Journal of Agricultural Science; Vol. 14, No. 12; 2022
ISSN 1916-9752 E-ISSN 1916-9760
Published by Canadian Center of Science and Education

Involvement of Women in Adopting Climate Change Adaptation Practices in Cacao Farming in Côte d'Ivoire

Ouattara Yerayou Céline[1], M'Bo Kacou Antoine Alban[1], Cherif Mamadou[1], Sanogo Souleymane[1], Renée Brunelle[2], Leblanc Caroline[2] & Kone Daouda[1]

[1] African Center of Excellence for Climate Change, Biodiversity and Sustainable Agriculture, Félix Houphouët-Boigny University, Cote d'Ivoire

[2] SOCODEVI (NGO based in Quebec City, Canada)

Correspondence: Ouattara Yerayou Céline, WASCAL/CEA-CCBAD (African Centre of Excellence on Climate Change, Biodiversity and Sustainable Agriculture), Félix Houphouët-Boigny University (UFHB), Cote d'Ivoire. Tel: 075-925-1851. E-mail: yerayou1995@gmail.com

Received: September 11, 2022 Accepted: October 31, 2022 Online Published: November 15, 2022

doi:10.5539/jas.v14n12p101 URL: https://doi.org/10.5539/jas.v14n12p101

Abstract

The adverse effects of climate change are leading producers to adopt endogenous strategies. Nevertheless, the involvement of women in the adoption of adaptation practices was assessed in the localities of Abengourou, Gagnoa, Soubré and Vavoua. Interviews with cocoa farmers, 69 female and 288 male, show that drought (77.8%) is one of the most observed climatic factors by farmers in cocoa farms. In order to reduce the effects, 27% of women farmers preferred to set up nurseries close to water points and at home, compared to 15.2% of men. 73.7% Women leave the plants for 4 months before planting compared to 59.2% of men. In soil fertility management, 67.9% of women use leguminous plants as cover crops, compared to 52.8% of men. During the rainy season, they ferment the beans for 6 days (35% compared to 22% of men) and harvest the pods at least once a week (16% compared to 1% of men) in the absence of rain. Women are strongly involved in the adoption of practices at all stages of cocoa production. In terms of adaptation, it would be important that the practices identified be integrated into the training of women producers to enable them to be resilient.

Keywords: gender, cacao farming, climate, Côte d'Ivoire

1. Introduction

Côte d'Ivoire, like the countries of West Africa, is subject to strong climate variability for many years (Brou et al., 2003; Kanohin et al., 2012). This climatic variability adds another challenge to the current production constraints. Climatic disturbance leads to disruption of cropping seasons, causing high mortality of cacao trees after planting or even failure to replant on fallow and forest precedents (Ofori-Boateng & Baba, 2011). Projections based on greenhouse gas models over West Africa indicate that warming will continue and increase (Intergovernmental Panel on Climate Change [IPCC], 2013). These visible effects are already impacting the growth, morphology, physiology and yield of cacao trees. At the production level, it leads to a halt in the ripening of young fruits, a reduction in the size of the beans and pods and a deterioration of the quality of the beans (Moser et al., 2010; Adjaloo et al., 2012). According to Schroth et al. (2016), drought-induced changes are major threats to cocoa production (and is an environmental issue that deserves special attention in terms of planning, diversification of agricultural production and conservation of perennial species in cacao orchards). Faced with these constraints, endogenous practices are developed and adopted to cope with climate variability (Smith & Skinner, 2002). Some studies have focused on identifying best practices for climate-smart cocoa production in Côte d'Ivoire. These studies were carried in the regions of Agnéby-tiassa, Mé and Cavally and resulted in recommendations adapted to the climate (M'Bo et al., 2020; Dohmen et al., 2020). Indeed, the adoption of good resilient practices will contribute to mitigate the influence of climate change, particularly drought, on cocoa production in Côte d'Ivoire. Nevertheless, few studies focus on involvement of women in the adoption of climate adaptation practices in cacao farming.

In Côte d'Ivoire, women are certainly involved in cacao farming, but studies showed that cocoa farming is dominated by men and women's work tends to be invisible, less recognized and less valued (Enete & Amusa, 2010; Kpangui, 2015). However, other research showed the level of women contribution in several key stages of cocoa production (International Fund for Agricultural Development [IFAD], 2012). Indeed, men and women undertake essentially the same activities on cacao farms. However, the woman's work is considered to be that of a wife or family helper and not that of a worker. Some activities are associated with women and are considered less important than those usually performed by men. Female farmers are assigned physical activities such as planting seedlings. They are involved in the maintenance of the plantation and are usually responsible for weeding and pruning, which are very important to ensure adequate growth of the cacao. They also contribute to the establishment of the nursery, the management of the young plantation, take care of the harvest and are in charge of the fermentation time and the drying of the cocoa beans (Klasen et al., 2010; Fadimatou, 2015). Despite this active participation in cacao cultivation, the role of women in the development and adoption of climate change adaptation strategies remains unknown. The overall objective of this study is to assess the level of involvement of women in the adoption of climate change smart practices in cocoa production in Côte d'Ivoire.

2. Material and Methods

2.1 Study Area

This study was carried out in the localities of Abengourou, Gagnoa, Soubré and Vavoua, representing the main cocoa-producing area. Abengourou (latitudes 5°45′ and 7°10′ North and longitudes 3°10′ and 3°50′) located in the South-East constitutes the old cocoa production loop and is characterized by a senescent orchard and a strong dynamic of diversification towards other perennial crops. Abengourou is an area characterized by a sub-equatorial climate with average rainfall ranging from 1200 to 1700 mm per year. Average temperatures range from 24 to 32 °C. The soils are ferralitic with low desaturation on schist, micaschist or granite (Eldin, 1971).

