Determinants in the adoption of Conservation Agriculture in Eastern and Southern Cameroon

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Abstract

Giving more attention to the adoption of conservation agricultural practices (CAPs) will help in improving yields to ensure food security in Sub-Saharan Africa. Therefore, we are prompted to ask questions on the factors determining the adoption and adoption intensity of CAPS among Cameroon's smallholder farmers. Thus, data collected from 350 farmers in South and East Cameroon were used to study the factors that determine the adoption of CAPs amongst these farmers. The study considered agroforestry, intercropping, crop rotation, cover crop, mulching, and zero-tillage as the CAPs under investigation. The study adopted the multivariate and ordered probit models. According to the multivariate probit analysis, our multivariate probit model results showed that gender, age, family size, extension services, use of modern farm technology, distance from house to farm, livestock owned, and infertile soil all significantly influenced CAP adoption. Results on adoption intensity displayed that gender, distance from house to farm, and the number of livestock owned were critical drivers of CAP adoption intensity. According to this study's findings, to promote the adoption of CAPs, policymakers and concerned stakeholders should consider farmer, institutional, and biophysical aspects when developing policies. However, already existing extension services need to be improved upon.

Keywords: Conservation agriculture, Adoption, Intensity, Determinants, Cameroon

1. Introduction

Agriculture is the primary source from which about 70% of farmers in the rural areas derive their livelihood (World Bank, 2016). The World Bank has proved that the agricultural sector provides jobs for almost a 1.3billion farmers in rural settings (World Bank, 2008). Research from Ingutia & Sumelius, 2022; Tsige et al., 2020 has reported that most hungry people globally, are found in growing economies, with Sub-Saharan Africa (SSA) being among the most represented populations. However, rural farmer agriculture is not just a source for food; and it also contributes to a country's economic development.

A more significant share of Sub-Saharan Africa's population depends solely on smallholder agriculture, making it difficult for United Nations to attain its quest of zero poverty (Apraku et al., 2021). As one of the Sub-Saharan African countries, Cameroon has experienced agriculture as one of its primary sources of National income, which has given jobs to 70% of its population force (Molua, 2015). Akamin et al., 2017, reaffirm that agriculture has remained the mainstay of Cameroon's economy though classified as Sub-Sahara Africa’s fifth-biggest oil producer.

Improving poverty and food security is a big challenge to Sub-Saharan African governments; there are a challenge of greenhouse gas (GHG) emissions as a cutting-edge quest in improving food production to combat food insecurity and climate change mitigation (Wekesa et al., 2018; International Center for Tropical Agriculture and World Bank, 2018). Emissions from the interface of improving food production results to climate change, consequently, leading to the alteration of growing seasons and flowering periods in Cameroon (Molua, 2015). However, these climate changes have added up to the existent issues on access to land, decreased cultivable land, drops in soil fertility, and have thus caused uncertainties in production with subsequent low levels of yields (Apraku et al., 2021; Oyetunde-Usman et al., 2021; Nyasimi et al., 2017). Moreover, threats to the welfare of farmers of Sub-Saharan Africa who have proven to hinge on their farms as a basis of living have been attributed to changes in climate change due to an increase in GHGs (Apraku et al., 2021). Climate change has manifested in SSA through mid-season droughts where SSA experience low and consistent rainfall patterns, causing crop failure, with maize being the most hit crop and has experienced harvest failure (Daryanto et al., 2016). This harvest failure causes negative effects on food security.

To cope with these shocks, decision-makers and development agents have promoted the use of agricultural conservation practices across SSA. Methods geared toward conserving soil and water in Zambia and improved seed varieties in Nigeria are examples of these efforts (Awotide et al., 2016).

Therefore, conservation agricultural (CA) techniques are a better proposal as a solution to transform and re-orient Cameroon's agrarian food safety systems in the aspect of climate change (Mcharo & Maghenda, 2021). However, this climate-smart agricultural system "CA" has been brought forth to address three pillars: food security, adaptation and mitigation (FAO, 2013). Therefore, a representative of agricultural intensification can be seen in Conservation agriculture. CA is, consequently, a set of plot-level practices bounded by the following three principles (FAO, 2011);

1) Reducing soil loss (minimal/zero tillage)
2) Preserving everlasting soil cover (Cover crops, intercrops and mulching)
3) Diversifying crop rotations (crop rotation)

These practices are primarily geared towards improving yields and soil fertility. In addition to the benefits mentioned above, CA has the potential to boost carbon-based soil (Brouder and Gomez-Macpherson, 2014).

