employment in agriculture, in which similar studies within the Sahel have ignored.

Consequently, this paper is structured in this format. Problem of the study was identified with the appropriate justification in the introduction section of the paper. The subsequent section focuses on review of relevant empirical studies. Section three consists of methodology, analysis of data alongside discussion and policy recommendation.

2. LITERATURE REVIEW

Shirzad et al. (2022) reviewed 85 articles between 2013 and 2021 to determine the effect of registered land and the relationship between land ownership on output from agriculture in Iran and around the globe. The findings showed that land demand and advancements in agricultural practices were changing the patterns of land possession in Iran. The results highlighted the importance of enhancing land clearance and the effectiveness of local institutions saddled with the responsibility of managing land, as well as the need for additional research using an integrated locally-set approach to comprehend land tenure system network with agricultural output. Afridi et al. (2021) used special individual-level panel data for agricultural households in India spanning a half-decade to explore the gender-differentiated labour effects of droughts brought on by decreased precipitation. When unmeasured variability in peoples reactions was taken into consideration, it was discovered that womens workdays decrease by 11% more than mens during droughts, due to the latters lack of expansion into non-farm sectors. In reaction to droughts, women are less inclined than males to travel and work outside of their town, making it difficult for them to properly adapt to the negative shock to agricultural productivity. The results of the research were interpreted as the social costs of gender stereotypes that prevent women from accessing possibilities for non-farm jobs.

Chanana-Nag and Aggarwal (2020) investigated gender-based strategies and adjustment to climate change. India was used to exemplify the methodology. The findings pointed to 36 hotspots in 10 states of India where many women farmers were affected by significant risks of drought, excessive rainfall, and severe heat waves. 14.4% of all women farmers in the nation were represented in the hotspots target group. A socioeconomic analysis of the hotspot population identified obstacles for female farmers, such as limited accessibility to labour, credit, and markets, and inadequate wages for female labourers in those hotspots. The promise of sustainable farming technologies and practises was emphasised in light of the limitations and climate dangers that these women in the hotspots endured. Coulibaly and Li (2020) evaluated the effects of agricultural land loss on rural livelihoods in peri-urban settings employing the city of Ségou as a case study. Given the nearness to the city of Ségou, three villages in the locality of Sebougou were chosen. A systematic questionnaire was used during the 120 randomly selected household heads interviews. Owners of farms or those who were deprived of their land due to urbanisation made up the responses. Regression models, both multi-linear and logistic, were used in the research to analyse the data. The findings revealed that while family size and gender had adverse effects on the farmers yearly family income, age, occupation, land size, and degree of education had considerable beneficial influences. Farmers were more likely to lose their land to urbanisation if they had low-yielding land and young people leaving the country. On the other hand, agrarian land loss was negatively correlated with age, annual income, and land size.

Glazebrook et al. (2020) evaluated the effects of climate and gender bias on womens productivity in the global South and North and contested the male model of agricultural growth to support their claim that womens farming practices can be more sustainable. The authors prior longitudinal fieldwork in Ghana and the US was included in the level-based analysis (global, regional, local). Women farmers appeared to be underappreciated and to work more diligently, with fewer facilities, and for little pay; gender stereotypes were common worldwide while financial imbalances vary; violations of distributive, gender, and intergenerational justice as well as compromises to food sovereignty influence women everywhere. According to the studys findings, making investments in womens agriculture requires more than just traditional methods of funding and technological investment. Kumar and Sarangi (2020) analyzed the abundance of arable land in antiquity and developed the development of gender stereotypes that still have an impact on gender inequality. According to the study, gender inequality is lower, womens reproductive health is more effective, and their involvement in the labour force is higher in nations with more inherited arable land. The research discovered that it was favorably connected with perceptions of womens liberties and skills utilizing more than 80,000 individual-level surveys from more than 70 nations. The study demonstrated that the development of standards that support female involvement in the labour force is the main driving force underlying this association.

Maharjan et al. (2020) examined rural outmigration in the Lamjung, Chitwan and Nuwakot, districts of Nepal between 1990 and 2017. Subsistence farming, low productivity, restricted market access, terrain-related limitations, poor economic returns, and vulnerability to natural hazards now made worse by climate change were the hallmarks of Nepali agriculture. Three districts were chosen to depict the two major agro-ecological zones mountains and plains (Terai). Macro scale, longitudinal geospatial evaluation and econometrics were all combined in the researchs interdisciplinary method. Findings indicated that desertion of agricultural land was more common in mountainous regions than in the Terai. Gender is a crucial factor in how outmigration affects the abandonment of agricultural land; womens internal outmigration has a considerable beneficial impact. Tanure et al. (2020) investigated how climate change and global warming affected food production, land use, and agricultural output. The investigation used the Inter-regional General Equilibrium Model for the Brazilian Legal Amazon (REGIA), a Computable General Equilibrium (CGE) model, to analyze developments in agricultural production and use of land as motivated by climate change circumstances put forth by the IPCC (Intergovernmental Panel on Climate Change). The findings showed that a decline in economic measures in the Legal Amazon would cause a reduction in real GDP of around 1.18% in 2049 as an outcome of a decline in agricultural output and employment.

