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SUSTAINABLE AGRICULTURE AND LIVELIHOOD OUTCOMES: EVIDENCE FROM FARMERS ORGANIZATIONS IN TUBAH SUB-DIVISION, CAMEROON

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ABSTRACT

Agriculture is the main economic sector in most developing countries and accounts for more than 50% of the population. Low agricultural productivity, which is due to unsustainable agricultural practices, is a major negative contributor to farmers' livelihoods. The continuous use of fertilizers, pesticides and herbicides has led to low agricultural productivity, low soil fertility, unfavorable economic returns, and food poisoning due to unsustainable agricultural practices. Therefore, this study aimed to explore the effects of sustainable agriculture on livelihoods outcomes of farmers organizations in Cameroon. The data was elicited via survey questionnaire administered on the sample of 114 registered and 88 unregistered farmer organizations comprised of common initiative groups and cooperatives giving a total sample of 202. Using cluster sampling approach, proximity villages were grouped into four clusters of villages and stratified sampling was then used to selected members of the organizations to participated in the study. We used instrumental variable least square two stage and control function regression estimation techniques. Results revealed that sustainable agriculture have a negative significant contribution to the livelihood of farmer organisations to the tune of 21.1%. The negative contribution is explained in the usage of overdose chemical fertilizers, insecticides and pesticides as instruments of agricultural sustainability. This study recommended that policies directed towards agricultural sustainability should be soil nutrients and water friendly such as the use of organic fertilizer, bio pesticides, to reduce the negative effect of unsustainable agricultural practices on livelihood of farmers in Cameroon. It is therefore necessary to promote and adopt organic fertilizers on farms by farmer, bio pesticides and encourage farming methods such as crop rotation that maintain the soil fertility.

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INTRODUCTION

Agriculture is the backbone of the economy of most developing countries and in the provision of food and fibre. The contribution of agriculture to the promotion of economic development and livelihood outcomes cannot be over-emphasized. Being an important component of rural development, agriculture is considered one of the major pillars of Cameroon's national economy as it employs about 70% of the economically active population and accounts for about 80% of the primary sector's contribution to the country's GDP. It also provides 1/3 of foreign exchange revenue and 15% of the state budget. Despite this enormous potential, Cameroonian agriculture faces a variety of challenges that limit the country's ability to meet growing food needs adequately (Omorogiuwa et al., 2021). Most farmers in Cameroon are small-scale peasant farmers, producing around 80% of the country's food crops. Given a growing population, the use of non-environmentally sustainable agricultural inputs, and widespread changes in agricultural and forestry land use, trends in food production appear uncertain or rather stagnant, as research indicates that projected/expected agricultural production needs often exceed actual production (Epule & Bryant, 2016)

Taking the global importance of agriculture, the concerning debate among many stakeholders is food insecurity issues especially after the Covid-19 pandemic looming worldwide. Due to an increase in food trade deficit, there have been in increase in food insecurity. The agricultural sector is an essential source of growth to balance imports and exports gaps as well as management of international trade relations (Sridhar et al., 2019). Due to trade deficits, most developing countries like Cameroon on have adopted imports substitution policy in order to reverse the trends.

With sudden outbreak of COVID-19, trade, transportation, inflation and rising debt have hit the sector hard. The announcement of a nationwide lockdown has exacerbated the situation, leading to labor shortages, fertilizer shortages, supply and demand imbalances and post-harvest problems due to social distancing, increase in prices and flight restrictions. Due to post COVID-19 pandemic, agriculture faces tremendous challenges to meet the growing demand for food. Factors such as health and nutrition-based food, improved security, poverty reduction and environmental sustainability have been critical since the outbreak (Cain, 2021). Increasing agriculture and food production capacity with a focus on safety and sustainability has become a top priority during and after the pandemic as a means to sustain livelihood.

Livelihood is seen as a mechanism to promote development and encourage people to move away from the harmful exploitation and degradation of natural resources. Livelihood comprises of the capabilities, assets (including both material and social resources) and activities required for a means of living (Natarajan et al., 2022). Livelihood is sustainable when it can cope with and recover from stress/shocks and maintain or enhance its capabilities and assets both now and in future, while not undermining the natural resource base (Schneiderat et al., 2003). In order to better understand how people, develop and maintain livelihood, the UK Department for International Development (DFID), building on work of practitioners and academics, developed the sustainable livelihood framework (SLF).