However, adopting CA brings economic benefits to farmers by improving yields, enhancing food security and economic growth, and improving farmer welfare (Mugumaarhahama et al., 2021; Whitehead et al., 2020; Kassie, 2016). Furthermore, both consumers will enjoy the CA adoption by reducing the use of chemical fertilizers, pesticides, and herbicides, which reduces food contamination (Liu et al., 2020). Despite its numerous benefits, however, adoption rates in SSA are often low (Gurung et al., 2016). Just a little work has been done on adopting agricultural conservation practices in Cameroon (Angwafo and Danernyuy, 2020). This research attempts to close a gap in the adoption of agricultural conservation methods in Cameroon. Thus, our goal is to evaluate the scope of CAP implementation and the intensity of CAP adoption.

2. Methodology

2.1 Study Area

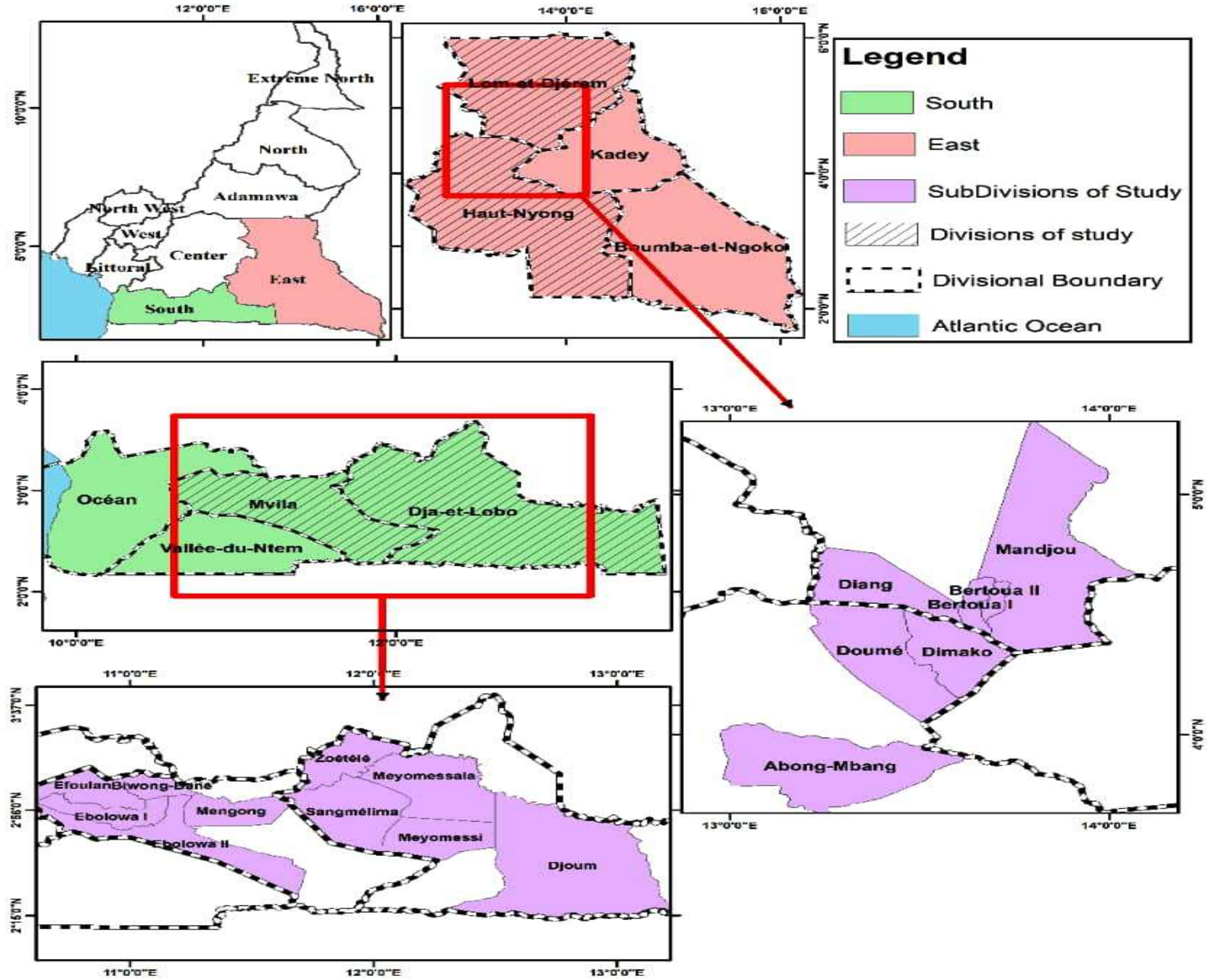

Fig 1. Study area indicating villages under investigation (Source: Authors, 2020)

The research was carried out in Cameroon's south and east regions. The Republic of Cameroon's South Western and South-Central regions make up the South region. The East region borders it on the east, the Centre region on the north, the Littoral region on the northwest, the Gulf of Guinea on the west, and Gabon, and Congo on the south. The South area covers 47,720 square kilometers, making it the country's fourth largest region. The Beti-Pahuin peoples, such as the Ewondo, Fang, and Bulu, are the most important ethnic groups. The South has a lot of industry, with logging, forestry, mining, and offshore oil drilling being the main sources of revenue. Industrial agriculture is also vital in the south, with cocoa and rubber being the most important cash crops. Cattle farming and fishing are also key economic activities. The great bulk of the population are subsistence farmers (Nkondjio et al., 2019).