Eastin (2018) examined whether the overestimation of costs that women experience as a consequence of climate change appears through larger macro-social institutions when it comes to gender equality and womens rights. Between 1981 and 2010, the researcher evaluated the link among a sample of emerging states. The results indicated that variances from long-term average temperatures and an increase in climatological and hydro-meteorological catastrophes are linked to drops in womens economic and social rights, suggesting that climate fluctuations and climatic disasters have an essentially detrimental effect on gender equality. Osabuohien et al. (2018) investigated how well large-scale agricultural land investments (LALIs) have lived up to their objectives (such as enhanced productivity, employment, and rural development, especially for rural women). Two instances of LALIs in Tanzanias Kilombero districts Morogoro region were included in the researchs empirical evaluations utilizing the Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) dataset (macro evidence). The outcomes of the research showed that the LALIs have a negligible impact on agricultural earnings. The findings, however, indicated that LALIs have a bad relationship with the welfare of households managed by women who reside in LALI-affected communities. According to the micro evidence, households led by women who worked in LALIs had somewhat reduced agricultural incomes than households who did not engage in LALIs. The conclusion suggests that prioritizing certain prospective recipients is necessary for the implementation of LALIs in Tanzania to accelerate agricultural transformation.

Xie and Lu (2017) looked at how land fragmentation and the availability of non-agricultural labour affected the movement of agricultural land management rights. Utilizing data from the rural fixed observation points provided by the Ministry of Agriculture of the Peoples Republic of China, the analysis was carried out from the perspectives of labour heterogeneity and family joint decision-making. The findings showed that land fragmentation has a big impact on how agricultural land is circulated. The female non-agricultural labour supply has a substantial impact on the flow of agricultural land when there is an upsurge in the non-agricultural labour force; land outflows rise and land inflows fall. Female non-agricultural labour supply has substantial effects on agricultural land outflow in the regions of eastern, central, and northeastern China. Klein et al. (2013) studied the advantages of multi-objective regional optimization for determining the best land management adjustments to climate change. In a mesoscale catchment on the Swiss Central Plateau with already scarce water resources, the research developed a multi-objective optimization process that incorporates a generic crop framework and takes into account two climate scenarios for 2050. The findings showed the adjustment will be required for the research location to handle a 0-10% decline in productivity, a 25-35% rise in soil loss, and a 30-45% rise in N-leaching.

Naab et al. (2013) evaluated the effects of fast urbanization on agricultural areas in developing cities using empirical data from Tamale, Ghana. To gather and evaluate data from stakeholders in certain peri-urban areas in the Tamale city region, the study utilized a combination of qualitative and quantitative methodologies, including interviews and surveys. The findings showed that Tamales accelerated urbanization is an outcome of its advantageous position and significant commercial activity. Prime agricultural fields have been changed to various land uses that are thought to be the most excellent usage as a result of Tamales fast urbanization. In the Tamale region, where farming communities are predominately poor, the demands of urbanization had detrimental effects. Goh (2012) investigated how climate change affects both men and women in emerging nations. The analysis found that in six damaged areas impacts on agricultural production, effects on food security, effects on health, effects on water and energy resources, effects on migration and conflict, and effects on natural disasters climate change influences womens and mens resources and psychological health in various ways. The results of the study demonstrated the complexity of the relationship between gender and climate change and suggested that broad investigation is required to further our understanding of how different climate impacts affect men and women differently in terms of property and overall wellness in rural and agricultural contexts.

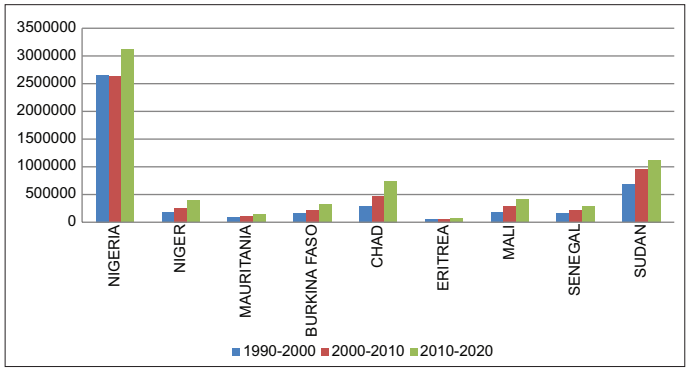
Zhang and Cai (2011) considered uncertainties surrounding the land classification and the hazard surrounding climate change estimates when evaluating the effect of climate change on the accessibility of agricultural land globally. Data collected from thirteen general circulation models (GCMs) and two typical emission scenarios were used to tackle uncertainty in GCM estimates. Fuzzy logic modelling was used to deal with inaccurate data and the ambiguous nature of land classifications driven by several indices (such as soil qualities, land slope, temperature, and humidity). It was determined that scenario A1B would likely result