The framework is an analysis tool, useful in understanding the many factors that affects person’s livelihood and how those factors interacts with each other. Small scale agriculture and livelihood enhancement can be understood where many individuals engage themselves in many activities that contribute to collective livelihood strategies. Livelihoods are also shaped by changing the natural environment. The quality of the soil, air and water; the climatic and geographic conditions; the availability of fauna and flora; and the frequency and intensity of natural hazards al influence livelihood decisions (Fan et al., 2020).

The agricultural sector is the source of income for more than 70% of Cameroonians. Agricultural production, including the various phases from planting, cultivating, tending, harvesting to shipping goods, requires labor inputs (Workie et al., 2020). Dependence on market value chains, food and agriculture sectors are considered less resilient to the pandemic. Sustainable agriculture through safe use of pesticides, modern technology and effective extension services will protect soil health, prevent erosion, reduce water pollution, promote biodiversity and mitigate climate change. This can improve farmers' income by reducing input costs, increasing yields and providing access to higher quality markets for organic or sustainably produced crops.

Using organic fertilizers and other biological alternatives can increase crop yield and replace harmful chemicals. However, these products are expensive and take months to get to market. In recent years, a promising approach to sustainable farming and agriculture has emerged to improve health and achieve economic outcomes (Arora & Mishra, 2016).

Local restrictions and travel bans resulted in limited access to agricultural inputs (seeds, fertilizers, etc.) and low agricultural production (Aromolaran & Muyanga, 2020). These restrictions affected the supply chain and led to shortages and increase in prices of agricultural input in Tubah sub-division. Due to rising prices of agricultural inputs such as seeds, chemical fertilizers, reduced household incomes, lack of availability of inputs and labor shortages in the early months of the pandemic affected the livelihood of farmers organisations in Tubah sub-division. It is for these arguments that this study seeks to analyze the effect of sustainable agriculture on farmers' organization livelihood in Tubah Sub Division, the North West region of Cameroon. This paper is divided into five sections which are; introduction, literature review, methodology, results, and conclusions.

LITERATURE REVIEW

The term "sustainable agriculture" emerged in the late 1980s and was boosted by the study "Alternative Agriculture" by the Board on Agriculture of the National Research Council, indicating a way of farming that should mimic natural ecosystems, and by being introduced in the US Agriculture 1990 Farm Bill (Gomiero, 2015). Wes Jackson is credited to have been the first to use the term "sustainable agriculture" in his publication New Roots for Agriculture in 1980 (Yunlong & Smit, 1994), the term was first used in a 1978 article by Jackson titled "Toward a sustainable agriculture" (Jackson, 1985). In a 1983 paper, Rodale proposed the concept of "regenerative agriculture," referring to the need for agriculture based on the principle of ecological interactions (Harwood, 1990). The concept of sustainable agriculture refers to the adoption of agricultural practices that aim at preserving the natural resource base, especially soil and water, by relying on minimum artificial inputs from outside the farm system and recovering from the disturbances caused by cultivation and harvest, while being economically and socially viable (Gomiero, 2021). According to Zahm et al, Sustainable agriculture is the ability of a farm to produce unlimited amounts of food without seriously or irreparably damaging the health of the ecosystem. The two key issues are biophysical (the long-term effects of different practices on soil properties and processes critical to crop productivity) and socio-economic (farmers' long-term ability to procure and manage resources such as labor (Zahm *et al*., 2006).

Alhassan et al., (2022) assessed the effect of sustainable agriculture on livelihood diversification of rural communities in Niger State by drawing a sampled of twenty percent of villages from each of Kaiji and Shiroro. With a sampled of 309 respondents and using ANOVA, the study establishes that the level of livelihood sustainability of rural households was low, in spite of their high level of livelihood abilities. It was argued that agricultural extension in rural development initiative could improve livelihood sustainability of rural households in Niger State(Alhassan et al., 2022). In a similar study, Rashid et al (2016) analyzes the impact of e-Agriculture on farmers' basic rights and quality of life in Bhatbour Block of Dhighi union under Sadar Upazila of Minikganj District. They found out that e-Agriculture helps the farmers to increase the basic rights and improve their quality of life. The argued that E-Agriculture appears to have reasonably increased respondents' access to basic rights and improved quality of life, as indicted by reduced food insecurity, improved nutrition, food and health, improved clothing, housing, sanitation and drinking water, better healthcare access and education facilities. The founding corroborates the argument posited by Rashid et al. (2016). The claimed that positive changes may influence the development of new policies that supports to enhance farmers' livelihood (Rashid et al., 2016).

