Journal of the Geographical Association of Tanzania, Vol. 44, No. 1: 108–128

Socio-economic Challenges Deterring Sustainable Pastoralism Among Women Pastoralists in the Sahel Region of Northern Nigeria

Verere Sido Balogun [*] ***& Johnson Egbemudia Dudu*** [§]

Abstract

Female pastoralists exhibit great strength in the drive to make a dependable livelihood from livestock tending. This is not without challenges that are gender-specific. This paper examines the socio-economic and environmental challenges faced by women pastoralists in the Sahelian Region of Northern Nigeria. Primary data were derived from an interview of 2,290 adult female household members in 6 local government areas in Bauchi and Gombe States in Nigeria. A stepwise regression analysis determined that amongst 23 socio-economic variables, 14 were significant explanatory or predictive variables ($p < 0.05$) for the socio-economic status of women, as a measure of their capacity to sustain pastoralism. The results indicate that the length of time or experience in pastoralism had the most predictive power ($\beta = 0.31$; $p < 0.05$), and contributed 13% ($R^2 = 0.13$) in enhancing the socio-economic status of pastoralist women. This was followed by other socio-economic factors such as the level of formal educational attained, participation in household livestock raising, ownership of large livestock, climate change awareness, prevalence of out-of-school children within the household, availability of household transportation means, category of health care facility accessed, involvement in non-agricultural economic sectors, involvement in food crop farming, ownership of small livestock, amount of rest/sleep affordable, membership of community development groups, and age. The paper recommends support for female education in pastoral communities, access to health care in remote areas, and upgrading community development groups to cooperative or self-help groups that can provide affordable loans to assist pastoralist women in thriving better in a supposedly male-dominated profession.

Keywords: *constraints, climate change, women pastoralist, Sahel region.*

Introduction

Pastoralism is one of the predominant livelihoods practised amongst ethnic groups across Sub-Saharan West Africa, East Africa and Southern Africa (Umoh, 2017). It contributes significantly to national economies, and conserves fragile ecologies by making the best use of dry and barren lands that are unsuitable for crop farming. Pastoralism is the aspect of agriculture that entails the raising of livestock by pastoralists for the economic value of their products (Djordjević-

[*]Department of Geography & Regional Planning, University of Benin, Benin City, Nigeria, and Centre for Population and Environmental Development: verere.sido@uniben.edu

[§] Department of Geography, Faculty of Social Sciences, Federal University of Kashere, Gombe State; and Centre for Population and Environmental Development: jedudu@fukashere.edu.ng

 ▪ https://doi.org/10.56279/jgat.v44i1.314

Milošević & Milovanović, 2020). This could be sedentary, involving keeping livestock within a semi-permanent location, usually near farms and villages; or nomadic, which implies moving from place to place in search of water and grazing areas in the form of fresh pasture (Weber & Horst, 2011; Turner & Schlecht, 2019). Blench (2001) defined pastoralism as one of the key production systems in the world's drylands that involves the use of extensive rangelands for livestock grazing and production. According to the IFAD (2012), about 200m nomadic and transhumant pastoralists throughout the world generate income and create livelihoods in remote and harsh environments where conventional farming is limited, or not possible. Majekodunmi et al. (2014) opine that, of the estimated 120m pastoralists globally, 50m are within Sub-Saharan Africa (SSA), and constitute 12% of the rural population of the same. In the Sahelian Region of Northern Nigeria, it is mostly the Fulani ethnic group that are noted for pastoralist activities (Blench, 1994).

Ownership of livestock is seen as a symbol of status in pastoral communities (Schmidt, 1992). Traditionally, pastoralist communities are patriarchal, meaning, for example, that though women could have access to land, they seldom have the ownership or the decision-making rights over land use, and the allocation of benefits thereof (Onyima, 2021). Female pastoralists are placed in the lower socio-economic class; and are considered secondary providers of the nuclear and extended family systems. Their informal economic activities are centred on dairy extraction, processing and marketing, which provide them with a source of income and livelihood. This implies that women pastoralists are discriminated against in two major ways: first, by their exclusion from property, livestock and land rights; and second, by their exclusion in the decision-making process among the hierarchy of community leadership (Farusa & Farusa, 2014). Despite the responsibilities they assume, they are much less involved in participating in the decisions that affect their lives and livelihoods compared with pastoralist men.

The exclusion of pastoral women from property ownership rights and decision-making places them at a severe disadvantage in terms of carrying out pastoralism sustainably, despite being key actors in livestock raising and processing of livestock byproducts. Their valuable role is not only partially recognized; but also they are particularly disadvantaged by the limitations they face within their societies in terms of owning property or livestock, and participating in decision-making processes (Balehey et al., 2018; Onyima, 2021). Moreover, the fact that pastoral women typically lack formal education makes them unable to access valuable information and technology to intensify and increase the value of their products (Warkineh & Gizaw, 2019). Similarly, with the adverse impacts of climate change, women and girls also bear the greatest burden of drought primarily because of the gendered division of labour

and decision-making power at the household level. For example, extreme drought brings a greater burden on women, as gendered division of labour entrenched in the societal norms require that they perform their biological reproductive and economic productive roles, and also contribute more to household sustenance despite having less support from societal structures. Notwithstanding the many challenges they face, pastoral women are resourceful in finding ways to ensure that the basic needs of their households are met (Gitungwa et al., 2021; Vincent, 2022). Increasing the awareness of pastoralist women's concerns and the value of their specific inputs is a step towards strengthening the socio-economic capacities of women in pastoral communities, thus accentuating their motivation for sustainable pastoralism.

This paper is based on the concept of sustainable pastoralism, which is a form of grazing that is beneficial socio-economically and environmentally. It is a form of animal grazing that protects the ecosystem from degradation while sustaining the socio-economic livelihoods of pastoralists (IUCN, 2022). The grazing practices adopted by Sahelian herders are expected to be in tune with nature's variability to enhance food and economic security, as well as to protect the environment from degradation. Despite being inhospitable, the dryness of the savannah provides vast ecosystems that are productive lands on which ruminant animals and their herders turn primary energy from sunlight and grass into milk and meat, thus complementing cultivated food crops, and economically empowering rural pastoral women. Therefore, sustainable pastoralism aims at maintaining livelihoods and food production on lands where crops cannot be grown sustainably. Sustainable pastoralism among women pastoralists enhances the continuity or longevity of the profession for women, despite the constraints posed by the society and environment (Ouedraogo & Davies, 2016).

Documented literature sources comprise the content that has shown the various enablers of sustainable pastoralism. A study by Usman (2010) has shown the ability of Sahelian women pastoralists to apply indigenous knowledge systems (IKSs)—i.e., skills derived from the cognitive, aesthetic, spiritual, and moral educational components of their traditional literacy—in enhancing the sustainability of their pastoral livelihood. These IKSs are based on the philosophy of realism, which is hinged on 'nature' and 'purpose'; and proposes the need for humans to exist in harmony with nature. These cultural attributes and knowledge are what define women's social agency and their coexistence. Other studies—such as by Köhler-Rollefson (2016), Seid et al. (2016), Warkineh and Gizaw (2019), Ouedraogo and Davies (2016), Raymond (2021), Kemal et al. (2022), and Xie et al. (2022)—have suggested pathways towards achieving sustainable pastoralism across rangelands in the world by making lands, which are characteristically very dry and minimally support crop cultivation, economically productive. These

pathways are embodied in adaptive strategies such as through organised self-help groups, livestock diversification, herd sharing, livelihood diversification, and mixed agricultural systems, amongst others.