in a drop of 0.8-1.7% in the total global arable land area, while scenario B1 would likely result in an upsurge of 2.0-4.4%. While tropical and sub-tropical regions may see varying degrees of lost arable land, regions with quite substantial latitudes, such as Russia, China, and the US, may see a rise in total arable land of 37-67%, 22-36%, and 4-17%, respectfully. Regionally, it is probable that the amount of arable land in Africa, South America, India, and Europe will decrease due to both climate change and population expansion. However, there could potentially be room for major arable land growth in the US, China, and Russia. Berry et al. (2006) evaluated the climate change sensitivity of agricultural species and land use, as well as the contribution of regulations to promoting adaptation. Model outputs were utilized to evaluate the species and farmers susceptibility to climatic and socioeconomic change. The findings demonstrated that the scenario under discussion affected both farmers and species vulnerability. The underlying connection between the two sectors demonstrated that effects on agriculture and subsequent adaptation could have a major influence on a species capacity for adaptability. This illustrated the value of cross-sector vulnerability assessments and underlined the significance of sectoral integration in the formulation and application of the regulation.

2.1. Stylised Facts about Arable Land, Climate Change and Female Employment in Agriculture in the Sahel Region

Figure 1 shows the emissions of greenhouse gas in the Sahel region spanning between 1990 and 2020. It is important to stress that Nigeria has the greatest emissions of greenhouse gas in the Sahel, these emissions were more prominent in Nigeria from 2010 to 2020. The reason for this surge in GHG emmissions in Nigeria might be directly or indirectly stimulated by persistent usage of fossil fuel for industrial and domestic purposes in the country. This shows that the inicidence of greenhouse gas emissions might make Nigeria to be more vulnurable to climate change crisis than all other countries in the Sahel. In the same vein, Sudan and Chad have the second and third largest emissions of GHG in the Sahel, which grew gradually but constently between 1990 and 2020. However, the least GHG emissions in the Sahel were recorded in Eritrea, followed by Mauritania and Senegal respectively. It is imporatnt to state that the lack of industrial activities, coupled with the small size of these countries might be the major reasons why the countries recorded less GHG emissions. As such, these three countries are likely to be less vulnurable to climate change induced by GHG emissions.

Figure 1: Green house gas emission in the Sahel Countries from 1990 to 2020

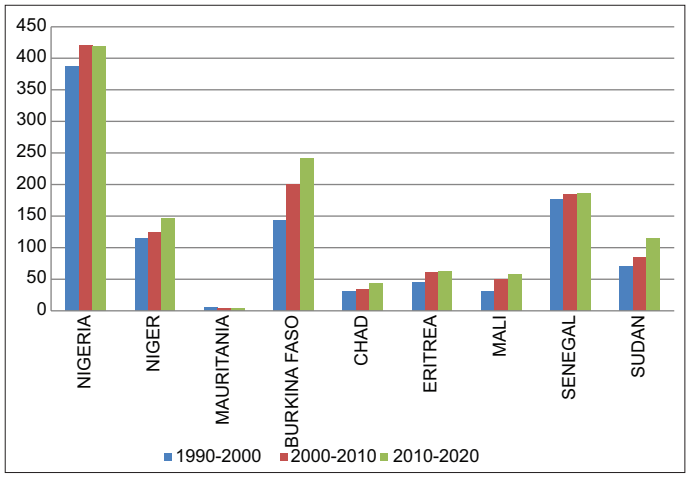


Source: Authors Computation (2025)

Figure 2 shows the distribution of arable land in each of the Sahel countries over the periods of 1990 and 2020. Nigeria has the biggest expanse of arable land, followed by Burkina Faso and Senegal respectively. It is instructive to enuciate that in spite of the fact that Sudan, Chad and Niger are the three biggest countries in term of land mass in the Sahel, they do not possess corresponding arable land. This is because the largest parts of these countries are made up of desert and arid land, which may not have enough fertility to enhance crop farming. According to the figure, Mauritiana possesses the least arable land, in which Chad and Mali followed suit respectively. Therefore, except Nigeria and possibly Bukina Faso, it is evident that the majority of countries in the Sahel region have inadeqaute arable land for crop farming. This suggests that these countries might be prone to desertificaction induced by climate change.