In another study, Pradhan et al, (2018) document the impact of dependency on rain fed agriculture on farmer livelihood. By employing ordinary least square regression technique, they found that rainfall and change in weather patterns have affected the yield of field crops that farmers use to sustain their livelihood. In addition, the study showed that there is a great impact on farmer's livelihood, and that there has been a massive effect in the harvest of crops, showing that 50% of the farmers in the area do not harvest more than 40 bags of the staple food, with the small lands that the farmers have (Pradhan et al., 2018).

Samuel Stouffer and his coworkers in their classic social psychological study "The American soldier" introduced the concept of "Relative Deprivation" in 1949. Relative deprivation is perceived as the conscious feeling of a negative discrepancy between legitimate expectations and presents actualities (Singh et al., 2000). Relative deprivation as theoretical concept has been used to analyze contexts perceived injustice and inequality, and is frequently used within the social sciences (Manzi, 2010). Relative deprivation theory claims that a person would feel relatively deprived if he or she (i) lacks an object, (ii) desires it, (iii) sees some other person(s) with that object, and (iv) thinks it is feasible to obtain that object (Lopez, 2012). Manzi (2007) also argued that Relative deprivation is the perceived difference between the material and social conditions that individual's think they should achieve, and the conditions they believe they would achieve which causes relative deprivation (Manzi, 2010). The decreasing availability of physical, environmental and land resources could create a condition of "group identity" and "deprivation "in the area which could provoke violent conflict of high magnitude due to population movement and the scramble for available resources (Gukas, 2018).

The theory of Relative Deprivation reports a gap between just wants and the satisfaction expected wants. Relative deprivation is therefore, the difference between what we need and what we get. A group of people who fail to get a desired improvement in their livelihood conditions, justice, equality, and infrastructural development are deprived. In addition to that, if they are poor, and feel society is morally obliged to provide them with basic necessities, the gap between a just want can generate irritation, anger, frustration and conflict. Thus, the idea of relative deprivation has been used to measure fairness, inequality, social justice, or to explain grievance, social hostility or aggression.

METHODOLOGY

Study area and site selection

The Tubah subdivision is located in the northwestern region Cameroon, about 15 km from Bamenda, the so-calledstate capital. It consists of four main villages Bambili, Bambui, Kedjom-keku and Kedjom-ketinguh, and lies between 4°50' and 5°20'Nlongitude 10°35' - 11°59'E with total population about 52,635 inhabitants. The height varies between 950-1500m, with flat wooded plain some regions. Its wooded area is to the north part of the division. The drainage system is very rich with streams and springs flowing from the north bars. The area has two seasons, dry and rainy runs November through April and May through October respectively. The average annual rainfall is about 2200 mm, July, August and September recording the maximum rainfall and December low. Also, an annual average the temperature is around 20.67 °C in January and February records the maximum and July, August and September lowest temperature (Yuninui, 1990). Imbalance agricultural practices have largely destroyed the forest partly the vegetation and impoverished the fertility of the soil. Likewise, years of overgrazing, burnt grass and, increasing the size of the heavily degraded herd there are pasture plots left.