This paper aims to understand the challenges of sustainable pastoralism from a gendered perspective. Being gender-based, it attempts to project women as reliable stewards in achieving sustainable pastoralism by identifying and analysing the modern-day socio-economic challenges faced by women pastoralists, which may have not been adequately espoused by previous research. This paper determines the nature of the challenging mix of gender-based constraints -- such as the level of women's participation in community development groups, asset ownership status, formal educational status, access to health care and means of transportation, climate change awareness -- and their collective influences on sustainable pastoralism by women pastoralists in the Sahel Region of Nigeria. Hence, the findings of the study aim to provide better understanding on how access to education, healthcare, transportation facilities and livestock assets: all challenge the capacities of female pastoralists to practise sustainable pastoralism. In turn, this will serve as a basis for determining the best interventions required for empowering women pastoralists in the Sahel Region of Nigeria.

Context and Methods

The Study Area

The six states that make up northeastern Nigeria are Adamawa, Bauchi, Bornu, Gombe, Taraba, and Yobe. The state capitals of these states are Yola, Bauchi, Maiduguri, Gombe, Jalingo, and Damaturu, in that order. The National Population Commission (2010) depicts its area size as 289,422km^2, and estimates its population size as 18,984,299 persons. The northeastern region of Sahel where the study was carried out includes Bauchi and Gombe States (Figure 1). According to Bello et al. (2020), and Abubakar (2022), the Bauchi State is situated geographically between latitudes 9°3′ and 12°3′N, and longitudes 8°50′ and 11°00′E; whereas the Gombe State is situated between latitudes 9°30' and 12°N, and longitudes 8°45' and 11°45'E.

The climate of the Sahel region is inextricably linked to the West African monsoon, the circulation regime that brings most of its rainfall. This is a wind circulation pattern influencing rainfall patterns, and is associated with the Intertropical Convergence Zone (ITCZ). The ITCZ over West Africa is marked by the convergence of the northeasterly Harmattan wind (a dry and dusty wind occurring during the dry season months that originates in the Sahara), and the southwest monsoon wind flow that emanates from the Atlantic Ocean, which is a moist wind associated with rainfall (Nicholson, 2013). According to Koppen's classification scheme, the climate of the Sahel region is categorized as the Savannah Climate (Aw) (Ayoade, 2011).

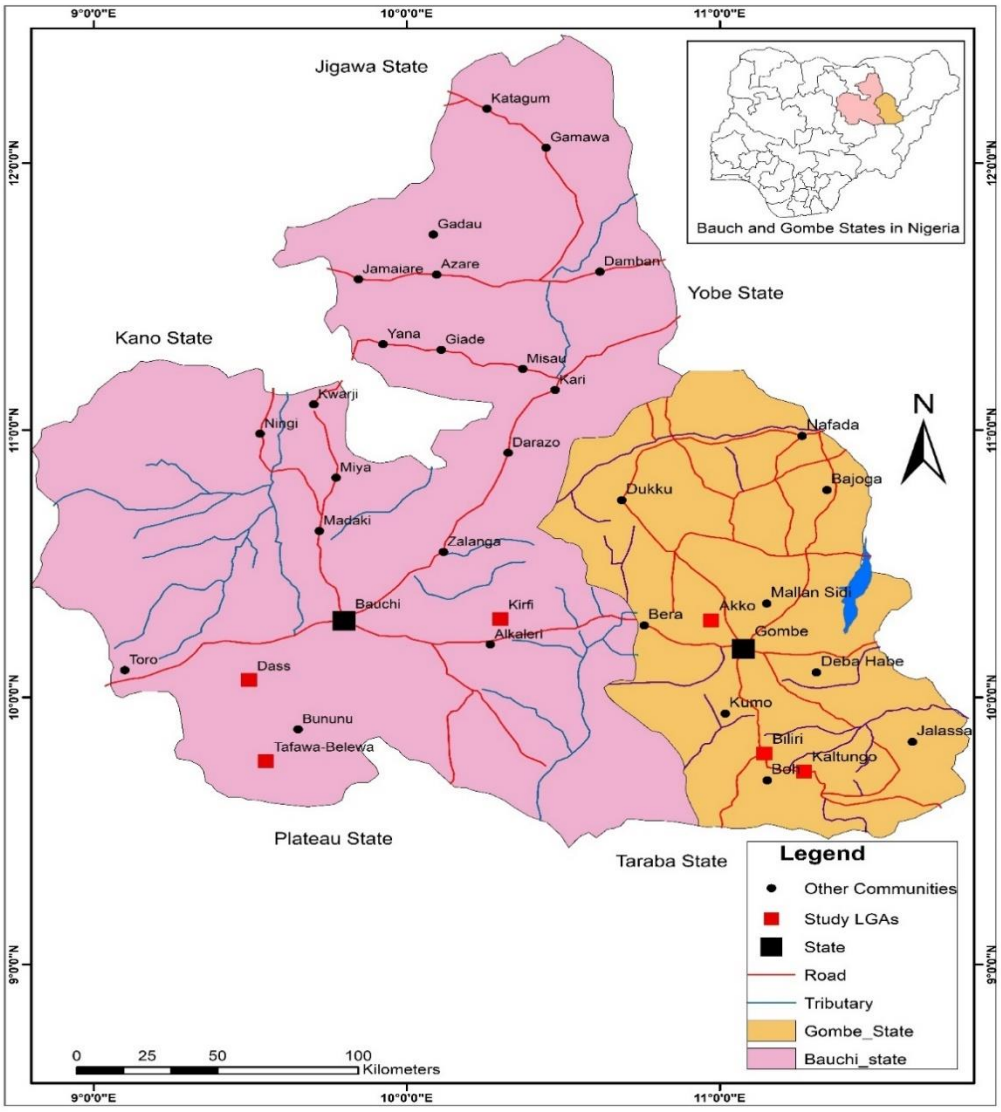

Figure 1: Locations of the Study LGAs in Bauchi and Gombe States

The climate has also been described as Sahelian hot climate by the World Bank Group (2021); and as a semi-arid climate by the World Meteorological Organization (WMO, 2021). The temperature of the Sahel region is generally high throughout the year, ranging from 22°C to 36°C. The average temperature increases were within the range of 0.6°C to 0.8°C from 1970 to 2010, and long-term projections indicate further temperature increases of between 3°C and 6°C (NUPI & SIPRI, 2021).

Rainfall in the Sahel is highly variable, with an intense dry season from November to March; and an irregular rainy season between April and October (Odjugo & Ikhuoria, 2003). During the last century, the Sahel experienced a slight increase in precipitation around the middle of the century, which was followed by an unprecedented and severe long-lasting droughts from the late 1960s to the late 1980s. In more recent years there has been a partial recovery (NUPI & SIPRI, 2021). Odjugo and Ikhuoria (2003) state that the annual rainfall in the Sahel region ranges from 400mm in the northern fringes, to 1,200mm in the southern fringes in Nigeria. According to the IPCC (2019), human-caused climate change, as well as natural climate cycles, have contributed to the expansion of the desert.