It is the largest and most sparsely populated region in the country, occupying 109,002 km2 of territory. While the area is rich in flora, but not fertile for nutrients are seeped out from these soils. (Maisels et al., 2014). High temperatures (on average 24°C) and a lack of conventional seasons characterize the East. Rather, this area experiences a dryness from December to May which is lengthy, with a short period of wetness from May to June, and a shorter period of dryness from July to October. This seasonal variation is crowned with an unembellished wetness from October to November. The study area experiences average rainfall of 1500-2000 mm per year, especially the far east and far north, with lesser rainfall averages (Maisels et al., 2014).

2.2 Model Specification

This research employed multivariate Probit (MVP) model in analyzing the aspects prompting CAP acceptance. This model is appealing for evaluating choice behaviour because it allows for a customizable correlation structure for unobservable factors (Huguenin and Fischer, 2020). Furthermore, Teklewold et al. (2019) discovered that MVP estimates differed greatly among all equations examined. However, instead of combining the practices into a sole variable, showing appropriateness of differentiating across practices as heterogeneity in adopting agricultural techniques and study of each unique practice is advocated (Teklewold et al., 2017).

A farmer embracing one agricultural conservation practice (CAP) does not change his likelihood of adopting another CAP. The MVP approach, alternatively, brings out descriptive factors impact on each of the multiple practices whereas accounting for the probable link amid unobserved disruptions and the adoption of alternative practices. Correlation can be caused by either complementarity or substitutability between distinct approaches in this scenario. To avoid bias and inefficient estimations, the link between adopters' actions and unobserved factors must be captured (Greene, 2000).

A random utility formulation is used to model the observed outcome of CAP acceptance. Considering the i^{th} farm house ($i = 1,\ldots\ldots, N$) deciding not or to employ a CAP on farm f(f= 1,….., F). U_0 signifies the profits farmers receive from old farming methods, while U_k denotes the benefits they receive after accepting the k^{th} CAP, wherever, k represents the choice of agroforestry (A), intercropping (I), cover crop (C), crop rotation (R), mulching (M), and minimum/zero tillage (T). If $Y_{ifk}^{*} = U_{K}^{*} - U_{0} > 0$., the farmer accepts the *k*th CAP on a farm f. The net profit (Y_{ifk}^{*}) derived by the farmer from implementing the kth CAP is a hidden variable defined through pragmatic farmhouse, farm, and site information (X_{if}) and error term (ε_{if}):

$$Y_{ifk}^{*} = X_{if}^{'}\beta_{k} + \varepsilon_{if} \tag{1}$$

The unnoticed predilections in equation (1) were changed to the pragmatic binary equation for every decision using the indicator equation of the form:

$$Y_{ifk} = \begin{cases} 1 \; if \;\; Y_{ifk}^{*} > 0 \\ 0 \; otherwise \end{cases} \quad (k = A, I, C, R, M, Z) \tag{2}$$

The error components in the multivariate model, in which the uptake of many CAPs is probable, mutually follow a multivariate assumption of normality with zero mean and variance standardized to unity (Kassaw et al. 2019),

where: µA, µI, µC, µR, µM, µZ ~: MVN (0, Ω) and the proportionate covariance matrix X as below:

$$\Omega = \begin{bmatrix} 1 & \rho AI & \rho AC & \rho AR & \rho AM & \rho AZ \\ \rho IA & 1 & \rho IC & \rho IR & \rho IM & \rho IZ \\ \rho CA & \rho CI & 1 & \rho CR & \rho CM & \rho CZ \\ \rho RA & \rho RI & \rho RC & 1 & \rho RM & \rho RZ \\ \rho MA & \rho MI & \rho MC & \rho MR & 1 & \rho MZ \\ \rho ZA & \rho ZI & \rho ZC & \rho ZR & \rho ZM & 1 \end{bmatrix} \tag{3}$$

The off-diagonal items in the covariance matrix, which epitomize the unnoticed association amid unpredictable elements of various kinds of CAPs, are of particular interest. However, assuming that equation (2) produces an MVP model which describes preferences to implement a specific farm method. Thus, enabling for cross-correlation by using non-zero off-diagonal elements. Multiple latent equations' error terms describe unnoticed features influencing a selection of different CAPs. We explore the role of non-observable family variables on adoption decisions when examining the determinants of adoption.