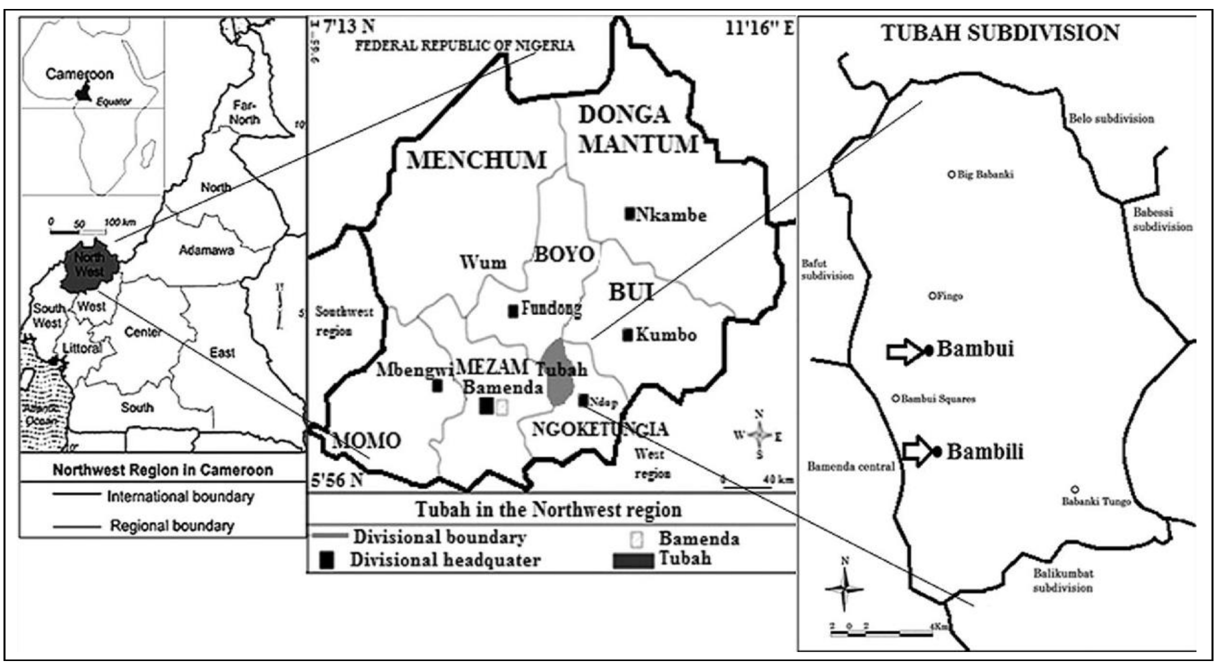

Figure 1. Map of Tubah Sub Division, Northwest Region, Cameroon (Source: Ngwa and Fonjong, 2002a).

Sample Size and Data

The data used in this study was obtained through survey structured questionnaire administered on the sample of 114 registered and 88 unregistered farmers' organizations which comprises of common initiative groups and cooperatives. The principal component analysis was used to assess reliability and validity of the questionnaire. Using cluster sampling approach, proximity villages were grouped into four clusters villages as indicated on Table 1 and stratified sampling was then used to selected members of the organizations to participated in the study.

Table 1. Distribution of Farmers Organisations in Tubah Sub-Division.

Villages	FOs				Total
	Registered FOs		Unregistered FOs		
	CIGs	Cooperatives	CIGs	Cooperatives	
Bambui	42	5	13	18	78
Bambili	23	2	13	4	42
Kedjom Ketinguh	20	2	12	8	42
Kedjom Keku	19	1	14	6	40
Total	104	10	52	36	202

Source: ACEFA Mezam Division, 2018.