Vavoua is a forest-savannah transition zone (7°22′54.998.8″ North and 6°28′40.001″ West). Located in the Centre-west, it is marked by the cessation of cocoa extensions, the ageing of the orchard and the decline in soil fertility. In terms of climate, the Vavoua area is characterized by a tropical type of climate, locally known as the "attiéen" climate, with rainfall varying between 1200 and 1600 mm The annual temperature average is 26 °C (SODEXAM, 2019). This area has two types of vegetation, notably the forest zone, which occupies the major part, and the savannah or pre-forest savannah zone. The soils are classified in the group of ferralitic soils and hydromorphic soils of little evolution.

Soubré (5°47′34.0″ North and 6°35′41.8″ West) and Gagnoa (6°7′54″ North and -5°57′02″ West) located in the South-West and West are characterized by a vertiginous development of cocoa farming over the last two decades and represent the first production zone. Soubré and Gagnoa have a humid equatorial climate. Rainfall is between 1600 mm and 1800 mm and the temperature is between 26 °C and 32 °C (Koua, 2018). Three types of soil are found in these departments: ferralitic soils; tropical brown soils and hydromorphic soil complexes found along rivers and lowlands.

2.2. Methods

2.2.1 Sampling and Data Collection Method

The sampling method was based on the reasoned choice model (Louis et al., 2019). The target population was all female cocoa farmers in Soubré, Vavoua, Gagnoa and Abengourou. A questionnaire consisting of closed, open and multiple choice questions was sent to women and men with a view to identifying endogenous practices adopted in cocoa farming to improve livelihoods in these areas. The strategy to collect the information in the different localities was based on face-to-face interviews with people (young men and women) aged at least eighteen years. Two cooperatives per zone and 3% of the active members of each cooperative were surveyed. The number of women per cooperative varied from 15% to 30% of the sample size. Two cooperative leaders were also interviewed. The choice of producers in the cooperatives was based on a preliminary co-analysis of the list of cooperative members and focused on female cocoa farmers who take part in different field activities on their cacao with knowledge of cocoa production and to a lesser extent of climate change and variability in the locality.

A community workshop was also conducted in the localities. At least 15 adult women (over 18 years old) from the target communities involved in cocoa production, representing the different categories of women producers. This group of women was made up of those who have a good knowledge of the biophysical and socio-institutional contexts of the sites and who work in cocoa, either as owners or assisting a spouse or a father or a brother.

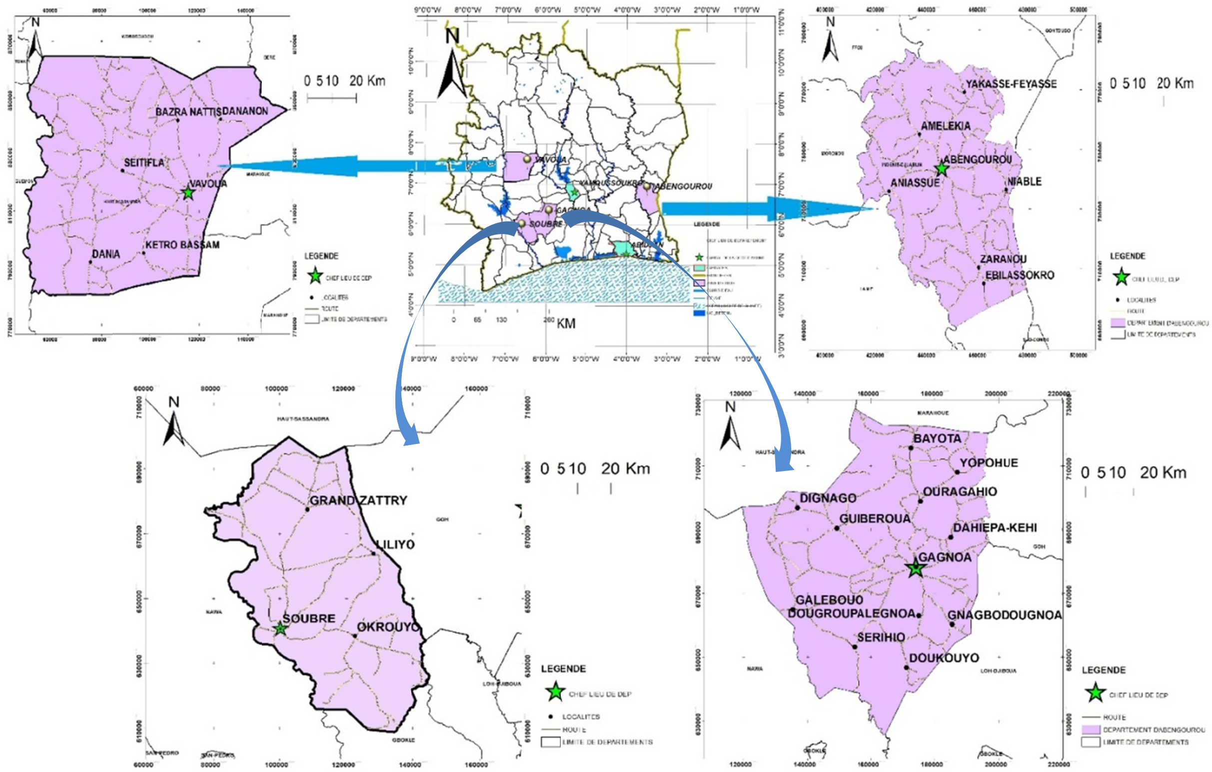

Figure 1. Areas of survey and collection of agroecological practices in cocoa production