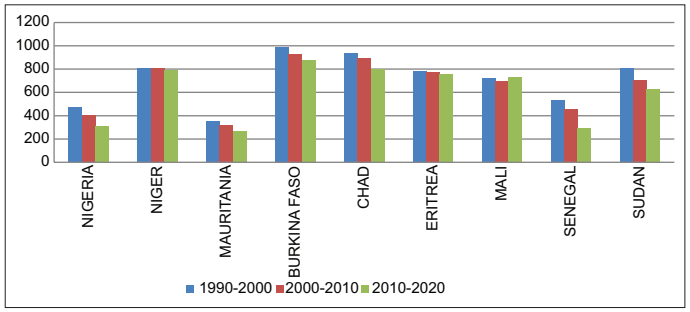
Figure 3 provides the rate of women employment in agriculture in the Sahel from 1990 to 2020. It could be deduced that Burkina Faso has the largest proportion of its female working population in agicultural sector. This is closely followed by Chad and Niger respectively. It should be sressed that, it is only Nigeria and Senegal that have insignificant proportion of their female working

Figure 2: Arable land (agricultural land as percentage of land area) in the Sahel Countries from 1990 to 2020



Source: Authors Computation (2025)

Figure 3: Female employment in agriculture as percentage of female employment in the Sahel Countries from 1990 to 2020



Source: Authors Computation (2025)

population engaged in agricultural sector. This implies that the majority of women in the Sahel depend on agricultural activities for their livelihood. Therefore, the sources of livelihood of women could be threatened by climate change crisis in the Sahel region.

3. METHODOLOGY

3.1. Research Design

To consider the best research design for this study, an ex-post facto type of research was used for this study because the focus of study is assessment of viable relationship among arable land, climate change and female employment in agriculture in the Sahel region.

3.2. Model Specification

The model to estimate the nexus among arable land, climate change and female employment in agriculture in this study was adapted from this set of studies Obiakor et al. (2021), Obiakor et al. (2022), Aderemi et al. (2020), Aderemi et al. (2021) and Aderemi et al. (2022) as follows;

Female Employment in Agriculture = f (Arable Land, Climate Change) (1)

The econometrics illustration of model (1) when climate change variables – greenhouse gas emissions and change in rainfall patterns, and control variable - infrastructural development are included in the model, the model changes in its structure as thus;

$$FEM_{it} = \alpha_0 + \alpha_1 AL_{it} + \alpha_2 GHE_{it} + \alpha_3 GIR_{it} + \alpha_4 IFD_{it} + u_{it} \quad (2)$$

3.3. Technique of Estimation

Following the argument of Pesaran et al. (2001), Pesaran and Pesaran (1997) and Pesaran et al. (1999), this study utilizes the panel ARDL technique due to the mixture of I(0) and I(1) of the variables of interest as stipulated. The ARDL in a panel form is stated as follows;

$$FEM_{it} = \sum_{(i=1)}^{p1} \Omega_1 FEM_{it-j} + \sum_{j=1}^{p2} \Omega_2 AL_{it} + \sum_{k=1}^{p3} \Omega_3 GHE_{it} + \sum_{i=1}^{p4} \Omega_4 GIR_{it} + \sum_{i=1}^{p5} \Omega_5 IFD_{it} + \theta ECM_{it-1} + \sum_{i=1}^{p1} \Omega_6 \Delta FEM_{it-j} + \sum_{j=1}^{p2} \Omega_7 \Delta AL_{it} + \sum_{k=1}^{p3} \Omega_8 \Delta GHE_{it} + \sum_{i=1}^{p4} \Omega_9 \Delta GIR_{it} + \sum_{i=1}^{p4} \Omega_{10} \Delta IFD_{it} + u_{it} \quad (3)$$

It is instructive to state that the aprori expectation in model (5) should follow this pattern Ω_1 to Ω_{10} except Ω_3 and $\Omega_8 > 0$. θ which is the speed of adjustment < 0 and significant. Also, Ω_1 to Ω_5 denotes the long run parameters and Ω_6 to Ω_{10} represents the short run parameters simultaneously.

Similarly, the direction of causality among arable land, climate change and female employment in agriculture were investigated thorough a Panel Pairwise Granger Causality technique which its models are stated as thus.

$$FEM_{it} = \alpha_0 + \sum_{i=1}^{n} \alpha_i FEM_{2it-i} + \sum_{j=1}^{n} \beta_j AL_{it-j} + \sum_{k=1}^{n} \delta_k GHE_{it-k} + u_{lit} \quad (4)$$

$$AL_{it} = \alpha_0 + \sum_{i=1}^{n} \alpha_i AL_{2it-i} + \sum_{j=1}^{n} \beta_j FEM_{it-j} + \sum_{k=1}^{n} \delta_k GHE_{it-k} + u_{lit} \quad (5)$$

$$GHE_{it} = \alpha_0 + \sum_{i=1}^{n} \alpha_i GHE_{2it-i} + \sum_{j=1}^{n} \beta_j AL_{it-j} + \sum_{k=1}^{n} \delta_k FEM_{it-k} + u_{lit} \quad (6)$$

In Table 1, the operational definitions of various variables in the study are discussed as follows.