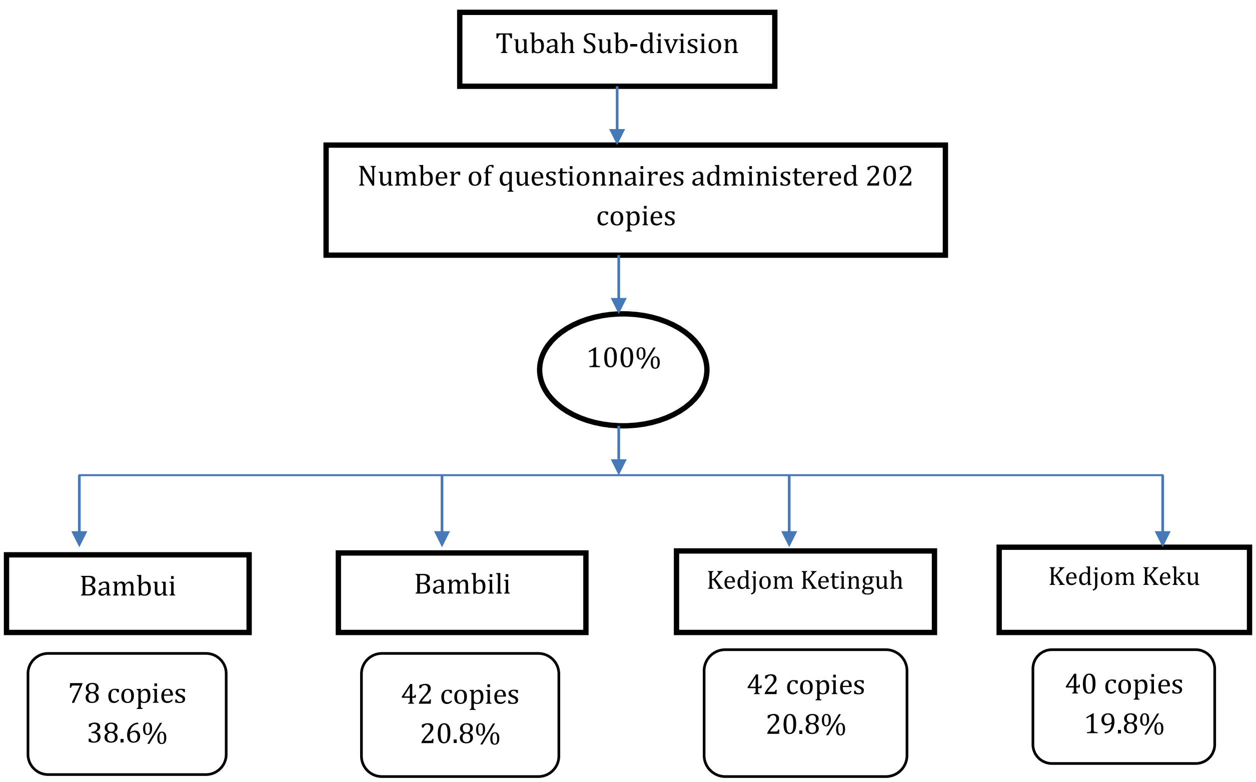

Figure 1. Spatial distribution of effective respondents in the four villages.

Model Specification

In order to analyze the contribution of sustainable agriculture on the livelihood of farmers' organizations in Tubah Sub-Division in this post Covid-19 era we follow the model of Alhassan et al (2022) as they argued that agricultural extension in rural development initiative could improve livelihood sustainability of rural households. The reason of using this model is the multifaceted nature of the variables sustainable agriculture and livelihood of farmer's organization. In another study on investigating the sustainability of agriculture production in plant sector in Latvia, (Lenerts et al., 2017) reported that expansion of agricultural production in the crop sector are mostly accompanied by a loss in natural capital and deterioration of environmental sustainability. The study furthered argued that the loss of natural resources can be attributed to the usage of unsustainable farm inputs.

The dependent variable in the study is an index of farmer's livelihood outcomes of farmer's organization

[LHOF]. The dependent variable livelihood of farmers is an index whiles the explanatory variable sustainable agriculture. Both livelihood and sustainable agriculture are index constructed using the principal component analysis. The reason for generating an index is due to the multifaceted nature of the variable's sustainable agriculture and livelihood of farmer's organization. The Table 2 summarized the indicators.

Table 2. Indicators of Sustainable agriculture.

Item	indicator
Chemical fertilizers reduces soil fertility	I001_1
Deterioration in land and water through soil erosion and nutrient lost	I002_1
Soil and vegetation loss through slash and burn	I003_1
Insecticides/pesticides pollutes fresh water sources	I004_1
Upland farming reduces water catchment potentials	I005_1
Biodiversity lost especially through habitat change	I006_1
Poor yield harvest due to sustainable farming	I007_1
Increase in pest and diseases due to sustainable farming	I008_1
Limited production potential	I009_1
Sustainable agriculture requires specialized knowledge	I010_1
Close monitoring of crops due to sustainable farming	I011_1
Increase vulnerability	I012_1
Poor farm to market roads	I013_1
Limited access to modern farming tools	I014_1
Insecurity at the suburbs	I015_1
Lack of improved and resistant seed varieties	I016_1

Source: Computed by Author (2023)

In order to construct the farmer's livelihood index, the principal component analyses (PCA) was employed since PCA is designed to model relationships between categorical variables in terms of loadings and shared explained variance. The index of livelihood outcome was generated using the formula below. It is assumed that $\boldsymbol{i}$ designated livelihood dimension and LFO is the values of the composite index generated. The mathematical exposition for the index is given by;

$$\boldsymbol{LFO_i} = \frac{\sum_{k=1}^{K}\sum_{jk=1}^{JK} w_{jk}^{k} L_{JK}^{K}}{K} \quad 1.1$$