2.2.2 Data Analysis Methods

Data were entered into Sphinx Plus 2 version 4.5 software (Moscarola & Baulac, 2016) Descriptive analysis and binary logistic regression were used for statistical processing of the data. Descriptive statistics (distribution, frequency) were used to describe the socio-demographic characteristics of cocoa farmers, their perception and constraints of climate change. The non-parametric chi-square test in SPSS version 25 was used to assess the relationship between the different variables (gender and socio-demographic, perception and effect of climate variability). The nature of the links between gender and adaptation practices was determined using a binary logistic regression with the software R 4.1.2 5 (Joseph, 2021).

Table 1. Description of the variables used for the non-parametric and regression test

Variables	Abbreviation
Nursery management	
Choice of nursery site	Sitpep
Maturity of the cocoa seedling before planting	Agecac
Choice and preparation of the ground	
Land clearing practice	Defr
Plantation management	
Manual weeding practices	Desherbma
Choice of the type of temporary shade associated with cacao trees	Ombrtemp
Type of crops associated with cacao trees	Cultasso
Shade tree	Arbreomb
Pruning for flowering	Tailflo
Soil fertility management	
Soil covering practices	Couvertur
Practice of the mulching practices	Paillage
Soil water management	
Practice to reduce soil water deficit in cacao farm	Modeplant
Watering techniques for cacao	Techeau
Harvest management	
Harvesting frequency if rain	Recoltabondpluie
Fermentation frequency if rain	Fermabondplui
Harvesting frequency in the absence of rain	Recoltabspluie
Fermentation in the absence of rain	Fermabspluies

3. Results

3.1 Socio-demographic Characteristics of Cacao Farmers

The socio-demographic characteristics of cocoa farmers in the study areas was analyzed using descriptive statistics as shown in the Table 2. The results indicate that 81% of men and 19% of women were involved in cocoa production. The proportion of women and men in each of the localities shows less than 30% female cocoa farmers, with varying proportions per zone (Figure 2). The farmers are from diverse origins (chi2 < 0.05). The statistical analysis shows that there is significant difference between the origins of the farmer. The observation by locality show in the Abengourou, most of the respondents are indigenous (79%), as opposed to Gagnoa (90%), Soubré (84%) and Vavoua (55%), where more than half of the respondents are non-indigenous. The education status of cocoa farmers varied significantly by gender (chi2< 0.05), no female farmer had completed secondary and higher education, only 31% had completed primary education and 5.8% had completed secondary school. However, 22% and 9% of the male population have reached upper secondary and higher education, and 26% have completed primary education. In Abengourou 48% of women and 26% of men are non-literate. Less than 50% of women (45%) and 26% of male producers have primary education. A large number of illiterates were observed in Gagnoa (90% of women against 63% of men), Soubré (74% of women against 46% of men) and Vavoua (55% of women against 49% of men). No woman has completed secondary or tertiary education in all localities.

The work experience in cocoa production is not influenced by gender. 37.2% of the men had more than 21 years of experience in cocoa production compared to women (42%) who had between 0 and 10 years in cacao farming. In Gagnoa, 50% of women and 45% of men have more than 21 years' experience. In Soubré, 53% of women have less than 11 years', while most men have more than 21 years' experience. Meanwhile, in Vavoua, 50% of female have between 11 and 20 years of cocoa farming experience, unlike men, where the majority of respondents have less than 11 years.

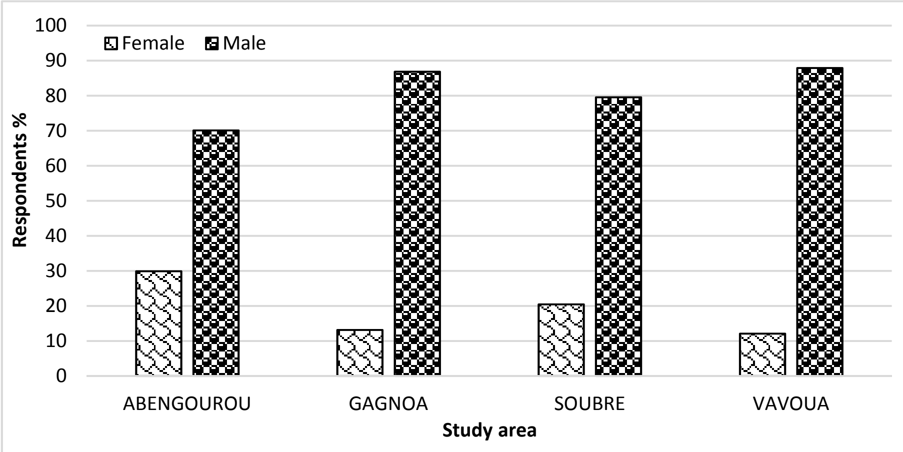

Figure 2. Socio-demographic characteristics of cocoa farmers in the study areas

Table 2. Socio-demographic characteristics of female and male cocoa farmers

Socio-demographic variables	Study zone								Test of khi[2]
	Gender (%)								
	Abengourou		Gagnoa		Soubré		Vavoua		
	M	F	M	F	M	F	M	F	
Educational level									
Illiterate	29	48	65	90	47	74	49	55	
Primary	26	45	15	10	27	21	34	36	
First cycle	21	7	15	0	18	5	10	9	0.006
Second cycle	15		9	0	4	0	8	0	
Higher	9	0	0	0	4	0	0	0	
Origin									
Allochthonous	49	17	85	90	73	84	36	55	
Allogeneous	21	3	15	10	27	5	3	0	0.001
Indigenous	31	79				11	61	45	
Years of experience									
[0-10]	24	45	23	30	22	53	44	30	
[11-20]	45	21	31	20	26	26	34	50	0.173
[21 and over]	30	34	45	50	52	21	23	20	

Note. For chi-2 values < 0.05 indicate a significant difference from gender.