4. RESULTS AND DISCUSSION

4.1. Results of the Study

The key variables in this study are arable land, change in rainfall pattern, climate change and female engagement in agriculture. In Table 2, it is pertinent to show the distribution of the data over the period of the analysis. Firstly, arable land- AL in its both maximum and minimum capacities accounts for 40.6% and 0.37% of land area in the Sahel region. However, AL has a mean value of 11.6%, this means that about 11.6% of the land area in the Sahel region has been used for agricultural purposes. Similarly, female employment in agriculture- FEM, in its both maximum and minimum capacities accounts for 65.6% and 51.6% of women who are engaged in productive employment respectively in the Sahel region. Whereas, on an average basis, from 1990 to 2020, agriculture employment accounts for 59.9% of women who are engaged in productive employment in the Sahel region as against current 52% recorded in SSA, 59% in South Asia, 20% in East Asia and Pacific region, 16% in the Middle East and North Africa, 8% in Latin America and Caribbean and 3% in Europe. This implies that the Sahel region has the highest percentage of women employment in agriculture among all the other regions of the world.

Table 1: Measurement of variables

Abbreviation	Variable	Operational definition	Expected sign
FEM	Female employment in agriculture	Female employment in agriculture as % of female employment	
AL	Arable land	Arable land is measured as agricultural land as percentage of land area	+
GHE	Greenhouse gas emission	This is measured by total greenhouse gas emission	−
GIR	Change in Rainfall	This is measured by average precipitation in depth in MM per year	+
IFD	Infrastructural development	The number of individual who have access to electricity as percentage of total population.	+
u	Error term	Other variables that affect the study but not captured in the model.	

Source: Authors' Computation (2025)

Table 2: Descriptive statistics of the data for the study from 1990 to 2020

Descriptive statistics	IFD (%)	AL (%)	FEM (%)	GHE (Kt)	GIR (MM per year)
Mean	26.12061	11.62860	59.90496	54807.56	450.6301
Median	24.49741	7.891414	66.80769	24020.00	450.8432
Maximum	70.40000	40.62497	91.04525	317590.0	451.6345
Minimum	1.100000	0.378384	15.63723	3700.000	441.3508
Std. Deviation	17.66533	10.81070	20.08728	75651.78	1.914296
Skewness	0.387191	1.322588	−0.505036	2.110325	4.555092
Kurtosis	1.995163	3.922281	1.976628	6.188224	25.12608
Jargue-Bera	18.64180	90.90085	23.94895	324.0861	6712.1875
Probability	0.000090	0.000000	0.000006	0.000000	0.000000
Sum	7261.529	3232.751	16653.58	1523650	916.2865
Sum Sq. Dev.	86441.65	32373.32	111769.2	1.59E+12	8675.074
Observations	278	278	278	278	278

Source: Authors' (2025)

In the same vein, the minimum total greenhouse gas emitted in the region is 3,700Kt, whereas, the maximum value emitted is 3,17,590Kt. But, the total greenhouse gas emission in the Sahel region has an average value of 54807.56Kt which is far lower than 823,787Kt emitted in SSA, 1,627,955Kt emitted in Latin America and Caribbean, 2,544,021Kt emitted in the Middle East and North Africa, 3,383,432Kt emitted in Europe, 4,156,424Kt emitted in South Asia, and 14,658,934Kt emitted in East Asia and Pacific region.

Furthermore, the change in rainfall pattern has an average value of 450.6452 MM per year. It is important to stress that the change in rainfall pattern ranges between 451.6667 MM and 441.3333 MM per year in the last three decades in the Sahel region.

The estimation of the data stationarity test is very important in a study that involves time series data because this kind of data is unique in the sense that it could produce spurious results if not well managed. As such, this study tried to avert the emergence of spurious results by conducting a stationary test on the collected data, in which the estimated results were outlined in Table 3. It could be drawn from the table that two variables, GIR and FEM are stationary in their current form, but the case of the other three variables, AL, GHE and IFD are stationary after first differencing. This implies that the studied variables are a mixture of I(0) and I(1) scenarios. In a situation like this, ARDL technique has been adjudged to be the best estimation technique as enunciated by Pesaran et al. (2001), Pesaran and Pesaran (1997) and Pesaran et al. (1999). Thus, panel ARDL results were presented in the subsequent table to analyse the short run and long run relationship among arable land, climate change and female employment in agriculture in the Sahel.