For example, a link could exist amid plot-invariant attributes (such as supervisory skill) and the choice to use a particular CA technique. Because unnoticed heterogeneity is unassociated with reported explanatory variables, a collective MVP model is reliable. We took advantage of our data's many plot observations then projected equation (2). However, this was done to account for unobserved heterogeneity by introducing the means of different farm factors (e.g., farm attributes average, farm distance to a farmer's residence) as extra confounders in the multivariate regression.

According to our MVP model, before adopting CAPs, a farm house assesses net profit of accepting vs not accepting and only makes a choice to implement new CAPs if net profit is better than failure to adopt. Farming houses are more likely to accept CAPs if the previous implementation provided greater utility. The MVP model, on the other hand, is confined to assessing the intensity of CAP acceptance. As a result, an ordered probit model is employed in this study to calculate the intensity of CAPs uptake. Furthermore, we investigated measuring the amount of acceptance by the number of CAPs used at the house level. However, this approach is comparable to a Poisson count distribution model; which violates a premise of CAP dependency, making it inapplicable.

Typically, a common analytical procedure for determining the intensity of adoption takes into account a fraction of land area specified by various adoption studies (Awazi et al., 2019). Due to data constraints on useful factors, we defined our outcome variable as a categorical variable of which the conceivable values are ordered, such as houses that utilize more CAPs. Our ordered events are represented progressively as a dormant variable y*, where y* is an inherent unnoticed ration of farm houses' acceptance of CAPs in numbers, and specified as trails:

$$y_i^* = X_I' B + u_i \tag{4}$$

In a j^{th} farm home, standardization is when the regression coefficients x don't comprise the interception, a low-slung y^*, indicates low adoption of CAPs, a high $y^* > 1$ indicates increased adoption, a higher $y^* > 2$ indicates more increased adoption, and so on. The likelihood of witnessing event i translates to the following for m categories using a typical ordered probability model:

$$\Pr\ (outcome_{j=i} = \Pr\ (K_{i-1} < X_i'\beta + \mu_i \leq \alpha_i) \tag{5}$$

In this case, μ_i is considered to be ordinarily spread with a predictable normal cumulative distribution role. The coefficients $\beta_1 \ldots\ldots\ldots \beta_k$ are computed in conjunction with the cutpoints α_1, $\alpha_2, \ldots\ldots \alpha_{k-1}$, where k is the numeral of alternative outcomes. Table 1 shows a description of the model's outcome and control variables (see Appendix).

3. Results and Discussion

3.1 Social and economic Statistics of the Smallholder Farmers

From the analysis presented on table 1, average age of household heads is around 44 years, with 18 years of farming experience, indicating that heads of these households are still in their productive agriculture years. Furthermore, many homes (45 percent) are headed by a woman. While this suggests that females play an important role in farming, it does not diminish the significance of male-heads, who may be land administrators and impact acceptance preferences(6). Age plays a vital role in driving household decisions to embrace agricultural novelties in many adoption studies since it might represent experience in farming methods and use. However, age is said to have a diverse outcome on CAP acceptance (Nigussie et al., 2017).

However, the average home size is around seven people, indicating a typical large family environment. Most agricultural settings in developing nations have large family sizes, indicating the potential for family labor use. The average farm size cultivated by the majority of farmers is 2.42 hectares, indicating that the mainstream of farmers in the zone are typical rural farmers. The size of a farm influences technological adoption. Larger farms size holders are more inclined to accept new methods because they can devote a section of their land to testing emerging innovations, whereas farmers with smaller farms are far less willing to do so (Gebremariam and Tesfaye, 2018).

Furthermore, household size has been noted as a predictor in households' decisions to adopt CAPs (Oyetunde-Usman et al., 2021). Soil and water-saving technologies, for example, necessitate additional labor requirements are said to be beneficial by encouraging implementation (Gebremariam and Tesfaye, 2018). Adopting comparable habits, however, could have a detrimental impact. Household statistics revealed that 80 percent of household heads could get at least one year of formal training, implying that the majority of household heads are uninformed and unable to understand optimal farming techniques and technology knowledge uptake.