3.2 Perception of Climate Variability and Its Effect In Cacao

The perception of climatic variability in the cocoa sector by farmers did not show a significant statistical difference by gender (Table 3). Nevertheless, the manifestation of the negative impact of climate change in terms of drought, irregular rainfall, low air humidity, strong winds, high temperatures as well as heavy rainfall and late onset of rains was observed by 77.8% of the farmers. The effects of drought, irregular rainfall (9.2%) and low humidity (7%) were also noted by respondents in their cacao farms. The least observed climatic adverse events were strong winds (2.8%), high temperatures (2%) and late onset of rains (0.6%). The perception of climate effect on cacao survival, yield and bean quality was not significantly related to gender (chi2 > 0.05). The majority of female farmers reported that the severity of the effects of climate change is highly significant on the survival of cocoa trees (41.9%), yield (38%) and bean quality (29%).

Table 3. Perception of climate variability by cocoa farmers in the different areas

Climate hazard	Study zones								Test of khi-2
	Gender (%)								
	Abengourou		Gagnoa		Soubré		Vavoua		
	M	F	M	F	M	F	M	F	
High temperatures	3	3	1	0	3	5	1	0	
Late of rains	9	10	9	0	8	5	14	0	
Air humidity too low	0	0	0	0	0	0	1	0	
Irregularity of rainfall	9	6	3	0	8	11	9	0	0.511
Drought	76	76	84	100	76	63	74	91	
Heavy precipitation	1	3	0	0	1	0	0	0	
Strong winds	1	0	2	0	4	16	1	9	

Note. For chi-2 values > 0.05 indicate that there is no significant difference by gender.

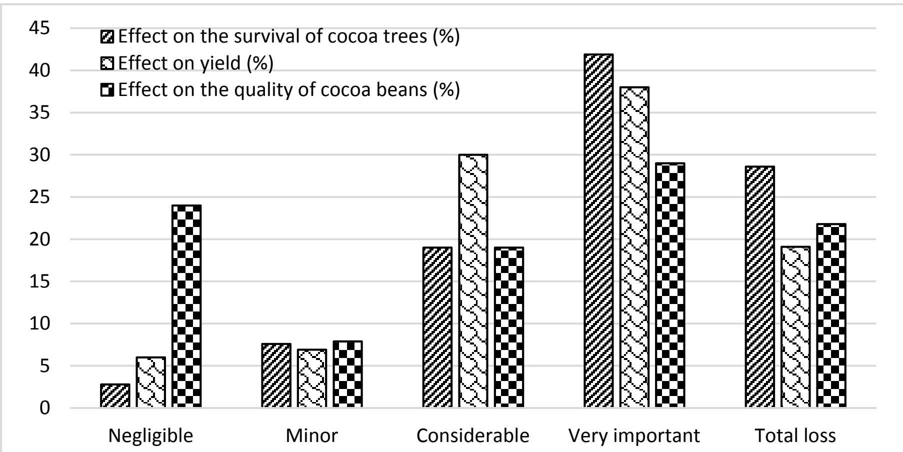

Figure 3. Effects of climatic factors on survival, yield and quality of cocoa beans

3.3 Adoption of Practices by Cocoa Farmers to Reduce the Effects of Climate

Cocoa farmers, both men and women, use several adaptation practices in the different stages of cocoa production to reduce the effects of climate variability. Among the practices analyzed are nursery management, choice of planting site, shade management, crop diversification, orchard management, water management, soil fertility management and harvesting.

3.3.1 Nursery Management Practices

The farmers create nurseries in the proximity of water points, at home or in certain more accessible sites, while allowing the cocoa trees to reach 2 to 6 months age before planting. The majority of respondents set up nurseries close to water points. Cacao nursery, at home is done by more women (27% against 15.2% of men). 73.7% of the women interviewed waited 4 months before transferring the seedlings to the field. The choice of nursery site and the age of planting differ from one zone to another but is not linked to gender (Table 4).

Table 4. Relationship between gender and choice of nursery site and seedling age and gender

Practices	Modalities	Gender		Test of khi-2	Linking gender and practice				
		M	F		Estimate	Std. Error	z value	Pr (> |z|)	Significance
Sitpep	Close to a water source	70	60	0.109	-7.75-01	6.26-01	-1.238	0.2157	ns
	Home	15.2	27						
	Accessible	14.8	12.7						
Agecac	2 months	16.4	12.3	0.117	-4.15-01	6.24-01	-0.665	0.506	ns
	4 months	59.2	73.7						
	6 months	24.4	14						

Note. Significance of the regression: Significant “s” when P < 0.05; not significant “ns” when P > 0.05. Sitpep: not significant, P = 0.2157; Agecac: not significant, P = 0.506.

3.3.2 Choice and Preparation of the Ground

Strategies were used by farmers in the establishment of new cocoa farm, these practices identified don’t reveal statistical differences between men and women. Clearing without burning or with burning are practices adopted in land preparation. However, clearing without burning is the most common practice adopted by women (52.1% of women versus 49.5% of men) (Table 5). In addition, most women used other methods of land preparation (45.8% of women versus 44.7% of men).