In providing empirical analysis for the relationship among arable land, climate change and female employment in agriculture in the Sahel, the panel ARDL short-run and long-run estimates were presented in Table 4 with the following findings. First and foremost, it is important to stress that all the coefficients of the short run analysis are not significant. This implies that the relationship among arable land, climate change and female employment in agriculture in the Sahel region is a long run phenomenon. In other words, arable land and climate change do not have a noticeable impact on female employment in agriculture in the Sahel region.

Table 3: Stationarity test for the variables of interest

Levin, Lin and Chu unit root test			
Variables	**t-statistic**	**Probability**	**Order**
GIR	−0.99857	0.1590	I (1)
FEM	3.88031	0.9999	I (1)
AL	−8.62641	0.0000	I (0)
GHE	−6.88268	0.0000	I (0)
IFD	−10.0274	0.0000	I (0)
Im, Pesaran and Shin W-stat test			
Variables	**t-statistic**	**Probability**	**Order**
GIR	−1.09154	0.1375	I (1)
FEM	7.08497	1.0000	I (1)
AL	−8.63594	0.0000	I (0)
GHE	−7.73475	0.0000	I (0)
IFD	−13.4468	0.0000	I (0)

(*) (**) indicate significance at a 5% probability level. Source: Authors Calculation (2025)

Therefore, this study emphasizes the long run component of the above table as follows; arable land has a non-significant negative relationship with female employment in agriculture. Greenhouse gas emission has a significant negative relationship with female employment in agriculture. However, change in rainfall pattern contributes a positive impact to female employment in agriculture, though the impact is significant at 10% level of significance. In addition, access to electricity and female employment in agriculture have a significant negative relationship. Also, the adjustment coefficient (Coint.) is -0.088575 which has the expected sign though not significant. Thus the adjustment dynamic exists between the short run and the long run in arable land, climate change and female employment in agriculture. This implies that for the equilibrium to be restored in the model, 8.85% of the short-run perturbation must be adjusted per annum.

In accounting for the causal relationship that exists among arable land, climate change and female employment in agriculture in the Sahel, Pairwise Dumitrescu Hurlin Panel causality tests was estimated in which its results were contained in Table 5. The findings show that a uni-directional causality flows from arable land to climate change. In the same vein, one way causality flows from climate change to female employment in agriculture. However, there is no causal relationship between female employments in agriculture and arable land in the Sahel region. This implies that is a strong connection exists among arable land, climate change and female employment in the Sahel region.

Table 4: Relationship among arable land, climate change and female employment in agriculture in the Sahel

Method: Panel ARDL Dependent Variable: FEM						
Regressors	**Long run coefficient**	**T-stat**	**Prob.**	**Short run coefficient**	**T-stat**	**Prob.**
AL	−0.478632	1.507406	0.1335	0.379968	0.965073	0.3358
GHE	−0.000484*	5.461129	0.0000	−0.000141	1.184567	0.2378
GIR	0.486185***	1.921964	0.0562	−0.629004	0.689557	0.4914
IFD	−1.075730**	2.188564	0.3000	0.075694	0.378125	0.7058
Coint.	−0.088575	1.535497	0.1265			

Source: Authors' Computation (2025). *Significant at1% **Significant at5% ***Significant at10%

Table 5: Pairwise Dumitrescu Hurlin panel causality tests for arable land, climate change and female employment in agriculture in the Sahel

Null hypothesis	W-Stat.	Zbar-Stat.	Prob.
FEM↔AL	2.02341	1.74106	0.0817
AL↔FEM	1.49762	0.77033	0.4411
GHE↔AL	3.41226	4.30518	2.E-05
AL↔GHE	2.15725	1.98816	0.0468
GHE↔FEM	5.69600	8.52757	0.0000
FEM↔GHE	4.29466	8.52757	3.E-09

Source: Authors' Computation (2025). ↔ does not homogeneously cause

4.2. Discussion of the Findings

None of the coefficients of the short run parameters is significant. This confirms that it is only in the long run that arable land and climate change could exert a meaningful impact on female employment in agriculture in the Sahel region. From the results, it could be inferred that greenhouse gas emission contributes a negative significant impact to female employment in agriculture. Based on the finding, holding all other factors constant, a unit change in climate change variable will induce a reduction in female employment in agriculture by 0.0004% in the Sahel region. This indicates that climate change is a major factor reducing female employment in agriculture in the Sahel region. This finding in tandem with conclusion of Chanana-Nag and Aggarwal (2020) in a related study in India. However, change in rainfall pattern contributes a positive and significant impact to female employment in agriculture. In the same vein, arable land contributes a negative but insignificant impact to female employment in agriculture in the Sahel region.