The sandy Sahelian soils are dominated by low-activity clay soils consisting mainly of Entisols and Alfisols. Entisols are mainly composed of quartz sand, while Alfisols have a clay accumulation horizon and a high base saturation because of lower rainfall and leaching. Both soils have poor structural stability, low water retention and nutrient holding capacity, low organic matter content, and low effective cation exchange capacity (ECEC); and are highly susceptible to drought (Kang as cited by Bationo et al., 2005). The vegetation type is that of the tropical savannah (Odjugo & Ikhuoria, 2003), although most parts of the Sahel are gradually being overtaken by the Sahara Desert. Nigeria's Sahel region is relatively fertile and endowed with great potential for renewable energy, and is positioned above some of the largest aquifers on the African continent. Hotter climatic conditions and irregular rainfall and seasonal patterns in the Sahel affect herders, farmers and fishers who rely on the renewable natural resources of the region. For pastoralists, the effects of hotter climate and irregular rainfall patterns result in decreased pastoral lands and competing demands for less available land, giving rise to overstocking in private land enclosures, and social conflicts between farmers and herders. These environmental constraints require indigenous strategies to sustain viable pastoralism despite the odds.

Data Generation

Primary data were captured through the use of questionnaires that elicited socio-economic information from women pastoralists in the study area. Stratified and random sampling techniques were used in selecting female pastoralists as respondents. A total of 2290 females responded to household questionnaires in the two target states: Gombe (1151), and Bauchi (1139). These female respondents were selected from 6 chosen LGAs: 3 in Bauchi State (Dass, Kirfi, and Tafawa Balewa); and 3 in Gombe State (Akko, Billiri, and Kaltungo). These LGAs were purposively selected because they were considered as having the least security risk. The sample sizes for each of the LGAs were estimated using the Krejcie and Morgan table of sample size determination (see Table 1) (Krejcie & Morgan, 1970). The 6 LGAs were further stratified into administrative wards.

Table 1: Distribution of Respondents by State and LGA

Study States	Sampled LGAs	Female Population 2006	Projected Female Population (2020) $P_1 = P_o \cdot e^{r \cdot t}$	Sample Size
Bauchi	Dass	43,419	65,072	378
	Kirfi	70,299	105,357	381
	Tafawa Balewa	110,938	166,263	380
Gombe	Akko	169,920	252,176	388
	Billiri	99,479	147,635	377
	Kaltungo	80,216	119,047	386
Total				**2,290**

Note: P_o = Initial population; r = growth rate factor; t = time in years

Source: National Population Commission, Nigeria (2010)

Each ward was further demarcated into blocks of 10 housing units to ensure that women in all parts of the ward had an equal chance of being included in the sample. On average, there are 5.42 persons per household in the rural areas of Nigeria (National Bureau of Statistics, 2020), which adds up to about 10,000 persons per ward. Therefore, each ward had 150–200 blocks. All the blocks were listed, and the number of blocks equivalent to the sample size assigned to a ward were randomly selected using the random number function in Microsoft Excel. In each selected block, one pastoralist household was randomly selected. In each randomly selected household (headed by either a male or female household member), one adult female pastoralist was interviewed. Female pastoralists who had been involved in pastoralism, but were currently not in possession of livestock, were also included in the survey. The same applied to female pastoralists who had no livestock of their own but tended to the livestock of others in exchange for wages.

Data Analysis

The data collected from the field were encoded using the Statistical Product and Service Solutions (SPSS) software. Quantitative analysis involved the use of Stepwise regression, which is a statistical technique that estimates the structure of dependencies among variables involved by picking out relevant regressors from several possible ones (Johnsson, 1992). The technique involves adding or removing potential independent or explanatory variables in successions of iterations, and testing for statistical significance after each. This is mathematically expressed as:

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_n x_n + \in$$

Where Y is the dependent variable; x_1, x_2, x_3..... are the explanatory variables or possible regressors; and $\beta_{1....n}$ are the regression coefficients.

In the study, the dependent variable—which represents the socio-economic status of pastoral women—is represented as 'income'. The study regressed 23 variables against 'income' to test their predictive potential in determining the socio-economic status of women as a measure of their capacity for sustainable pastoralism. The regressed determinants were drawn from the outcome of previous studies (Kristjanson et al., 2010; Warkineh & Gizaw, 2019; Onyima, 2021; Kemal et al., 2022; Xie et al., 2022); and from field observations during the reconnaissance survey carried out during the onset of the study.

Results

The paper investigates the various dimensions of the socio-economic environment in a typical Sahelian region, which could influence the economic sustainability of female pastoralists. The results of the stepwise regression carried out on twenty-three (23) socio-economic predictor variables are shown in Tables 2, 3 and 4. From the 23 variables regressed, 14 variables were significant predictors of the income status of female pastoralists ($p < 0.05$). The average monthly income of women pastoralists was adopted as an indicator or measure of the level of economic sustainability among women pastoralists in the Sahelian region (Hatfield & Davies, 2006). The results show the sequencing of predictor variables that account for variance in the outcome variable, which is the monthly income of female pastoralists.

Table 2: Model Summary Showing the Socio-Economic and Environmental Predictors of Sustainable Pastoralism among Women

Predictor Variables Entered	R	R^2	Adj. R^2	Change Statistics		
				ΔR^2	ΔF	Sig. F Chg.
(a) Length of time or experience in pastoralism	.361	.130	.130	.130	342.186	.000
(b) Highest educational level attained	.391	.153	.152	.022	60.708	.000
(c) Participation in household livestock raising	.413	.171	.170	.018	50.633	.000
(d) Household ownership of large livestock	.422	.178	.176	.007	19.205	.000
(e) Period of observed climate change	.427	.182	.180	.004	12.303	.000
(f) Number of out-of-school children in the household	.430	.185	.183	.003	8.538	.004
(g) Availability of household transportation means	.434	.188	.186	.003	8.891	.003
(h) Access of female household members to healthcare personnel	.436	.190	.188	.002	5.582	.018
(i) Involvement in non-agricultural economic activities	.438	.192	.189	.002	4.968	.026
(j) Involvement in food crop farming	.440	.194	.190	.001	4.027	.045
(k) Household ownership of small livestock	.442	.195	.191	.002	4.607	.032
(l) Number of daily rest/sleeping hours	.444	.197	.192	.001	4.025	.045
(m)Membership of community development committees	.445	.198	.194	.001	4.022	.045
(n) Age of female respondent	.447	.200	.195	.001	4.049	.044

Notes: ΔR^2 = *r* Square Change; ΔF = F Change; Sig. F Chg. = Sig. F Changed

Source: Authors' computations.