Table 2: Summary Data of Socio-economic Variables

Variables	Description	Average	Std Dev.	Min	Max

Household Factors					
Age	Age of house head (years)	44.52	14.31	19	90
Farm house Size	Number of members in the house (count)	7.26	4.79	1	35
Gender	Gender of house head (Dummy, female=1, male=0)	0.55	0.50	0	1
Marital Status	1 = not married; 2 = common-law; 3 = married monogamy; 4 = married polygamy; 5 = widow; 6 = Divorce	2.71	1.34	1	6
Education	Years of education of household head (count)	1.39	0.80	0	7
Economic Profile					
Farm Size	Farmland size(hectares)	2.42	2.64	1	28
Farms Cultivated	Number of farms cultivated (in numbers)	2.28	1.51	0	10
Land Ownership	Land ownership status (1= family, 2= owned land, 3= leased land	0.50	1.76	1	3
Farm Experience	Household head farming experience (Years)	17.79	14.23	1	70
Distance from Home to Farm	Distance from farm households to farmland (in kilometers)	56.39	50.43	1	260
Access to Extension	Contact with extension worker (Dummy, yes=1, No= 0)	0.36	0.48	0	1
Access to Credit	Available agricultural finance (Dummy, yes=1, No= 0)	0.18	0.38	0	1
Received Government Subsidies	Farmers who received government subvention (dummy, yes=1, No=0)	0.08	0.27	0	1
Use of sustainable Farm Tech	Modern farm technology (dummy, 1=yes, No =0)	0.63	0.48	0	1
Perception of Soil Fertility	Perception on fertility of soil (1=very fertile, 2=moderately fertile, 3= not fertile	1.27	0.67	0	3
Perception of climate Variability	If farmers perceive variability in climate (Dummy, yes=1, No=0)	1.03	0.19	0	1

(Source: Analysis from Survey data, 2020)

In addition, just approximately half of household heads have tenure secured, which may be owing to difficulties in transferring tenure rights, as in most Central African countries (Mugumaarhahama et al., 2021). Similarly, only approximately 36% and 18% of farmers had a contact with an extension worker and financing, respectively. Contacts with extension advisers is critical for raising awareness, showcasing farm practical trials and techniques, and prompting sustained acceptance. However, access to extension services remains low, indicating a significant alleged risk of accepting CAPs among farm households. Nevertheless, research has proven that farmer contacts with extension advisers have a favorable stimulus on uptake of innovative agricultural practices (Wekesa et al., 2017).

Furthermore, relatively few farmers in this study site had access to agricultural loans. Agricultural finance is a major driver of technological adoption (Wekesa et al., 2017). The average age of farming expertise for farmers in this area is 18 years. This knowledge allows them to compare the performance of new and old farming technologies and gain confidence in taking farming risks. It is also a critical aspect in agricultural success. This is important because farmers develop more knowledge about farming as they get older. However, experienced farmers are more familiar with environmental deterioration and crop failure issues. This, nonetheless, influences their decision to adopt or reject new technology.

3.2 Smallholder Farmers' Conservation Agricultural Practices

According to the findings, farmers in both regions adopt the following conservation agriculture practices: agroforestry, intercropping, cover crops, crop rotation, mulching, and zero/minimum tillage. Interestingly, Table 3 shows that agroforestry was implemented by the majority of smallholder farmers (61.82 percent), while mulching was the least popular conservation agriculture method (17.38 percent).

Table 3: Smallholder Farming Households' CAPs

Conservation Agricultural Practices	Percentage Adoption (%)
Agroforestry	61.82
Intercropping	49.86
Cover Crop	25.93
Crop Rotation	20.51
Mulching	17.38
Zero/minimum Tillage	33.90

(Source: Analysis from Survey data, 2020)

3.3 Determining factors of CAPs Adoption among Smallholder Farmers in Cameroon

Table 4 displays the multivariate probit model's coefficient estimations. The correlation of CAP error terms suggests our six CAPs under consideration are interdependent. It also includes agroforestry, intercropping, crop rotation, cover crops, mulching, and zero/minimum tillage. The findings showed that the model's log-likelihood ratio (LR) of -1058.61 and the Wald2 (114) = 252.23 is significant at (P0.00), indicating that the model is well-fitting. The significance of LR also implies that the decision to use several conservation farming strategies is interconnected. This relevance level is derived from the fact that identical unobserved home factors can influence the adoption of various CAPs (Oyetunde-Usman et al., 2020).

Gender of house head has a beneficial consequence on agroforestry uptake. According to findings from this research, men were more likely than women to use agroforestry. This prediction backs up prior research that males control farming resources and, as a result, easily embrace practices that require more resources (Oyetunde-Usman et al., 2021). However, it contradicts Musafiri et al (2022), who showed that females are more likely to pursue agroforestry.

The findings found that old farmers use agroforestry, cover crops, and zero tillage more, whereas young farmers use more of intercropping, crop rotation, and mulching. The disparities in these practices could be attributed to young farmers' capacity to recognize the value of sustainable farming practices such as intercropping and mulching.