Table 5. Relationship between adaptation practices in site preparation and gender

Practices	Modalities	Gender		Test khi-2	Linking gender and practice				
		M	F		Estimate	Std. Error	z value	Pr(> |z|)	Significance
Prepter	Clearing with burning	5.8	2.1	0.109	-3.10-01	4.14-01	-0.749	0.4536	ns
	Clearing without burning	49.5	52.1						
	Other	44.7	45.8						

Note. Significance of regression: Significant “s” when P < 0.05; not significant “ns” when P > 0.05. Prepter: not significant, P = 0.4536.

3.3.3 Crop Diversification and Shade Management

The adoption of permanent or temporary shade trees that contribute to crops diversification, nutrition and food security are all practices adopted by cocoa farmers. 57.4% of women and 54.1% of men use permanent shade trees. The temporary shade species encountered were plantain used by more than 90% of men and women and leguminous shrubs with less than 3% use. More than 50% of respondents use trees to satisfy their food needs (Table 6).

Table 6. Relationship between shade management practices and gender

Practices	Modalities	Gender		Test khi-2	Relationship between gender and adaptation practice				
		M	F		Estimate	Std. Error	z value	Pr(> |z|)	Significance
Arbreomb	Yes	54.1	57.4	0.640	1.15+00	8.43-01	1.366	0.172	ns
	No	45.9	42.6						
Ombrtemp	Plantain	97.3	98.1	0.744	1.29+01	1.81+04	0.001	0.9994	ns
	Leguminous shrubs	2.7	1.9						
Cultasoc	Ground cover	31.7	42.6	0.167	-9.09-01	8.46-01	-1.074	0.283	ns
	Food security	68.3	57.4						

Note. Significance of the regression: Significant “s” when P < 0.05; not significant “ns” when P > 0.05. Arbreomb: not significant, P = 0.172; Ombrtemp: not significant, P = 0.9994; Cultasoc: not significant, P = 0.283.

3.3.4 Cocoa Orchard Management Practices

Manual weeding and pruning for flowering are the practices adopted by farmers in the management of the plantation. The frequency of pruning trees for flowering and manual weeding are predominant practices in the management of the cocoa orchard. The maintenance of the orchard is carried out by male and female producers for the most part 2 to 3 times per year, unlike the pruning of trees for flowering, which is practiced more by 46.3% of women and 33.8% of men.

Table 7. Relationship between manual weeding practices, flowering pruning and gender

Practices	Modalities	Gender		Test khi-2	Relationship between gender and adaptation				
		M	F		Estimate	Std. Error	z value	Pr(> |z|)	Significance
Desherbmanue	1 time	5.6	2.9	0.788	-1.47+00	6.29-01	-2.338	0.0194	s
	2 times	29.9	31.9						
	3 times	53.5	52.2						
	4 times	11	13						
Tailflo	Yes	33.8	46.3	0.056	-7.03-01	9.03-01	-0.779	0.4361	ns
	No	66.2	53.7						

Note. Significance of regression: Significant "s" when P < 0.05; not significant "ns" when P > 0.05. Desherbmanue: significant, P = 0.0194; Tailflo: not significant, P = 0.4361.

3.3.5 Soil Fertility Management Under Cacao

The strategy developed by producers for soil management is based on soil cover techniques and different types of mulch. 67.9% of women compared to 52.8% of men use leguminous crops for soil cover. Male and female farmers generally expose weed debris (66.7% of women versus 63.2% of men) as well as cocoa cortex and cocoa leaf (10.1% of women and 7.3% of men) as mulch (Table 8). The adoption of soil fertility management practices showed no significant statistical difference by gender ($p > 0.05$).

Table 8. Relationship between adaptation practices in soil fertility management and gender

Practices	Modalities	Gender		Test khi-2	Relationship between gender and adaptation				
		M	F		Estimate	Std. Error	z value	Pr(> |z|)	significance
Coverage	Leguminous crops	52.8	67.9	0.144	-1.20+00	6.31-01	-1.902	0.0572	ns
	Leguminous debris	3.6	0						
	No cover	43.5	32.1						
Type of mulch	Cocoa cortex and leaves	7.3	10.1	0.545	8.28-02	3.40-01	0.243	0.8078	ns
	Leguminous debris	6.3	7.2						
	Weeds	63.2	66.7						
	None	23.3	15.9						

Note. Significance of regression: Significant "s" when P < 0.05; not significant "ns" when P > 0.05. Coverage: not significant, P = 0.0572; Mulch type: not significant, P = 0.8078.

3.3.6 Water Management

The mapping of water management practices of trees revealed two types of strategies. One of these strategies is the use of the plantain as a source of water for cacao. To this end, 66.7% of women and 69.8% of men planted banana trees close to cacao, compared to 13% of women and 15.3% of men who planted banana between four cacao (Table 10). This practice is used more by women than men. However, the men create boreholes and make basins around the cocoa trees in order to maintain the humidity of the cocoa trees' soil.

Table 9. Relationship between adaptation practices in soil water management and gender

Practices	Modalities	Gender		Test of (khi-2)	Relationship between gender and water management practice				
		M	F		Estimate	Std. Error	z value	Pr (> |z|)	Significance
Modeplant	Plantain between 4 cacao trees	15.3	13	0.000	1.37-01	3.28-01	0.417	0.6766	ns
	Plantain close to cacao trees	69.8	66.7						
	Both modes	0.3	10.1						
	Other	14.6	10.1						
Consereau	Wells	6.9	2.9	0.021*	-1.56+01	1.92+03	-0.008	0.9935	ns
	Water tank	11.1	2.9						
	Bowl techniques	14.9	8.7						
	No practice	67	85.5						

Note. Significance of regression: Significant "s" when P < 0.05; not significant "ns" when P > 0.05. Modeplant: not significant, P = 0.6766; Consereau: not significant, P = 0.9935.