Table 3: ANOVA Table for the Final Model

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	184.070	14	13.148	40.507	.000
Residual	738.430	2275	.325		
Total	**922.500**	**2289**			

Table 4: Coefficients for the Final Model

Model Variables Entered	Stand. Coeff. Beta	T	Sig.	R	Coll. Tol.
(a) Constant		8.823	.000		
(b) Length of time or years of experience in pastoralism	0.307	13.474	.000	0.272	.676
(c) Level of formal educational attained	0.142	7.029	.000	0.146	.858
(d) Non-participation in household livestock raising	-.093	-3.952	.000	-0.083	.640
(e) Non-ownership of large livestock by household	-.063	-3.183	.001	-0.067	.890
(f) Length of time or years of awareness of observed climate change	0.063	3.106	.002	0.065	.869
(g) Number of out-of-school children in the household	-0.068	-3.489	.000	-0.073	.938
(h) Non-availability of household transportation means	-0.068	-3.440	.001	-0.072	.901
(i) Category of healthcare facilities utilized by female household members	-0.043	-2.283	.023	-.048	.995
(j) Non-involvement in other economic sectors	0.053	2.591	.010	.054	.841
(k) Non-involvement in food crop farming	-0.049	-2.272	.023	-.048	.751
(l) Non-ownership of small livestock by household	-0.046	-2.094	.036	-.044	.741
(m)Amount of daily rest/sleep and leisure hours	0.043	2.227	.026	.047	.930
(n) Non-membership of community development committees	0.041	2.085	.037	.044	.901
(o) Age group	0.046	2.012	.044	.042	.669

Notes: Stand. Coeff. Beta = Standardized Coefficients Beta; Coll. Tol. = Collinearity Tolerance
Source: ???

From the variables used in the stepwise regression in Table 2, it was observed that 14 variables were significant predictors of socio-economic sustainability as typified by the income of female pastoralists. The results in Table 3 show that a combination of all 14 significant predictors ((a) to (n)) contributed significantly to higher income for female pastoralists {$F(14, 2275) = 40.51, p < 0.05$}. The multiple correlation in Table 2 was $r = 0.447$, which accounted for 20.0% ($R^2 \times 100\%$) variance in the income status of women pastoralists. The tolerance values in Table 4, which were measures of the correlation among the predictor variables, were far above zero. High tolerance values indicate weak correlations among the variables, which is acceptable. This indicates a low level of multicollinearity (tolerance values = 0.676, 0.858, 0.640, 0.890, 0.869, 0.938, 0.901, 0.995, 0.841, 0.751, 0.741, 0.930, 0.901 and 0.669) for the predictors (a) to (n).

The standardized coefficient (β) for variable (a), having a t value which was significant at $p < 0.05$, indicates that the length of time or experience in

pastoralism had the most predictive power ($\beta = 0.31$; $p < 0.05$); and contributed 13% ($R^2 \times 100\%$) in enhancing the socio-economic status of pastoralist women {$\Delta R^2 = 0.13$, F (1, 2288) = 342.19; $p < 0.05$). This indicates that the length of time or years of experience in pastoralism among women increased their socio-economic capacity (income) for sustainable pastoralism ($r = 0.27$). The study by Warkineh and Gizaw (2019) supports the fact that the experience of women pastoralists plays a big role in enhancing their socio-economic sustainability. Years of experience are garnered right from a young age when girls are taught a range of indigenous knowledge and skills through informal processes. As pastoral girls build on experience, they become more equipped with the knowledge and skills for improving their income from pastoralism.

The level of formal education attained, (b), emerged as the second most significant predictor of the socio-economic status of women pastoralists, having a standardized coefficient (β) = 0.14; $p < 0.05$), and a t value that was significant at $p < 0.05$. Variable (b) contributed 2.2% ($\Delta R^2 \times 100\%$) in enhancing the socio-economic status of pastoralist women {$\Delta R^2 = 0.02$, F (1, 2287) = 60.71; $p < 0.05$). The results indicate that the level of formal education attained by pastoral women increased their socio-economic capacity (income) for sustainable pastoralism ($r = 0.15$). The level of education (either formal, informal or both) of pastoral women is tied to their level of experience. The more years of involvement in pastoralism, the more indigenous knowledge is gained. Usman (2010) has shown the ability of Sahelian women pastoralists to apply indigenous knowledge systems—i.e., skills derived from the cognitive, aesthetic, spiritual, and moral educational components of their traditional literacy—in enhancing the sustainability of their pastoral livelihood. On their part, Warkineh and Gizaw (2019) suggest the need to integrate the knowledge and skills of marginalized pastoral groups into formal schooling systems for an improved outcome.

Non-participation in household-owned livestock raising, (c), emerged as the third significant predictor of the socio-economic status of female pastoralists, having a standardized coefficient (β) = -0.09; $p < 0.05$), and a t value that was significant at $p < 0.05$. Variable (c) contributed 1.8% ($\Delta R^2 \times 100\%$) in enhancing the socio-economic status of pastoralist women {$\Delta R^2 = 0.018$, F (1, 2286) = 50.63; $p < 0.05$). In some cases, women pastoralists were by then not involved in livestock raising due to the loss of livestock as a result of illness, poverty, drought, banditry, internal displacement of families due to insecurity, etc. The results indicate that the more the instances of non-participation of women in household-owned livestock raising, the less their socio-economic capacity (income) for sustainable pastoralism ($r = -0.08$). In other words, the involvement of women in household-owned livestock raising improved their socio-economic capacity. This implies that women are economically influential to the economic success of pastoral households (Onyima, 2021), especially as they are involved in direct household-owned livestock production (herding);

and in direct and indirect livestock complementary activities (such as milking, cheese-making, leatherworks, etc.); and in the sale of livestock products.

Non-ownership of large livestock by household, (d), emerged as the fourth significant predictor of the socio-economic status of female pastoralists, having a standardized coefficient (β) = -0.06; $p < 0.05$), and a t value that was significant at $p < 0.05$. Variable (d) contributed 0.7% ($\Delta R^2 \times 100\%$) in enhancing the socio-economic status of pastoralist women {$\Delta R^2 = 0.007$, F (1, 2285) = 19.21; $p < 0.05$). The results indicate that the more the instances of non-ownership of large livestock by a household, the less their socio-economic capacity (income) for sustainable pastoralism (r = -0.067). In other words, ownership of large livestock by a household improves a pastoral woman's economic status. The results of this study indicate that large livestock are however economically more viable, though more labour intensive. This is similar to what Kristjanson et al. (2010) stated: that the ability of a household to meet its material needs is based not just on income or material wealth, but also on its assets. The assets—which could be social, human, natural or financial—determine how a pastoral household can sustainably cope with risks and shocks. According to Sen (1997), assets provide the basis of agency, or the "… power to act, to reproduce, challenge or change the rules that govern the control, use and transformation of resources."

The length of time or years of awareness of observed climate change, (e), emerged as the fifth significant predictor of the socio-economic status of female pastoralists, having a standardized coefficient (β) = 0.06; $p < 0.05$), and a t value that was significant at $p < 0.05$. Variable (e) contributed 0.4% ($\Delta R^2 \times 100\%$) in enhancing the socio-economic status of pastoralist women {$\Delta R^2 = 0.004$, F (1, 2284) = 12.30; $p < 0.05$). The results indicate that the more the length of time or years of awareness of observed climate change, the more their socio-economic capacity (income) for sustainable pastoralism (r = 0.07). Climate change can affect different demographic groups in different ways, making some more vulnerable than others. According to Baheley et al., (2018), women pastoralists are more vulnerable to climate change risks compared to male pastoralists due to social inequalities that affect their ability to adapt effectively. Xie et al. (2022) suggested that the knowledge of climate change, including the effectiveness of adaptation measures deployed in adapting to the challenges posed by climate change, is related to the income, amongst other socio-economic factors of agro-pastoralists. Kemal et al. (2022) reported that access to climate change information was one of the determinants of the type and success of adaptation measures adopted by pastoralists. Some of the adaptation measures used by the Sahelian women pastoralist interviewed in this study include adjusting breeding seasons, inter-specie breeding, construction of watering holes/reservoirs, building enclosures for the animals, engaging in part-time crop farming, partaking other non-agriculture based socio-economic activities, and securing credit facilities.