Farm size is significant ($p = 0.01$) only for driving cover cropping adoption, meaning that increase in farm size enhances the household chances of adopting cover crops as a conservation farming approach. As a result, a farmer with a larger farm has more financial resources and greater area to devote to enhancing technology adoption. They can also purchase more advanced and sophisticated technologies, as well as the ability to bear risk if the equipment fails to function properly. Deininger et al. (2008) found that farm size was substantially connected to the likelihood of investing in conserving soil and water.

Correspondingly, Menale (2010) found that farm size was associated with the adoption of numerous CAP methods for the reason that it mirrors capital, which alleviates liquidity limitations in applying the practices. They discovered that farm houses with large farms have greater chances to use current technology than farmers with smaller farm sizes. Abdul-Hanan et al. (2014) discovered similar results.

Contact with extension agents had a considerable beneficial influence on cover crop uptake, whereas mulching had a negative influence. Extension agents are critical in raising knowledge of and showcasing new CAP technology. Fundamentally, the more contacts made, the more knowledge gained, because sustainable farming necessitates new abilities such as observation, monitoring, and risk assessment. The results relates to the necessity of knowledge on applying cover crop strategies rather than mulching. These results are in support with those of Gido et al. (2015), who discovered that extension advise is for developing institutional frameworks that facilitate the propagation and transfer of information amid. However, our findings, agree with Anang et al. (2020), who emphasized the vitality of extension advise in increasing new farm method acceptance.

Availability of loans for farming has a negative impact on zero tillage adoption. Farmers with access to agricultural financing no longer see the need to use zero-till since they have more money to spend on inputs for other techniques. Furthermore, the distance between home and farm encourages the use of agroforestry, intercropping, and zero tillage. Shorter distances encourage farmers to adopt these strategies.

The quantity of farms a farmer owns has a favorable influence on zero tillage adoption, and a farmer with more cultivable farms has the comfort of experimenting with various farming techniques on one of the farms. In contrast, marital status had a strong negative relationship on zero tillage adoption. Marriage generates family labor, and because women and children can assist in crop production, processing, and marketing, the household can engage in more complex agricultural practices such as intercropping. Our results agree with Abioke et al (2012).

Land access also facilitates household decision to implement innovative farm methods. According to findings from this study, land security played a substantial role in increasing the use of cover crops. As a result, farmers who own their farms may employ intricate and demanding conservation methods. This consequence could be because land security permits farmers to explore complicated technologies, impacting cover crop use.

Soil fertility had a considerable impact on zero tillage adoption but had a negative impact on mulching adoption. This can be clarified further by stating that soil fertility is said to impact the uptake of recovery methods, and zero tillage is a soil fertility recovery practice. As a result, a farmer with infertile soils will prefer zero tillage to mulching. The discovery could boost soil fertility by utilizing minimal tillage, hence increasing livelihood and food security. Furthermore, farmers may expect reduced output from infertile soils, resulting in a refusal to apply more costly strategies. This finding supports the findings of Musafiri et al (2022).

Furthermore, the coefficient for a farmer using modern farm technologies such as improved seeds is a significant promoter of adoption of intercropping and mulching as conservation farming methods. However, modern farm technology is a promoter of farmer's uptake of cover crop and zero-tillage. Results from this research postulates modern agricultural techniques to be an improving factor for the likelihood of farmers in Cameroon's South and East Forests using conservation farming strategies such as intercropping and mulching.

The number of animals owned has a favorable influence on intercropping, cover crop, and crop rotation adoption but has a negative influence on agroforestry adoption. The findings revealed that as animal ownership increased, so did the proclivity for intercropping, cover crops, and crop rotation. The larger requirement for animal manure for crop farms may explain the influence of livestock ownership on intercropping, cover cropping, and crop rotation. However, animal dung might potentially be used to boost soil fertility by being applied to agricultural land. Nonetheless, these outcomes line up with Ndeke et al. (2021), who indicates keeping livestock as a strong predictor of improved technology adoption.

Table 4: Econometric Estimates of factors influencing CAPs Adoption amid rural farm households in Cameroon