3.3.7 Harvest and Conservation Management Practices

The frequency of harvesting was not influenced by gender. However, the post-harvest activities analyzed were influenced by gender (P = 0.02). When rainfall is abundant, most farmers harvest once every 14 days (43% of women versus 48% of men). 35% of female cocoa farmers fermented the beans for 6 days, while men fermented the beans in 4 days (33%). In the absence of rain, only women harvested the pods at least once a week (16% versus 1% of men) and most fermented for 6 days (54% of women versus 47% of men) (Tables 11 and 12).

Table 10. Relationship between harvesting and fermenting practices during rainfall abundance by gender

Practices	Modalities	Gender		Test of khi-2	Relationship between gender and harvesting and fermentation practices				
		M	F		Estimate	Std. Error	z value	Pr(> |z|)	Significance
Frequency of harvesting if it rains	1 × week	2	9	0.110	-3.32E01	5.25-01	-0.632	0.5273	ns
	1 × 2 weeks	48	43						
	1 × 3 weeks	20	15						
	1 × month	30	34						
Fermentation frequency if rain	3 days	17	24	0.038*	9.21E-03	4.64E-01	0.02	0.02	s
	4 days	33	25						
	5 days	25	15						
	6 days	22	35						
	7 days	4	1						

Note. Significance of the regression: Significant "s" when P < 0.05; not significant "ns" when P > 0.05. Harvest frequency if rain: not significant, P = 0.5273; Fermentation frequency if rain significant, P = 0.02.

Table 11. Relationship between harvesting and fermentation practices in the absence of rain by gender

Pratictices	Modalities	Gender		Test of khi-2	Relationship between gender and harvesting and fermentation practices				
		M	F		Estimate	Std. Error	z value	Pr(> |z|)	Significance
Harvesting frequency in the absence of rain	1 × week	1	16	0.000	6.96E-01	5.91E-01	1.177	0.2393	ns
	1 × 2 weeks	44	31						
	1 × 3 weeks	22	21						
	1 × month	33	31						
Fermentation frequency in absence of rain	3 days	9	10	0.930	-1.19-01	4.07-01	-0.294	0.769	ns
	4 days	16	13						
	5 days	20	15						
	6 days	47	54						
	7 days	8	7						

Note. Significance of regression: Significant "s" when P < 0.05; not significant "ns" when P > 0.05. Harvest frequency in absence of rain: not significant, P = 0.2393; Fermentation frequency in absence of rain, not significant, P = 0.769.

4. Discussion

The objective of this study is to provide scientific information on the level of engagement of women in the adoption of climate change adaptation practices in cocoa sector in Côte d'Ivoire. To carry out this study, analyses were done on socio-demographic characteristics, women's and men's perception of climate change and adaptation practices adopted to cope with climate change. The socio-demographic characteristics of cocoa farmers indicate that women are less involved in cocoa farming. The low proportion of women may be due to the fact that they do not have sufficient land and area to develop cacao farming. As Yemefack et al. (2013) point out, women are generally disadvantaged mainly in relation to customary land acquisition regimes. Our work has shown that the majority of women are illiterate and very few of them have a primary education. This low level of education among women can be explained by the reticence of parents in previous decades to send young girls to school. These findings are in line with those of Marston (2016) who following her study on women's rights in the cocoa sector in Côte d'Ivoire, stated that many women in rural communities have a low level of education.

The distribution of work experience in cocoa production showed that the majority of women had between 0 and 10 years of experience while men had more than 21 years of experience. This indicates that women are increasingly accessing land through gifts from husbands or fathers in recognition of their contribution to the farm, a practice that is particularly common among the matrilineal Akan (Quisumbing et al., 2001; Duncan, 2010).