The number of out-of-school children in a household, (f), emerged as the sixth significant predictor of the socio-economic status of female pastoralists, having a standardized coefficient (β) = -0.07; $p < 0.05$), and a t value that was significant at $p < 0.05$. Variable (f) contributed 0.3% ($\Delta R^2 \times 100\%$) in enhancing the socio-economic status of pastoralist women {$\Delta R^2 = 0.003$, F (1, 2283) = 8.54; $p < 0.05$). The results indicate that pastoral households having more out-of-school children were associated with less socio-economic capacity (income) for sustainable pastoralism (r = -0.073). Agu et al. (2018), Kibret and Abebe (2019), and Ali (2019), reported that a high number of out-of-school children characterized pastoral communities, and this was due to social and economic factors that include the pre-occupation of female children in herding, farming and other home chores. Other factors include early marriage, lack of parental interest and support for girl education, preference for religious education, poverty, early demise of parent(s), absence of government educational interventions in pastoral communities, and long distance and insecurity on the way to school. Raymond (2021) opines that formal education among female pastoralists facilitates the capabilities of female pastoralists in sustaining better household livelihoods.

The non-availability of household transportation means, (g), emerged as the seventh significant predictor of the socio-economic status of female pastoralists, having a standardized coefficient (β) = -0.068; $p < 0.05$), and a t value that was significant at $p < 0.05$. Variable (g) contributed 0.3% ($\Delta R^2 \times 100\%$) in enhancing the socio-economic status of pastoralist women {$\Delta R^2 = 0.003$, F (1, 2282) = 8.89; $p < 0.05$). The results indicate that the more the instances of non-availability of household transportation means, the less the women's socio-economic capacity for sustainable pastoralism (r = -0.072). This implies that the availability of household transportation means enhances their socio-economic capacity for sustainable pastoralism. Lambert-Derkimba (2015) asserts that mobility is crucial for the majority of pastoral systems worldwide. Because transhumance and nomadic pastoralism are being threatened, the option of an affordable means of transportation required to move livestock to the market, or for the relocation of households and livestock to better resource areas, is essential to pastoralists. Most women pastoralists in the study area claimed ownership of bicycles, motorcycles and tricycles. Apart from the use of transportation means for relocation, pastoral women utilized motorcycles and tricycles to generate supplementary income by providing transportation services to community members.

The category of healthcare female household members had access to, (h), emerged as the eighth significant predictor of the socio-economic status of female pastoralists, having a standardized coefficient (β) = -0.043; $p < 0.05$), and a t value that was significant at $p < 0.05$. The categories of health care utilized by female household members ranged from home or family care (arbitrarily having the least coding value), to traditional care, government

health care facilities, non-governmental organization clinics, and private physicians (arbitrarily assigned the highest coding value). Variable (h) contributed 0.2% ($\Delta R^2 \times 100\%$) in enhancing the socio-economic status of pastoralist women {$\Delta R^2 = 0.002$, $F(1, 2281) = 5.58$; $p < 0.05$). The results indicate that female members of lower-income households utilized higher-level health facilities provided by the federal and state governments, private health facilities, and facilities run by NGOs ($r = -0.048$), most of which offered services at low costs, and sometimes free. However, the use of home treatment was more associated with low-income earners compared to higher-income earners.

The low-cost health services provided by the federal and state governments, as well as international NGOs, make high-quality health care available to female pastoralists of different socio-economic statuses in the Sahelian region. As such, access to quality healthcare is usually not impinged by the income status of households, thus enhancing their socio-economic capacity for sustainable pastoralism. However, findings by Wulifan et al. (2022), and Jebena et al. (2022), suggest that pastoral women have the least access to health services due to several socio-economic and political factors, including the non-availability of standard health infrastructure and skilled health workers, remoteness of pastoral communities, low quality of health services provided in primary health care centres, discrimination and marginalization of pastoral women, vulnerability due to political conflicts, poverty, gender roles depriving women of autonomy in decision-making, socio-cultural norms requiring non-exposure of women to health workers, and uninformed perceptions concerning orthodox health services.

Non-involvement of pastoral households in other economic sectors, (i), emerged as the ninth significant predictor of the socio-economic status of female pastoralists, having a standardized coefficient (β) = 0.053; $p < 0.05$), and a t value that was significant at $p < 0.05$. Variable (i) contributed 0.2% ($\Delta R^2 \times 100\%$) in enhancing the socio-economic status of pastoralist women {$\Delta R^2 = 0.002$, $F(1, 2280) = 4.97$; $p < 0.05$). The results indicate that more instances of non-involvement of pastoral households in other economic sectors were associated with lower income status ($r = -0.072$). The involvement of pastoral women in non-agricultural activities as complementary sources of income is an adaptive strategy enhancing their socio-economic capacity for sustainable pastoralism (Lambert-Derkimba, 2015; Idoma et al., 2022). This implies that the diversification of the economic activities of women pastoralists to other non-agricultural businesses improves their income. This explains that pastoral women who are engaged only in agricultural activities are less socio-economically enhanced than those who diversify to other occupations. These results support the need for the training of pastoral women for better productivity in the non-agricultural sector.

Non-involvement in food crop farming, (j), emerged as the tenth significant predictor of the socio-economic status of female pastoralists, having a standardized coefficient (β) = -0.049; $p < 0.05$), and a t value that was significant at $p < 0.05$. Variable (j) contributed 0.1% ($\Delta R^2 \times 100\%$) in enhancing the socio-economic status of pastoralist women {$\Delta R^2 = 0.001$, F (1, 2279) = 4.03; $p < 0.05$). The results indicate that the fewer the instances of non-involvement of pastoral households in food crop farming, the more their income (r = -0.049). In other words, more involvement of pastoral women in food crop farming enhanced their socio-economic capacity for sustainable pastoralism. Onyima, (2021) reports that pastoral women are involved in food crop farming to supplement income from livestock raising. Gitungwa et al. (2021) and Vincent (2022) report that due to the role of women in ensuring the dietary diversity for their households, they are also engaged in food crop farming to ensure nutritional balance for their respective households and livestock.

Non-ownership of small livestock by pastoral households, (k), emerged as the eleventh significant predictor of the socio-economic status of female pastoralists, having a standardized coefficient (β) = -0.046; $p < 0.05$), and a t value that was significant at $p < 0.05$. Variable (k) contributed 0.1% ($\Delta R^2 \times 100\%$) in enhancing the socio-economic status of pastoralist women {$\Delta R^2 = 0.001$, F (1, 2278) = 4.61; $p < 0.05$). The results indicate that the fewer the instances of non-ownership of small livestock by pastoral households, the more their socio-economic capacity for sustainable pastoralism (r = -0.044). This suggests the economic viability of small livestock reared by female pastoralists. Some female pastoralists limit themselves to raising small livestock, such as chickens, goats and sheep. Others combine both small livestock with large livestock, mostly cattle. The diversity of livestock is seen as one of the adaptive measures for pastoralists (Kemal et al., 2022). Findings by Adams et al. (2021) suggest that small ruminant livestock provide more non-market (non-cash) value compared to market (cash) value.