However, change in rainfall pattern induces a significant rise in female employment in the Sahel. A unit change in rainfall pattern will cause 0.48% rise in female employment in the Sahel. This indicates that the pattern of rainfall in the Sahel is favorable to engagement of female folks in the agricultural activities in the region. This finding contradicts the submission of Eastin (2018) in a similar study focusing on developing states.

5. CONCLUSION AND POLICY IMPLICATIONS OF THE STUDY

Having utilized a Panel ARDL and a Pairwise Dumitrescu Hurlin Panel Causality Test to empirically verify nexus among arable land, climate change and female employment in agriculture in the Sahel Region**,** this study therefore concludes that change in rainfall pattern induces a significant rise in female employment in the Sahel whereas, greenhouse gas emission orchestrates a significant adverse effect on female employment in agriculture. Hence, this study emphasizes that, for the SDGs 13, 14 and 15 to be achieved within the Sahel, there is an urgent need for the policymakers in this sub-region to mitigate emission of greenhouse gas and degeneration of arable land through policies and programmes that would foster anti-grazing, sustainable agricultural practices, afforestation and sustainable extractive industries. In the same vein, since climate change induces reduction in female employment in agriculture in the Sahel, any time the policymakers in this sub-region want to achieve the SDGs 5, the policies that foster climate resilience environment should be embarked upon. Also, gender equality should be encouraged and considered when allocating arable land for agricultural purposes. The findings of this research will allow for African countries in general, and the Sahel in particular to improve the use of arable land to generate employment for women in the face of the current global warming, this will invariably consolidate implementation of the environmentally sustainable and climate resilient economies and communities alongside full gender equality in agricultural sector as the strategic part of the African Union Agenda 2063.

Finally, future studies could apply different methods of estimations. The interpretations of this study are based on the specific regression analysis performed and should be considered in light of any limitations or assumptions made during the analysis. Additionally, further analysis and robustness checks may be necessary to validate and strengthen these findings.

REFERENCES

Aderemi, T.A., Abalaba, B.P., Adeniran, A.A., Amadi, C.E. (2020), Agricultural sector and employment generation in post sap Era Nigeria: An empirical perspective. International Journal of New Economics and Social Sciences, 11(1), 185-196.

Aderemi, T.A., Omitogun, O., Osisanwo, B.G. (2022), Effect of FDI inflows on employment generation in selected ECOWAS Countries: Heterogeneous panel analysis. Central Bank of Nigeria Journal of Applied Statistics, 13(1), 241-263.

Aderemi, T.A., Wahid D.O., Ayodeji, G.B., Christiana Onyohu Hassan, C.O., Osabohien, R., Azuh, D.E. (2021), Role of agriculture in poverty reduction in Nigeria: An implication for sustainable development goals (SDGs). African Journal of Business and Economic Research (AJBER), 2021, 267-280.

Afridi, F., Mahajan, K., Sangwan, N. (2021), The Gendered Effects of Climate Change: Production Shocks and Labor Response in Agriculture. [IZA Discussion Papers, No. 14568], Institute of Labor Economics (IZA), Bonn.

Anser, M.K., Ogede, J.S., Huizhen, W., Aderemi, T.A., Ali, S., Osabohien, R. (2024), Analysing the impacts of shadow economy, financial inclusion and economic policy uncertainty on CO_2 emissions. Politická Ekonomie, 72(6), 867-895.

Berry, P.M., Rounsevell, DA.M., Harrison, P.A., Audsley, E. (2006), Assessing the vulnerability of agricultural land use and species to climate change and the role of policy in facilitating adaptation. Environmental Science and Policy, 9(2), 189-204.

Chanana-Nag, N., Aggarwal, P.K. (2020), Woman in agriculture, and climate risks: Hotspots for development. Climatic Change, 158(1), 13-27.

Coulibaly, B., Li, S. (2020), Impact of agricultural land loss on rural livelihoods in Peri Urban Areas: Empirical evidence from Sebougou, Mali. Land, 9(12), 470.

Eastin, J. (2018), Climate change and gender equality in developing States. World Development, 107, 289-305.

FAO. (2020), National agrifood systems and COVID-19 IN ECOWAS. In: Effects, Policyresponses and Long Term Implications. Rome: FAO; p1-8.

Fiorillo, E., Maselli, F., Tarchiani, V., Vignaroli, P. (2017), Analysis of land degradation processes on a tiger bush plateau in South West Niger using MODIS and LANDSAT TM/ETM+ data. International Journal of Applied Earth Observation and Geoinformation 62, 56-68.