Depending on how men and women differ in terms of education and years of farming experience, their understanding of climate variability could also differ. The analysis showed that there is not significant difference between gender and perceptions of climate variability. This is in line with some research reports that reveal, in most West African countries, producers are aware of climate variability (Fosu-Mensah et al., 2012). Despite the indifferences between genders in the perception of climate variability, the majority of cocoa farmers, men and women, distinguished drought, irregular rainfall and too low air humidity in the cocoa plantations. These results are in agreement with the work of certain authors who confirm that climatic variability would be manifested by a drop in rainfall, long dry and harsh seasons which will be detrimental to cocoa production (Bigot et al., 2005; Fièle et al., 2019). To mitigate the effects of these climatic factors, several adaptation practices have been developed and adopted by cocoa farmers in the different agro-ecological zones. The results of the data obtained in the field revealed that most of the adaptation practices are mostly adopted by women. This could be because women are more vulnerable to climate variability than men. Therefore, they will have a high likelihood of adopting adaptive practices as a necessary intervention to respond to erratic onset of rainfall and drought. The study also showed that there is not significant difference between gender and nursery management practices and land preparation. However, our results only illustrate that the majority of women, in addition to opting for sites close to water points like men, do their nursery at home for better monitoring of plants This could be explained by the fact that women are very involved in the activities carried out during the establishment of the nursery, even in the farms where the man is owner, it is noted that women would play a primordial role (Fair Labor Association [FLA], 2015). Cocoa plantation management practices are the same for women and men. The producers plant the plantain trees to increase the percentage of success of the new plantation. The role of temporary shade is to protect young cocoa trees against direct exposure to the sun and strong winds. According to the Conseil du Café-Cacao (2015) temporary shade is traditionally done by producers with plantain and Leguminous such as *Gliricidia sepium, Albizzia lebbeck*. The adoption of permanent or temporary shade trees is done by farmers to contribute to crop diversification and food security. In the cocoa sector, women's economy generally comes from food crops that they grow for marketing purposes in addition to those for household consumption. The results of the logistic regression showed a significant gender difference in the adoption of manual weeding practices. Research reveals that herbicide-based weeding is an activity that is mostly carried out by men or workers (Klasen et al., 2010). Gender is not significant in the adoption of soil moisture and water management practices in plantations. Indeed, to maintain water and soil humidity around the cocoa trees, the producers mostly use the method of planting banana near the cocoa trees and between four cocoa trees. This corroborates the work of Daymond and Hadley (2008) which confirms that soil irrigation techniques are obvious solutions in a changing climate. The descriptive analysis (frequency) shows that the techniques of wells, basin and the establishment of water reservoirs in the plantation are mostly carried out by men for the management of water in the plantation This could be due to the fact that women do not have sufficient funds to purchase drilling and tank equipment and to pay for labour for preparation. In the case of abundant and absent rainfall most farmers change their harvesting and fermentation practices to avoid losses and degradation of bean quality. However, the post-harvest activities analyzed are influenced by gender ($P = 0.02$) in the case of abundant rainfall. The results reveal that 35% of women compared to 22% of men are likely to ferment the beans over a longer period of time. Indeed, women are very much involved in post-harvest activities including fermentation and drying. These practices are generally best adopted by women in a changing climate. The reason for the better quality of the bean among women is the diligence and special attention given to improving the quality of the cocoa produced. These results are in line with some studies that show women's involvement in harvesting, fermenting, sorting and drying the beans (Leadafricaines, 2012). Given the involvement of women in harvesting and post-harvest activities, Barrientos (2013) argues that the future of high quality cocoa production depends on the women involved.

5. Conclusion

Climate change is a reality in Côte d'Ivoire. The main cacao production areas suffer from climatic variability which affects production. To cope with this, producers are adopting various adaptation strategies in the different cocoa tree production areas. The study showed that although cocoa tree cultivation is considered a male activity, women are also interested in it and are very involved in the adoption of key climate-smart practices. They are involved in several stages of cocoa farming, namely, the establishment of the nursery, the choice and preparation of the land, the management of shade, the management of water and soil fertility, and the management of the harvest and of the cocoa crop. Given their involvement in each stage of cocoa tree cultivation, they are therefore able to fully dispose of their cocoa tree plantation. Adopting the best climate smart practices by women in cocoa sector could therefore boost the country's productivity quality.

Acknowledgements

This work was done in the framework of the Adaptcoop project in Côte d'Ivoire. The authors would like to thank the IDRC (International Development Research Centre of Canada) for funding the project. We also thank SCODEVI, OURANOS, WASCAL/CEA-CCBAD (African Centre of Excellence on Climate Change, Biodiversity and Sustainable Agriculture).

References

Adjaloo, M. K., Oduro, W., & Banful, B. K. (2012). Floral Phenology of Upper Amazon Cocoa Trees: Implications for Reproduction and Productivity of Cocoa. *International Scholarly Research Network, 2012*, 8. https://doi.org/10.5402/2012/461674

Barrientos, S. (2013). *Gender Production Networks: Sustaining cocoa-chocolate sourcing in Ghana and India* (p. 30). Brooks World Poverty Institute, Manchester. https://doi.org/10.2139/ssrn.2278193

Bigot, S., Brou, Y. T., Oszwaid, J., & Diedhiou, A. (2005). Factors of rainfall variability in Côte d'Ivoire and relations with certain environmental modifications. *Sécheresse, 16*, 5-134.

Brou, Y. T., Ngoran, J. A. K., Bicot, S., & Servat, E. (2003). Climate risk and agricultural production in Côte d'Ivoire: effect of rainfall variations on cocoa production. *Proceedings of the 14th International Conference on Cocoa Research, October 18-23, 2003, Accra, Ghana* (pp. 259-267).

Conseil du Café-Cacao. (2015). *Technical manual on sustainable cocoa production* (p. 165).

Daymond, A. J., & Hadley, P. (2008). Differential effects of temperature on fruit development and bean quality of contrasting genotypes of cacao (*Theobroma cacao*). *Annals of Applied Biology, 153*(2), 175-185. https://doi.org/10.1111/j.1744-7348.2008.00246.x

Dohmen, M. M., Bisseleua, D. H., Ouattara, C., Walz, H., M'Bo, A. A. K., Degrande, A., … Muilerman, S. (2020). *Extension manual for climate-smart cocoa farming* (p. 132). World Cocoa Foundation and Rainforest Alliance.

Duncan, B. (2010). Cocoa, marriage, labour and land in Ghana: Some matrilineal and patrilineal perspectives. *Africa, 80*, 301-321. https://doi.org/10.3366/afr.2010.0206

Eldin, M. (1971). The climate. The natural environment of the Côte d'Ivoire. *Mémoires ORSTOM, 50*, 77-108.

Enete, A. A., & Amusa, A. T. (2010). Determinants of Women's Contribution to Farming Decisions in Cocoa Based Agroforestry Households of Ekiti State, Nigeria. *Tropicultura, 28*, 77-83.