The amount of daily rest/sleep hours by pastoral women, (l), emerged as the twelfth significant predictor of the socio-economic status of female pastoralists, having a standardized coefficient (β) = 0.043; $p < 0.05$), and a t value that was significant at $p < 0.05$. Variable (l) contributed 0.1% ($\Delta R^2 \times 100\%$) in enhancing the socio-economic status of pastoralist women {$\Delta R^2 = 0.001$, F (1, 2277) = 4.03; $p < 0.05$). The results indicate that more daily sleep/rest hours by pastoral women enhanced their socio-economic capacity for sustainable pastoralism (r = 0.047). The findings show that female pastoralists work longer hours than males (Eneyew & Mengistu, 2013). This is because a considerable proportion of women's working hours is spent on unpaid household work and care, leaving less time for livestock management and rest. This has been similarly reported by Pierotti et al. (2022). Drought conditions require pastoral women to go long

distances in search of water for livestock and household use, leaving little or no time for the rearing of livestock and processing of their associated products, as well for rest.

Non-membership to community development committees, (m), emerged as the thirteenth significant predictor of the socio-economic status of female pastoralists, having a standardized coefficient (β) = 0.041; $p < 0.05$), and a t value that was significant at $p < 0.05$. Variable (m) contributed 0.1% ($\Delta R^2 \times 100\%$) in enhancing the socio-economic status of pastoralist women {$\Delta R^2 = 0.001$, F (1, 2276) = 4.02; $p < 0.05$). The results indicate that the more the instances of non-membership to community development committees by pastoral women, the more their socio-economic capacity for sustainable pastoralism ($r = 0.044$). In other words, women pastoralists who were not members of community development committees were more economically empowered compared to those who were members. It may be possible that community development committees were seen as not being relevant to economically enhanced female pastoralists. However, lower-income pastoralists seemed more involved in community development committees, perhaps due to the need for economic empowerment. The findings by Badejo et al. (2017) stressed the importance of self-help groups in engaging pastoral women towards improving their livelihood in an environmentally and socially constraining environment.

The age of female pastoralists, (n), emerged as the fourteenth and last significant predictor of the socio-economic status of female pastoralists, having a standardized coefficient (β) = 0.046; $p < 0.05$), and a t value that was significant at $p < 0.05$. Variable (n) contributed 0.1% ($\Delta R^2 \times 100\%$) in enhancing the socio-economic status of pastoralist women {$\Delta R^2 = 0.001$, F (1, 2275) = 4.05; $p < 0.05$). The results indicate that the higher the age of a female pastoralist, the more their socio-economic capacity for sustainable pastoralism ($r = 0.042$). The age of a female pastoralist is tied to her years of experience. According to Fernández-Giménez et al. (2022), the identity of a pastoralist is shaped by social inequalities based on gender, race, ethnicity, class, and age. In other words, pastoralists could either be at an advantage or disadvantage socio-economically due to the structure of a society based on the stated demographics. The influence of age and gender-specific labour demands can pose certain constraints to young pastoralists of either gender (Prall et al., 2018). According to Usman (2010) and Badejo et al. (2017), younger female pastoralists, who are less experienced, are usually under the tutelage of older and more experienced women in self-help groups, wherein indigenous knowledge is exchanged, to garner more experience to adapt effectively to the rigours of pastoralism. Livestock management for optimum productivity is part of the experience gained from older herders.

Conclusion and Recommendation

Socio-economic structures play a large role in either enhancing or undermining the success of women engaged in pastoralism. The findings from the synthesis of the literature and fieldwork indicate factors that can enhance sustainable pastoralism among women to include their experience in pastoralism, level of formal education, ownership of large livestock, period of awareness of climate change, number of out-of-school children in their households, availability of means of transportation for a household, quality of healthcare facilities utilized, involvement in non-agricultural economic activities, amount of daily sleep and rest hours, membership to community development groups, and the age-group of pastoral women. These socio-economic parameters provide the basis for policies and interventions that are specially targeted at pastoral women in pastoral communities in the Sahel region. National and state policies and legislations—such as the setting up of 'cattle colonies', particularly in recent years—have largely been in response to the rising security challenges in the region. Nigeria's National Livestock Transformation Plan was also designed to bring about an incremental shift from open grazing to ranching, reducing the movement of herding communities, modernizing livestock management, and improving agricultural productivity. The implementation of these policies, though beneficial to both male and female pastoralists, has been met with challenges concerning indigenous tribe ownership, and the title to land resources.

This study does not belittle the importance of the security challenges facing herders in general, but also brings to the fore the dynamics of other socio-economic issues that could help enhance the sustainability of pastoralism among female herders. For instance, enhanced access to education for pastoralist communities, and women in particular, is still a crucial starting point. Basic education in government-owned schools should be free and accessible. Also, cultural narratives against girls/women's education should be erased through awareness programmes, which could be piloted by government, non-governmental and religious agencies. Such social and awareness programmes should portray a recognition that gender-based norms and roles should be more flexible. For instance, social norms and narratives should encourage more involvement of men in household tasks to reduce the double labour burden on women.

Moreover, self-help or community development groups should be encouraged. These groups should be empowered to operate as cooperative societies that provide short-term loans for their members as capital for the purchase of livestock younglings. Females who own large or small livestock are more economically enhanced than herders without livestock, who resort to tending the livestock of others for minimal compensation. Female herders should be encouraged not to limit themselves to agricultural activities, especially when opportunities present themselves in non-agricultural sectors, such as lucrative

downstream occupations like processing and trading of output from farms, artisanship, as well as service in industries, transportation, government and private institutions. Such opportunities augment income from pastoralism, especially during extreme environmental episodes such as drought conditions. Access to affordable health care is an important factor in enhancing the sustainability of female pastoralists. The primary health care plan of the Nigeria government has been particularly effective in meeting the health needs of communities in remote areas, though not without its challenges. Mobile clinics would be especially convenient in reaching out to transient nomadic communities. At the societal level, civil society organizations, government ministries responsible of women's affairs and youth development, and private sector groups: all need to carry out demonstrations in local dialect, including the context of social norms that could be adjusted to influence increased acceptance of gender equitable norms in aspects such as asset ownership and liberal decision-making. Also, the growing participation of pastoralist women in community leadership and politics in general should be encouraged. This is necessary to enable pastoralist women, and other women in leadership positions, to continue mentoring younger women to grow and emerge successful from their challenging contexts.

Acknowledgement: This work was carried out with the aid of a grant from the International Development Research Centre (IDRC), Ottawa, Canada; that was awarded in partnership with the Supporting Pastoralism and Agriculture in Recurrent and Protracted Crisis (SPARC) Programme, which is funded by the United Kingdom's Foreign, Commonwealth and Development Office (FCDO). However, opinions stated in this paper are those of the author(s), and do not necessarily reflect the policies or opinions of the IDRC, FCDO or partners.

References

Adams, F., Aidoo, R. & Wongnaa, C. A. (2021). Economic Benefits of Livestock Management in Ghana. *Agricultural and Food Economics*, 9(1): 1–17. https:// doi. org/10.1186/s40100-021-00191-7.