Where; LFO_i represents livelihood index for all the dimensions or domains considered**;** K is the number of indicators which is 15; JK the value of categorical indicator k; L is the loading of the indicators. The index of livelihood of farmers 'organization was normalized within the range of 0 to 1. The reason for normalizing the scores is to get rid of negative value of the index of livelihood which poses interpretation challenges. In other words, by so doing we get rid of the negative values of the index by adjusting the scores within the range of 0 to 1. The mathematical exposition for the normalized index procedure is outline below;

$$\widetilde{\boldsymbol{LFO_i}} = \frac{(LFO - \text{r(min)})}{(\text{r(max)} - r(\text{min}))} \quad 1.2$$

Where is r(max) is the maximum value while r(min) is the minimum value of LFO raw scores. By the same token of appreciation, sustainable agriculture was also captured. The index was constructed using all the indicators so as not to leave out any facet of the dimension of sustainable agriculture. The model was specified as following the ideology of Lenerts *et al*., (2017).

$$FLO = \vartheta_1 + \vartheta_1 SA + \vartheta_2 PEDU + \vartheta_3 SEDU + \vartheta_4 TEDU + \vartheta_5 Female + \vartheta_5 Married + \vartheta_6 Member + \varepsilon_1 \quad 1.3$$

Where FLO stands for farmers' livelihood; SA represents the exogenous endogenous variable sustainable agriculture. There is possibility of reverse causation between sustainable agricultural and livelihood farmer's organization. PEDU is a dummy variable for primary education, that is, it takes the value 1 if the respondents have attended primary education, 0 otherwise. SEDU and TEDU represent secondary and tertiary education respectively and are also binary. Female stands for gender of the respondents as indicated on description of variables in Table 1.2 While ε_1 captured the idiosyncratic terms which are other variables which can as well effect farmers' livelihood of farmer's organization though are assumed to have mean value of 0 and standard deviation of value 1. While v is vector of the parameters to be estimated using ordinary least square estimation techniques.

However, estimation of the parameters using the ordinary least square without accounting for the strong possibility reverse causality between sustainable agriculture and livelihood farmer's organization might lead to bias estimates. In order to account for the endogeneity of sustainable agriculture in the livelihood function, the study adopts two stage instrumental variable approaches, control function with and without interaction. The appropriate instruments use in the first stage equation is the mean of non-self-sustainable agriculture and farm size [fs] as these variables are assumed to have negligible or no effect of livelihood of farmer's organization. In the first stage we estimated the reduced form equation of sustainable agriculture as observed below.

$$SA = \vartheta_0 + \alpha_1 NonSA + \alpha_2 fs + \vartheta_2 PEDU + \vartheta_3 SEDU + \vartheta_4 TEDU + \vartheta_5 Female + \vartheta_5 Married + \vartheta_6 Member + \varepsilon_2 \quad 1.4$$

Equation 1.4 is the reduced form of sustainable agriculture. The two instruments non-self-sustainable agriculture and farm size are expected to be significant predictors of sustainable agriculture. To address the issue of unobservable variable that could bias the estimated coefficients we included the residual of the reduced form equation of sustainable agriculture as well as the interaction of the residual of sustainable agriculture and sustainable agriculture to account for the nonlinear heterogeneity bias. The inclusion of the control function variables into equation 3.4, lead to the re-specification of the model as suggested in the work of (Baye & Fambon, 2010; Mwabu, 2009; Wooldridge, 2002), The control function was used in its parsimonious form to account for external endogeneity and heterogeneity only as indicated in the equation 1.5.

$$FLO = \vartheta_1 + \vartheta_1 SA + \vartheta_2 PEDU + \vartheta_3 SEDU + \vartheta_4 TEDU + \vartheta_5 Female + \vartheta_5 Married + \vartheta_6 Member + \alpha_0 \varepsilon_2 + \alpha_1 \varepsilon_2 * SA \quad + \varepsilon_3 \quad 1.5$$

Where ε_2 is the fitted residual of sustainable agriculture, derived from the reduced form linear model of sustainable agriculture in equation 3.2; $\varepsilon_2 * SA$ is the interaction effect of the residual of sustainable agriculture and livelihood of farmers' Organization; and ε_3 is the error term. The fitted residual of sustainable agriculture account for unobservable variables are assumed to be correlated with livelihood of farmers' Organization. The interaction term account for the effect of non-linear interaction of unobservable variables with farmer's livelihood. If α estimates are statistically equal to zero following the t and F statistics, it means that the structural parameters of the livelihood function of farmer's Organization can conveniently be estimated using OLS, otherwise control function becomes indispensable.