Parameters	**Agroforestry**		**intercropping**		**Cover cropping**		**Crop rotation**		**Mulching**		**Zero -tillage**	
	Coef	*Se*	*Coef*	*Se*	*Coef*	*Se*	*Coef*	*Se*	*Coef*	*Se*	*Coef*	*Se*
Gender	0.581^{***}	0.158	0.239	0.157	-0.166	0.170	0.165	0.171	-0.148	0.185	0.210	0.167
Age	0.019^{**}	0.007	-0.005	0.007	0.013^{*}	0.007	-0.007	0.007	-0.007	0.009	0.015^{**}	0.008
Land Size	0.047	0.035	-0.015	0.029	0.050^{*}	0.030	0.008	0.034	0.028	0.031	-0.070	0.043
Farm Experience	-0.008	0.007	0.006	0.007	-0.008	0.007	-0.001	0.008	-0.005	0.008	0.003	0.007
Access to Extension	0.057	0.164	-0.166	0.165	0.423^{**}	0.170	0.024	0.178	-0.446^{**}	0.209	0.068	0.169
Agricultural Credit	0.217	0.212	-0.343	0.212	0.006	0.220	0.198	0.218	-0.006	0.245	-0.711^{**}	0.226
Distance home-farm	0.003^{*}	0.002	0.003^{*}	0.001	0.001	0.002	0.000	0.002	0.003	0.002	0.003^{*}	0.002
Number of farms	0.027	0.053	0.017	0.049	-0.038	0.060	-0.020	0.058	0.062	0.057	0.104*	0.057
Farm house size	-0.007	0.016	0.012	0.016	-0.008	0.017	-0.011	0.017	-0.005	0.018	-0.025	0.018
Marital status	0.014	0.060	-0.055	0.060	-0.079	0.066	0.025	0.065	0.044	0.072	-0.122^{*}	0.066
Education	0.000	0.092	-0.022	0.091	0.089	0.094	-0.110	0.103	-0.055	0.119	0.155	0.095
Land ownership	-0.122	0.151	-0.181	0.152	0.349^{**}	0.169	0.216	0.165	-0.004	0.177	-0.170	0.158
Soil fertility status	-0.003	0.108	-0.045	0.111	-0.089	0.122	-0.012	0.129	-0.439^{**}	0.134	0.250^{**}	0.116
Modern farm technique	0.075	0.160	0.310^{**}	0.158	-0.327^{*}	0.169	-0.173	0.174	0.803^{***}	0.211	-0.857^{***}	0.160
Government subsidy	0.127	0.304	0.145	0.295	-0.068	0.295	0.294	0.295	0.647^{**}	0.337	0.052	0.317
Climate variability	0.265	0.360	0.706^{*}	0.417	0.110	0.378	-0.573	0.496	0.216	0.434	-0.487	0.457
Livestock owned	-0.067^{***}	0.018	0.098^{***}	0.019	0.079^{***}	0.021	0.061^{**}	0.022	0.009	0.021	-0.026	0.019
Persistent soil erosion	0.168	0.160	-0.292^{*}	0.158	0.269	0.166	0.175	0.171	0.055	0.188	0.142	0.163
_cons	-0.736	0.606	-1.174^{*}	0.629	-2.256^{**}	0.649	-0.691	0.713	-1.151	0.725	0.035^{**}	0.660

N = 350 Log Likelihood = -1058.6109 Wald chi2 (114) = 252.23 Prob> Chi2= 0.000 *** 1%, ** 5%, * 10%

Source: Computed from Field Survey (2020)

3.4 CAPs Adoption Intensity

Smallholder farmers must enhance their adoption intensity in order to improve agricultural yields and revenue while also reducing the effects of climate change (Oyetunde-Usman et al., 2021). From our findings the model used is significant, as indicated by the LR Chi2(18) = 41.36 and Prob > chi2 = 0.0014. This degree of significance shows that the ordered probit model is trustworthy. Gender of house head indicated severity of CAP adoption (Table 5).

Table: 5 Factors that influence intensity of adopting Conservation Agricultural Practices

Variables	Coefficient	Std Error	P-Value
Gender	0.2550**	0.1219	0.037
Age	0.0061	0.0055	0.268
Land Size	0.0114	0.0228	0.617
Farm Experience	-0.0035	0.0054	0.518
Access to Extension	0.0126	0.1264	0.921
Agric Credit	-0.0369	0.1611	0.818
Distance from home to farm	0.0026**	0.0011	0.022
Number of fields cultivated	0.0554	0.0395	0.160
Household size	-0.0123	0.0121	0.311
Marital status	-0.0291	0.0469	0.536
Education	-0.0185	0.0709	0.794
Land ownership	-0.0007	0.1180	0.995
Perception of soil fertility	-0.0168	0.0859	0.845
Use of modern farm techniques	-0.1317	0.1224	0.282
Government subsidy	0.3784*	0.2257	0.094
Perception on climate variability	0.0231	0.2815	0.935
Livestock owned	0.0742***	0.0148	0.000
Persistent soil erosion	0.1439	0.1223	0.239
Number of observations =350	LR Chi^2 (18) = 41.36	Prob > chi^2 = 0.0014	
Log Likelihood = -612.735	Pseudo R^2 = 0.0326		

*** p<0.01, ** P<0.05, * p<0.1

According to the findings, male-headed households improve their agricultural methods more than female house heads. Nonetheless in support of the idea of male house heads promoting new agricultural methods because they have an edge over land and labor (Diiro et al., 2018 & Kasaw et al.,2019). However, this results are contrary to those of Oyetunde-Usman et al. (2021), which postulate male-headed families to boost sustainable farming methods, attributing this to a shortage of complementary inputs. They are, nevertheless, identical to Musafiri et al (2022).The distance between home and farm increases the intensity of CAP adoption.