Agu, A. O., Ejigu, M., Yimam, S., Gidey, M., Mamo, E. & Mollarences, S. (2018). Pastoralism, Gender and Girls Education in Afar and Somali Regions of Ethiopia: Structural and Institutional Reforms for Promoting Collective Action. *International Journal of Education and Human Developments,* 4(2): 9–20. https://ijehd.cgrd.org/ images/vol4no2/2.pdf.

Ali, A. I., (2019). Challenges of Nomadic Pastoralists in Availing Primary Education to their Children, Focusing on Hawd Region of Somaliland. *American Research Journal of Humanities Social Science,* 2(2): 28–47. https://www.arjhss.com/wp-content/ uploads/2019/02/D222847.pdf.

Ayoade, J. O. (2011). *Introduction to Climatology for the Tropics.* Ibadan, Nigeria: Spectrum Books Limited.

Badejo, A.F., Majekodunmi, A.O., Kingsley, P. et al. (2017). The Impact of Self-Help Groups on Pastoral Women's Empowerment and Agency: A Study in Nigeria. *Pastoralism* 7: 28. https://doi.org/10.1186/s13570-017-0101-5.

Balehey, S., Tesfay, G. & Balehegn, M. (2018). Traditional Gender Inequalities Limit Pastoral Women's Opportunities for Adaptation to Climate Change: Evidence from the Afar Pastoralists of Ethiopia. *Pastoralism*, 8(1): 1–14. https://doi.org/ 10. 1186/s13570-018-0129-1.

Bationo, A., Kihara, J., Waswa, B., Ouattara, B. & Vanlauwe, B. (2005). Technologies for Sustainable Management of Sandy Sahelian soils [Conference Session]. First Symposium on the Management of Tropical Sandy Soils for Sustainable Agriculture: A *Holistic Approach for Sustainable Development of Problem Soils in the Tropics.* FAO Regional Office for Asia and the Pacific, Bangkok 10200, Thailand. https:// www.fao.org/3/ag125e/AG125E32.htm.

Blench R. M. (1994). The Expansion and Adaptation of Fulbe Pastoralism to Subhumid and Humid Conditions in Nigeria. In: *Cahiers d'études africaines, 34*, 133–135*, L'archipel peul*, 197–212; https://doi.org/10.3406/cea.1994.2047.

Blench, R. M. (2001). Pastoralism in the New Millennium. FAO: *Animal Health and Production Series*, No 150.

Brottem, L. & McDonnell, A. (2020). *Pastoralism and Conflict in the Sudano-Sahel: A Review of the Literature.* Washington DC: Search for Common Ground. https:// www. sfcg.org/wp-content/uploads/2020/08/Pastoralism and Conflict in the Sudano-Sahel Jul 2020.pdf.

Djordjević-Milošević, S., Milovanović, J. (2020). Pastoralism: Indigenous Way of Mitigating Climate and Poverty Risk. In: Leal Filho, W., Azul, A., Brandli, L., Özuyar, P., Wall, T. (eds) Zero Hunger. Encyclopedia of the UN Sustainable Development Goals. Springer, Cham. https://doi.org/10.1007/978-3-319-69626-3_89-1.

Eneyew, A. & Mengistu, S. (2013). Double Marginalized Livelihoods: Invisible Gender Inequality in Pastoral Societies. *Societies*, 3(1): 104–116. https://doi.org/10.3390/ soc3010104.

Fernández-Giménez, M. E., Ravera, F. & Oteros-Rozas, E. (2022). The Invisible Thread: Women as Tradition Keepers and Change Agents in Spanish Pastoral Social-Ecological Systems. *Ecology and Society* 27(2):4. https://doi.org/10.5751/ES-12794-270204.

Furusa, Z. & Furusa, M. (2014). Women's Coping and Adaptation Capacities in Pastoralist Communities in Africa: Dealing With Climate Variability and Change. *Agenda,* 28(3): 65–72, https://DOI: 10.1080/10130950.2014.951218.

Gitungwa, H., Gustafson, C. R., Jimenez, E. Y., Peterson, E. W., Mwanzalila, M., Makweta, A., Komba, E., Kazwala, R. R., Mazet, J. A. K. & VanWormer, E. (2021). Female and Male-controlled Livestock Holdings Impact Pastoralist Food Security and Women's Dietary Diversity. *One Health Outlook 3*, (3). https://doi.org/10.1186/ s42522-020-00032-.

Hatfield, R. & Davies, J. (2006). *Global Review of the Economics of Pastoralism*. The World Initiative for Sustainable Pastoralism (WISP) and World Conservation Union (IUCN), Nairobi, Kenya.

Heinrigs, P. (2010). Security Implications of Climate Change in the Sahel Region: Policy Considerations. OECD, Sahel and West Africa Club Secretariat. https://www.oecd.org/swac/publications/47234320.pdf.

Idoma, K., Buba, S. & Gabriel, J. O. (2022). Adaptation Strategies to Climate Variability by Pastoralists in Akko Local Government of Gombe State, Nigeria. *African Journal of Geographical Sciences*, 3(1). https://ajgs.com.ng/ Journal/ index.php/AJGS/ article/view/7.

IPCC, 2019: Summary for Policymakers. In: *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* [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.- O. Pörtner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (eds.)]. in press.

International Fund for Agricultural Development (IFAD), (2012). *Women and Pastoralism*. Livestock Thematic Papers by International Fund for Agricultural Development, Via Paolo di Dono, Rome, Italy https://www.ifad.org/ documents/ 38714170/ 39148759/ Women+and+pastoralism.pdf/bc1ac853–bfd4–420e-aeae-1d63dd7ea3e1.

International Union for Conservation of Nature–IUCN, (2022). *Sustainable Pastoralism: A Nature-based Solution Proven Over Millennia*. https://www.iucn.org/ crossroads-blog/202206/sustainable-pastoralism-nature-based-solution-proven-over-millennia.

Jebena, M. G., Tesfaye, M., Abashula, G., Balina, S., Jackson, R., Assefa, Y., Kifle, Y., Tesfaye, C., Yilma, M., Hiruy, A., Teklu, A., Bahru, B. A., Assefa, E., Demissie, M., Mitike, G. & Tushune, K. (2022). Barriers and facilitators of maternal health care services use among pastoralist women in Ethiopia: Systems thinking perspective. *Pastoralism*, 12(1): 1–17. https://doi.org/10.1186/s13570-022-00236-6.

Johnsson, T. A. (1992). Procedure for stepwise regression analysis. *Statistical Papers,* 33: 21–29. https://doi.org/10.1007/BF02925308.

Kemal, A., Mohammed, A. and Lelamo, L. (2022) Pastoralists' Adaptation Strategies to Climate Change and Determinant Factors in Korahey Zone, Ethiopia. *American Journal of Climate Change*, 11: 79–102. doi: 10.4236/ajcc.2022.112005.

Kibret, B. W. & Abebe, S. (2019). The Status and Contributing Factors for Students' Dropout in Primary Schools of Pastoralist Areas of Sewena Woreda, Bale Zone, Oromia. *Journal of Education and Practice, 10*(34): 69–81. https://core.ac.uk/ download/pdf/276531377.pdf.