Table 3. Description of Variables.

Variable	Code	Description
Dependent Variable		
Farmers' livelihood organization	LFO Index	Continuous
Endogenous Exogenous		
Sustainable Agriculture	nor sa	Continuous
Instrumental Variables	Instrument	
Non-self-Sustainable Agriculture	Mean of SA	Continuous
Farm Size	fs	Categorical
Exogenous Variable		
Gender (1=female, 0 otherwise)	Female	Binary
Marital Status (1=Married, 0 otherwise)	Married	Binary
Education (1=Primary education, 0 otherwise)	Pedu	Binary
Education (1=Secondary education, 0 otherwise)	Sedu	Binary
Education (1=Primary Education, 0 otherwise)	Tedu	Binary
Member of farmer of association (1= Cooperative, 0 otherwise)	Cooperative	Binary
Member of farmer of association (1= association, 0 otherwise)	Association	Binary
Control function		
Residual of Sustainable agriculture	sa error1x10^6	Continuous

Interaction of Residual of Sustainable agriculture times sustainable agriculture	sa error interact1x10[6]	Continuous

Source: Computed by Author (2023)

RESULTS AND DISCUSSION

Table 4 shows the descriptive statistics for modeling the effect of sustainable agriculture and livelihood outcomes. Table 4 show that sustainable agriculture has the highest mean of 0.683 with a standard deviation of 0.148. The variable sustainable agriculture is not binary but rather it ranges from 0 to 1. Livelihood outcomes had a mean of 0.547 and this mean varies from 0.270 to 0.824 because of the standard deviation (0.277). The index livelihood outcomes is continuous and not binary, the score ranges from 0 to 1. Also, on average female have a mean of 0.545 and a standard deviation of 0.499 than males. This finding indicates that both female & male farmers were well represented. Balance of opinions is necessary to reduce opinion disparity bias in the study. Its further shows that female farmers are more represented than male counterpart in farmer's organization in the North West region. Married person had a mean of 0.652 and a standard deviation of 0.478, this finding indicates some level of social cohesion. Marital status is a responsibility and stability at individual and community level. Married individuals may be more likely to have grown up in a family with a farming background and continue the tradition. Table 5 shows results of sustainable agriculture on farmer's livelihood outcomes.

Table 4. Descriptive Statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Lo	195	.547	.277	0	1
nor sa	196	.683	.148	0	1
Female	198	.545	.499	0	1
Married	198	.652	.478	0	1
Pedu	198	.338	.474	0	1
Sedu	198	.222	.417	0	1
Tedu	198	.308	.463	0	1
Cooperative	198	.258	.438	0	1
Association	198	.111	.315	0	1
sa error1x10[6]	191	.001	134235.87	-702520	323455.34
sa error interact1x10[6]	191	.00036	91619.301	-493534.34	218831.98

Source: Computed by Author (2023)

Table 5. Results of the Model fitted.

1	Model 1 OLS	Model 2 IV	Model 3 Control Function Without Interaction	Model 4 Control Function With Interaction
VARIABLES	SA	LFO	LFO	LFO
nor_sa		-2.372***	-2.147***	-2.105***
		(0.526)	(0.356)	(0.347)
Nonself -SA	0.7774675*** (0.2003422)	na	na	na
fS	-0.0366716*** (0.0155065)	na	na	na
female	0.0227255 (0.0214324)	-0.00844 (0.0598)	-0.0232 (0.0327)	-0.0202 (0.0315)
married	0.0311067	0.0627	0.0593*	0.0622*