Fadimatou, A. (2015). *The organisation of work in cocoa tree-based agroforestry systems: The case of the village Yambassa* (p. 28).

Fièle, Y., Benjamin, K. K., Adama, D., Louis, A. M., Yapo, K. K., Dro, T., … Paul, A. (2019). Evaluation of Rainfall and Temperature Conditions for a Perennial Crop in Tropical Wetland: A Case Study of Cocoa in Cote d'Ivoire. *Advances in Meteorology, 2019*, Article ID 9405939. https://doi.org/10.1155/2019/9405939

FLA (Fair Labor Association). (2015). *Assessing the current situation of women and young farmers and the nutritional status of their families in two cocoa-producing communities in Côte d'Ivoire* (p. 53). Report Forum Nachhaltiger Kakao.

Fosu-Mensah, B. Y., Vlek, P. L., & Macarthy, D. S. (2012). Farmers' perception and adaptation to climate change: A case study of Sekyedumase district in Ghana. *Environ Dev Sustain, 14*, 495-505. https://doi.org/10.1007/s10668-012-9339-7

IFAD (International Fund for Agricultural Development). (2012). *Youth in Agriculture*. Special session of the Farmers' Forum Global Meeting, Synthesis of Deliberations, February 18, 2012, Italy

IPCC (Intergovernmental Panel on Climate Change). (2013). *The Physical Science Basis*. Contribution of Working Group I to the Fifth Assessment Report, Summary for Policymakers, Intergovernmental Panel on Climate Change.

Joseph, J.A. (2021). *Logiciel R Vesrsion 4.1.2 5*.

Kanohin, F. O., Saley, M. B., Aké, G. E., & Savané, I. (2012). Climate variability and production of coffee and cocoa in wet tropical zone: The caseof Daoukro region (east-central Côte d'Ivoire). *International Journal of Innovation and Applied Studies, 1*, 194-215.

Klasen, S., Kumase, W., & Bisseleua, H. (2010). Opportunities and constraints in agriculture: A gendered analysis of cocoa production in Southern Cameroon. *Courant Research Center: Poverty Equity and Growth—Discussion Papers* (No. 27, p. 63). Georg-August-Universität Göttingen, Germany.

Koua, S. (2018). Characterization of cocoa orchards and diseases in Côte d'Ivoire: Case of Abengourou, Divo and Soubré departments. *Journal of Animal &Plant Sciences, 35*, 5706-5714.

Kpangui, K. B. (2015). *Dynamics, plant diversity and ecological values of cocoa tree-based agroforests in the Kokumbo sub-prefecture (centre de la Côte d'Ivoire)* (p. 187, Thèse de Doctorat, Université Félix Houphouët-Boigny, Abidjan).

Leadafricaines, Gender Equality. (2012). *Protection and promotion of women's rights and social and economic empowerment: Report Care-Union Européenne* (p. 8).

Louis, G. Y., Kouadio, K. A., & Gnamba, Y. J. B. (2019). *The extension of cocoa cultivation and the degradation of the forest environment in the Department of DUEKOUE: Review of geographical space and Moroccan society* (Vol. 30, p. 75).

M'Bo, K. A., Kouassi, A., Amani, K., Degrande, A., Bayala, J., & Kouame, C. (2019). Climate adapted recommendations for the cacao regions of Côte d'Ivoire. *Study to develop a training programme on the best practices in climate-smart cocoa production in Côte d'Ivoire* (p. 81). World Agroforestry, ICRAF-West and Central Africa & Rainforest Alliance, Abidjan, Côte d'Ivoire.

Marston, A. (2016). *Women's rights in the cocoa sector: Example of emerging good pratices* (p. 32). Rapport Oxfam, Ghana.

Moscarola & Baulac. (2016). *More sophisticated survey software*.

Moser, G., Leuschner, C., Hertel, D., Hölscher, D., Köhler, M., Leitner, D., … Schwendenmann, L. (2010). Response of cocoa trees (*Theobroma cacao*) to a 13-month desiccation period in Sulawesi, Indonesia. *Agrofor Syst, 79*, 171-187. https://doi.org/10.1007/s10457-010-9303-1

Ofori-Boateng, K., & Baba, I. (2011). An empirical analisis of the impact of climate change on cocoa production in selected countries in West Africa. *Journal of Sustainable Development in Africa, 13*, 24-50.

Quisumbing, A., Payongayong, E., Aidoo, J., & Otsuka, K. (2001). Women's land rights in the transition to individualized ownership: Implications for tree-resource management in Western Ghana. *Economic Development and Cultural Change, 50*, 157-182. https://doi.org/10.1086/340011

Schroth, G., Läderach, P., Matinez-Valle, A. I., Bunn, C., & Jassogne, L. (2016). Vulnerability to climate change of cocoa in West Africa: Patterns, opportunities and limitations to adaptation. *Sci Total Environ, 556*, 231-241. https://doi.org/10.1016/j.scitotenv.2016.03.024

Smit, B., & Skinner, M. W. (2002). Adaptations options in agriculture to climate change: A typology. *Mitigation and Adaptation Strategies for Global Change, 7*, 85-114. https://doi.org/10.1023/A:1015862228270

SODEXAM. (2019). *Airport and Meteorological Operation and Development Company*. Retrieved from https://www.sodexam.com

Yemefack, M., & Alemagi, A. (2013). *Feasibility Study for Emission Reduction*. the Efoulan Council, South Cameroon, Mohamed Elloumi Institut National de la Recherche Agronomique, Ariana, Tunis.

Copyrights