Glazebrook, T., Noll, S., Opoku, E. (2020), Gender matters: Climate change, gender bias, and women's farming in the global South and North. Agriculture, 10(7), 267.

Goh, A.H.X. (2012), A Literature Review of the Gender-Differentiated Impacts of Climate Change on Women's and Men's Assets and Well-Being in Developing Countries. Washington, D.C.: International Food Policy Research Institute; [CAPRi Working Paper No. 106].

IPCC. (2019), Shukla, P.R., Skea, J., Calvo Buendiam, E., Masson-Delmotte, V., Pörtner, H.O., Roberts, D.C., Zhai, P., Slade, R., Connors, S., van Diemen, R., Ferrat, M., Haughey, E., Luz, S., Neogi, S., Pathak, M., Petzold, J., Portugal Pereira, J., Vyas, P., Huntley, E., Kissick, K., Belkacemi, M., Malley, J., editors. Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems. Switzerland: IPCC.

Klein, T., Holzkämper, A., Calanca, P., Seppelt, R., Fuhrer, J. (2013), Adapting agricultural land management to climate change: A regional multi-objective optimization approach. Landscape Ecology, 28, 2029-2047.

Kumar, J.C., Sarangi, S. (2020), Arable Land in Antiquity Explains Modern Gender Inequality; [MPRA Paper No. 104336].

Maharjan, A., Kochhar, I., Chitale, V.S., Hussain, A., Gioli, G. (2020), Understanding rural outmigration and agricultural land use change in the Gandaki Basin, Nepal. Applied Geography, 124, 102278.

Naab, F.Z., Dinye, R.D., Kasanga, R.K. (2013), Urbanisation and its impact on agricultural lands in growing cities in developing countries: A case study of tamale in Ghana. Modern Social Science Journal, 2(2), 256-287.

Nkonya, E., Mirzabaev, A., Von Braun, J. (2016), Economics of Land Degradation and Improvement: A Global Assessment for Sustainable Development. Washington, DC: SpringerOpen. p695.

Obiakor, R.T., Olanipekun, W.D., Omoyele, O.S., Aderemi, T.A. (2022), Agriculture, food security and poverty reduction in Nigeria: Cointegration and granger causality approach. Acta Universitatis Danubius Œconomica, 18(1), 52-60.

Obiakor, R.T., Omoyele, O.S., Olanipekun, W.D., Aderemi, T.A. (2021), Is agriculture still a strong force in employment generation in Nigeria? An empirical investigation. Euro Economica, 40(2), 90-100.

Osabuohien, E.S., Efobi, U.R., Herrmann, R.T., Gitau, M.W.C. (2019), Female labor outcomes and large-scale agricultural land investments: Macro-micro evidence from Tanzania. Land Use Policy, 82, 716-728.

Pesaran, H., Shin, Y., Smith, R. (1999), Pooled mean group estimation and dynamic heterogeneous panels. Journal of the American Statistical Association, 94, 621-634.

Pesaran, M., Pesaran, B. (1997), Microfit 4.0 (Windows Version). New York: Oxford University Press Inc.

Pesaran, M.H., Shin, Y., Smith, R.J. (2001), Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16(3), 289-326.

Shirzad, H., Barati, A.A., Ehteshammajd, S., Goli, I., Siamian, N., Moghaddam, S.M., Pour, M., Tan, R., Janečková, K., Sklenička, P., Azadi, H. (2022), Agricultural land tenure system in Iran: An overview. Land Use Policy, 123, 106375.

Sikwela, M., Aderemi, T.A. (2025a), Effect of climate change on agricultural productivity: A case study of Nigeria. Asian Journal of Agriculture and Rural Development, 15(4), 542-553.

Sikwela, M., Aderemi, T.A. (2025b), Clean energy consumption and human welfare in Nigeria: Implication for the sustainable development goal 7. International Journal of Energy Economics and Policy, 15(1), 456-465.

Sikwela, M.M., Ntshangase, B.A., Ramsarghey, K., Aderemi, T.A. (2025), Carbon emissions, out-of-pocket expenditure and life expectancy of reproductive age women in West Africa. Asian Economic and Financial Review, 15(3), 345-353.

Tanure, T.M.P., Miyajima, D.N., Magalhães, A.S., Domingues, E.P., Carvalho, T.S. (2020), The impacts of climate change on agricultural production, land use and economy of the legal amazon region between 2030 and 2049. EconomiA, 21(1), 73-90.

Xie, H., Lu, H. (2017), Impact of land fragmentation and non-agricultural labor supply on circulation of agricultural land management rights. Land Use Policy, 68, 355-364.

Zhang, X., Cai, X. (2011), Climate change impacts on global agricultural land availability. Environmental Research Letters, 6, 014014.