	(0.0223362)	(0.0610)	(0.0354)	(0.0359)
pedu	-0.0508761	-0.0972	-0.0638	-0.0571
	(0.0337293)	(0.0902)	(0.0537)	(0.0520)
sedu	-0.0590983	-0.120	-0.0885	-0.0882
	(0.0361025)	(0.0975)	(0.0604)	(0.0597)
tedu	-0.0207351	-0.120	-0.0961	-0.0958*
	(0.0367643)	(0.0948)	(0.0590)	(0.0568)
cooperative	-0.0085765	-0.146**	-0.165***	-0.159***
	(0.0257407)	(0.0666)	(0.0412)	(0.0406)
association	0.0209455	-0.126	-0.151***	-0.152***
	(0.0352467)	(0.0945)	(0.0578)	(0.0573)
inc_201_400_frs	0.0386606	0.211***	0.135***	0.127***
	(0.0237874	(0.0616)	(0.0354)	(0.0353)
inc_401_600_frs	-.0047557	0.0316	0.0562	0.0609
	(0.0381811)	(0.100)	(0.0632)	(0.0614)
inc_601_1000_frs	0.0105208	0.0275	0.0709	0.0851
	(0.0540257)	(0.139)	(0.0800)	(0.0718)
food_crop	0.0050861	0.00306	-0.0298	-0.0297
	(0.1991158)	(0.0749)	(0.0447)	(0.0445)
Residuals of SA x 10^6	Na	na	2.05e-06***	4.29e-06*
			(3.78e-07)	(2.29e-06)
Interaction of SA with its Residuals x10^6	na	na		-3.35e-06
				(3.23E-06)
Constant	0.1991158	2.199***	2.084***	2.049***
	(0.1502139)	(0.361)	(0.261)	2.049***
R-squared		-0.702		(0.255)
Uncentered R-Square (On excluded Instruments)	Na	0.6509	na	na
Joint F/Chi2(p-value) test for Ho: coefficients on instruments=0	Na	47.149[0.000]	na	na
Weak identification Anderson-Rubin Wald test F(2, 176)	Na	34.29[0.000]	na	na
Anderson canon. corr. LM statistic / Under-identification test	Na	23.711[0.000]	na	na
Sargan statistic (over-identification test of all instruments)	Na	0.9737	na	na
Observations	190	190	190	190

Source: Computed by Author (2023) in STATA 14

Note: The values in the parentheses are the standard errors;*, **, and *** indicates significant at 10%,5% and 1% significantly. na stands for non-applicable.

Table 5 shows sustainable agriculture had a statistically significant negative effect on farmer's livelihood for the instrument variable model, control function without interaction and control function model with interaction. This finding permit us to reject the null hypothesis three in the study which states that sustainable agriculture has no significant effect on farmers 'livelihood outcomes. The implication of this finding is that farmers engage themselves into agricultural practices such as the use of chemical fertilizers, insecticides and pesticides. These practices deteriorate the land and water through soil erosion and nutrient loss and therefore contribute negatively to farmer's livelihood. Farmer's that are married have better livelihood than those not married. This may because married people are more stable and focus on improving their livelihood through farming compare to those that are unmarried. Level of education was found to be negatively associated with farmer's livelihood in the control function model with interaction. This make some intuitive sense in that; more time may have been allocated towards education than farming activities.

Belong to farmer's organization also was found negatively correlated with livelihoods irrespective of whether it is a corporative or association. Even though the relationship was significant implying that farmers are either not practicing the knowledge learning during their interaction as member of farmer's organization or there may be little or no knowledge sharing pooled for farmers. Income level was a significant predictor of farmer's livelihood. The control variable in the control function model with interaction and no interaction in Table 5 revealed that residual of sustainable agriculture was found to be significant indicating that the control function models account for the unobservable variables that correlate with sustainable agriculture in explaining farmer's livelihood. And therefore, use of neither OLS nor two stages least square instrumental variable may produce biased estimators. The first-stage F statistic on excluded instruments increases up to 47.149 (p-value = 0.0000). The Sargan p-value of 0.9737 suggests that the instruments are valid. This implies that the indicators of sustainable agriculture and livelihood outcomes were reliable.

CONCLUSION

The objective of the study was to analyze the effect of sustainable agricultural on the livelihood of farmers Organisation in Tubah sub-division in the post Covid-19 Era, in the North West region of Cameroon using instrumental variables two stage regression, pseudo control function with and without interaction. The result revealed that sustainable agriculture has a negative effect on the livelihood of farmers' organization due to the adoption of unsustainable practices such as usage of insecticides, pesticides and chemical fertilizers just to mention but few. Based on the finding this study recommends that the government policies directed towards agricultural sustainability should be environmentally friendly because of its consequences on the livelihood of the farmers in terms of poor yield. It is therefore necessary for Government to encourage organic fertilizers, bio pesticides and farming methods such as crop rotation and mix farming that protect soil nutrients. The Government should also promote extension services by training farmers on sustainable agricultural practices

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