According to the data, smallholders' adoption of numerous CAPs increased with distance from the farm. Households that reside far from the farm, nevertheless, are more likely to use CAPs. This conclusion explains why farmers will want to optimize the amount of time they spend on the farm and so implement many farm technologies to ensure a satisfactory harvest if one way fails. Contrary to popular belief, access to farms that drive adoption may not be limited by distance and may rely on locally available information networks. The strong forecast of government subsidies on multiple CAP adoption meant that smallholder farmers who got subsidies were more inclined to intensify agricultural methods. Receiving subsidies encourages the smallholder farmer to try new farm practices, thus boosting their use of farm practices.

Furthermore, livestock ownership has a considerable impact on CAP intensification, supporting Table 5. This finding emphasizes the significance of animals in agricultural intensification, with the fact that animal droppings are employed as manure. However, these outcomes line up with results of Ehiakpor et al. (2021), who said that cattle ownership to have a considerable impact on intensity of sustainable farming methods uptake. This fervor is ascribed to the likelihood of selling animals in order to buy farm need like agricultural chemicals, manures, and improved seeds.

4. Conclusion

The level and intensity of CAP uptake differed between studied families due to variations in social, economic, institutional, and biophysical factors. Gender and age of house head, family size, extension advise, usage of contemporary farm technology, distance from house to farm, animals owned, and infertile soil were key drivers of CAP adoption. Our findings demonstrated that the respondent's gender, distance from home to farm, and animal ownership were important drivers of CAP adoption intensity.

In light of the foregoing, policymakers should develop pro-farmer policies that encourage the use of different agricultural methods that complement one another in minimizing the negative effects of climate change.

Given that a multitude of factors influence CAP adoption, planners should look outside the box when optimizing CAP adoption to address smallholder views on soil fertility, erosion, and climate variability.

Attention should be directed to farmers who are able to perceive issues on fertility and erosion of soils, and climate variability in order to increase CAP implementation. Farmer capacity should be built by improving extension advisory services and trainings to scale up CAP implementation.

5. Declaration of Competing Interest

All authors declare that they have no known competing financial interests or personal ties that can influence material and results presented in this paper.

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APPENDIX

Table 1: Description of Variables

Variables	Calibration	Expected sign
Outcome Variables		
Agroforestry	Adoption of Agroforestry (Dummy, yes=1, No =0)	+
Intercropping	Adoption of Intercropping (Dummy, yes=1, No =0)	+
Cover Crop	Adoption of Cover crop (Dummy, yes=1, No =0)	+
Crop Rotation	Adoption of Crop rotation (Dummy, yes=1, No =0)	+
Mulching	Adoption of Mulching (Dummy, yes=1, No =0)	+
Zero/minimum Tillage	Adoption of zero/minimum tillage (Dummy, yes=1, No =0)	+
Control Variables		
Gender	Gender of farm house head (Dummy, female=1, male=0)	+/-
Age	Age of farm house head(years)	+/-
Land Size	Farmland size(hectares)	+/-

Farm Experience	Household head farming experience (Years)	+
Extension advises	Access to extension service (Dummy, yes=1, No= 0)	+
Agriculture Credit	Access to agricultural credit (Dummy, yes=1, No= 0)	+
Distance from Home to Farm	Distance from farm households to farmland (in kilometres)	-
Farms Cultivated	Number of farms cultivated (in numbers)	+/-
Household Size	Number of family members(count)	+/-
Marital Status	1 = single; 2 = common-law; 3 = married monogamous; 4 = married polygamous; 5 = widowed; 6 = Divorced/Separated	+/-
Education	Years of education of household head(count)	+
Land Ownership	Land ownership status (1= family, 2= owned land, 3= leased land	+
Perception of Soil Fertility	Perception of fertility status of soil (1=very fertile, 2=moderately fertile, 3= not fertile	+/-
Use of sustainable Farm Techniques	Modern farm technology (dummy, 1=yes, No =0)	+
Received Government Subsidies	Farmers who received government subvention (dummy, yes=1, No=0)	+
Perception of Climate Variability	If farmers perceive variability in climate (Dummy, yes=1, No=0)	+/-

(Source: Designed by authors, 2020)