Köhler-Rollefson I. (2016). Innovations and Diverse Livelihood Pathways: Alternative Livelihoods, Livelihood Diversification and Societal Transformation in Pastoral Communities. *Revue Scientifique et Technique (International Office of Epizootics):* 35(2): 611–618. https://doi.org/10.20506/rst.35.2.2529.

Kristjanson, P., Waters-Bayer, A., Johnson, N., Tipilda, A., Njuki, J., Baltenweck, I., Grace, D., and MacMillan, S. (2010). *Livestock and Women's Livelihoods: A Review of the Recent Evidence.* Discussion Paper No. 20. Nairobi, Kenya, ILRI.

Lambert-Derkimba A., Aubron C., Ickowicz A., Touré I., Moulin C.-H., (2015). An Innovative Method to Assess the Sustainability of Pastoral Systems in Their Territories (PSSAF). *Rev. Elev. Med. Vet. Pays Trop.,* 68(2–3): 135–142.

Majekodunmi, A.O., Fajinmi, A., Dongkum, C. *et al.* Pastoral Livelihoods of the Fulani on the Jos Plateau of Nigeria. *Pastoralism* **4**: 20 (2014). https://doi.org/10.1186/s13570-014-0020-7.

National Bureau of Statistics (2020). Nigeria Living Standards Survey (2018/2019) A Survey Report by the Nigerian National Bureau of Statistics (in collaboration with the World Bank). https://nigerianstat.gov.ng/elibrary/read/1123

Niamir-Fuller M. (2016). Towards sustainability in the extensive and intensive livestock sectors. *Revue scientifique et technique (International Office of Epizootics)*, 35(2): 371–387. https://doi.org/10.20506/rst.35.2.2531.

Nicholson, S. E. (2013). The West African Sahel: A Review of Recent Studies on the Rainfall Regime and Its Interannual Variability. *International Scholarly Research Notices, 2013.* https://doi.org/10.1155/2013/453521.

Norwegian Institute of International Affairs (NUPI) & Stockholm International Peace Research Institute (SIPRI). (2021). Climate, Peace and Security Fact Sheet: Sahel. https://www.sipri.org/sites/default/files/NUPI_Fact_Sheet_Sahel_LR5.pdf.

Odjugo, P. A. O. and I. A. Ikhuoria (2003). The Impact of Climate Change and Anthropogenic Factors on Desertification in the Semi-Arid Region of Nigeria. *Global Journal of Environmental Sciences,* 2(2): 118–126.

Onyima, B. N. (2021). Women in Pastoral Societies in Africa. In: Yacob-Haliso, O., Falola, T. (eds.) the *Palgrave Handbook of African Women's Studies*. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-030-28099-4_36.

Ouedraogo, R. & Davies, J. (2016). Enabling Sustainable Pastoralism: Policies and Investments That Optimise Livestock Production and Rangeland Stewardship. *Revue Scientifique et Technique (International Office of Epizootics)*, 35(2): 619–630. https://doi.org/10.20506/rst.35.2.2544.

Pierotti, R. S., Friedson-Ridenour, S. & Olayiwola, O. (2022). Women Farm What They Can Manage: How Time Constraints Affect the Quantity and Quality of Labor for Married Women's Agricultural Production in Southwestern Nigeria. *World Development*, *152*, 105800. https://doi.org/10.1016/j.worlddev.2021.105800.

Prall, S. P., Yetish, G., Scelza, B. A. & Siegel, J. M. (2018). The Influence of Age-and sex-specific Labor Demands on Sleep in Namibian Agropastoralists. *Sleep Health*, 4(6): 500. https://doi.org/10.1016/j.sleh.2018.09.012.

Raymond, A. (2021). Girls' Participation in Formal Education: A Case of Maasai Pastoralists in Tanzania. *Educ Res Policy Prac* 20, 165–185. https://doi.org/ 10. 1007/s10671-020-09273-7.

Schmidt, M. I. (1992). The Relationship Between Cattle and Savings: A Cattle-owner Perspective. *Development Southern Africa*, 9(4): 433444, DOI: 10.1080/ 037683592 08439650.

Seid, M. A., Kuhn, N. J. & Fikre, T. Z. (2016). The Role of Pastoralism in Regulating Ecosystem Services. *Revue Scientifique et Technique (International Office of Epizootics)*, 35(2): 435–444. https://doi.org/10.20506/rst.35.2.2534.

Sen, A. K. (1997). *Choice, Welfare and Measurement*. First Harvard University Press. Cambridge: Mass.

Turner, M. D. & Schlecht, E. (2019). Livestock Mobility in Sub-Saharan Africa: A Critical Review. *Pastoralism* **9:** (13). https://doi.org/10.1186/s13570-019-0150-z.

Umoh, N. R., (2017). Pastoralism in Nigeria's Middle-Belt Region: A Resource or a Curse? *International Journal of Development and Economic Sustainability*, 5(4): 11–30. https://www.eajournals.org.

Usman, L. M. (2010). The Indigenous Knowledge System of Female Pastoral Fulani of Northern Nigeria. In: Kapoor, D., Shizha, E. (eds) *Indigenous Knowledge and Learning in Asia/Pacific and Africa.* Palgrave Macmillan; New York. https://doi. org/10.1057/9780230111813_14.

Vincent K (2022) a Review of Gender in Agricultural and Pastoral Livelihoods Based on Selected Countries in West and East Africa. *Frontiers in Sustainable Food Systems.* 6(908018). doi: 10.3389/fsufs.2022.908018.

Vincent, K. (2022). A Review of Gender in Agricultural and Pastoral Livelihoods Based on Selected Countries in West and East Africa. *Frontiers in Sustainable Food Systems*, *6*, 908018. https://doi.org/10.3389/fsufs.2022.908018.

Warkineh, T. Z. & Gizaw, A. M. (2019). Exploring the Informal Learning Experiences of Women in a Pastoral Community in Ethiopia: The Case of Pastoral Women in Karrayyu. *Studies in the Education of Adults,* 51(2): 250–267, https://DOI:10. 1080/ 02660830.2019.1616932.

World Bank Group (2021). *Historical Climate Data: Nigeria.* https:// climate knowledgeportal.worldbank.org/country/nigeria/climate-data-historical.

World Meteorological Organization (2021). State of the Climate in Africa. https://library.wmo.int/viewer/58070/download?file=1300_State_of_the_Climate_in_Africa_2021_en.pdf&type=pdf&navigator=1.

Weber, K. T. & Horst, S. (2011). Desertification and Livestock Grazing: The Roles of Sedentarization, Mobility and Rest. *Pastoralism* **1**: (19). https://doi.org/10.1186/ 2041-7136-1-19.

Wulifan, J. K., Dordah, A. D. & Sumankuuro, J. (2022). Nomadic Pastoralists' Experience Accessing Reproductive and Maternal Healthcare Services in Low and Middle-income Countries: A Contextual Scoping Review. *Pastoralism*, 12(1): 1–18. https://doi.org/10.1186/s13570-022-00261-5.

Xie, S., Ding, W., Ye, W. & Deng, Z. (2022). Agro-pastoralists' Perception of Climate Change and Adaptation in the Qilian Mountains of Northwest China. *Scientific Reports,* 12(1): 1–15. https://doi.org/10.1038/s41598-022-17040-2.