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Supplying Environmental Services through Sustainable Agriculture in Rural Cameroon: An Estimation of Farmers' Willingness to Accept in Barombi Mbo

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ABSTRACT: The supply of environmental services from the multi-functionality of agriculture requires some forms of non-market valuation. The objective of the study is to estimate farmers' willingness to accept to supply biodiversity conservation and carbon sequestration through agro-forestry and afforestation, based on a survey of 200 farmers in Barombi Mbo. The results indicate that almost all farmers perceive the importance of forest for climate regulation, flood control, erosion control, wildlife habitat, and as a spiritual site. A total of 85.5% of farmers express a positive willingness to accept (WTA) for afforestation programme, while some are willing to adopt agro-forestry. From the Tobit model results, variables age, origin, environmental sensitivity, awareness to payment for environmental services scheme and knowledge of bio-fertilizers significantly influence the WTA. The mean WTA for environmental services provision is up to 4,488 FCFA /year with a total cost of afforestation programme of 1,370,491 FCFA /year. With appropriate policy incentives, farmers could adopt these practices and contribute to the improvement of the environment.

KEYWORDS: Sustainable Agriculture, Environmental Services, Externalities, Willingness to Accept, Cameroon.

1 INTRODUCTION

The agricultural ecosystems are shown to provide and rely upon important ecosystem services and primarily managed to optimize the provision of ecosystem services of food, fiber and fuel. On one hand, they depend upon a wide range of supporting and regulating services, including water, soil fertility and pollination that determine their underlying biophysical capacity; and on the other hand, they negatively affect the environment through overuse of natural resources as inputs or their use as a sink for waste and pollution [1], [2], [3], [4]. However, sustainable agriculture started to generate significant interest in the 1980s and has come to represent not just a different set of technologies to conventional agriculture, but a means to achieve sustainable development [5]. Defined as agro ecology, low-input agriculture, biological agriculture, regenerative agriculture or organic agriculture, sustainable agriculture aims to increase agricultural production while reducing negative effects on environment and providing a range of environmental services. Whereas ecosystem services are benefits people obtain from ecosystems [6], Environmental Services (ES) are externalities generated by human activities that sustain the provision of ecosystems services, including biodiversity conservation and carbon sequestration. The concept of ES is frequently used in the current debate on the multi-functionality of agriculture to describe the various agricultural activities that contribute to maintain, preserve, and to improve the environment in its various dimensions, including landscape, natural resources, and ecosystems [1], [3], [4], [2], [7], [8], [9], [10], [11]. An important place is then given to agriculture in providing these services, especially in developing countries where agriculture is one of the main sectors.

Agriculture is the mainstay of economy in Cameroon. About 75 % of the active population (estimated at 10,463,041 inhabitants) is involved in agricultural production, which accounts for 50 % of total exports and 19.7% of gross domestic product [12]. However, because of forests conversion, total forest area passed from 22.5 million ha in 1975 to 19.5 million in 2005, corresponding to a deforestation rate of 0.48% per year [12]. Peasant farmers used traditional methods to grow food crops for subsistence. A system of shifting agriculture was common and long fallow periods ensured ecological sustainability. With the decreasing land availability due to the creation of national parks (10 between 2006 and 2011) to protect biodiversity, in areas where traditional shifting agriculture is still practiced, fallow periods have been reduced or are non-existent anymore. Hence, soil fertility in the cleared land cannot recover to optimal levels and thus slash-and-burn farming systems become unsustainable. In some areas of Cameroon such as that of Barombi Mbo, this process is contributing to deforestation.

Barombi Mbo village shares borders with a protected Forest Reserve established in 1940 in order to protect the flora and fauna diversity in the area as well as those in “Barombi Mbo Lake”. The economic, social and cultural life of Barombi Mbo people is intimately linked to the use of the Lake and reserve’s resources. However, the reserve is threatened by the destruction of vegetation to provide land for farming. Very extensive areas of the reserve had been encroached and transformed into food crops farms, cocoa, palm oil and rubber plantations [13]. Unsustainable farming practices including slash and burn have largely contributed to the high rate of deforestation and forest degradation recorded in the area [14]. Some of the farms and cocoa plantations are located at the border of the lake, and the use of chemical fertilizers and pesticides to spray cocoa harms water quality as well as the life cycle of fishes in the lake. These unsustainable farming activities and encroachment into the reserve thus contribute to the depletion and the loss of biodiversity.

Given the unsustainable farming practices that affect both biodiversity and ecological sustainability in the zone coupled with the growing population due to soil fertility, there is a need to promote adoption of production models that favor biodiversity conservation such as agro-ecology.

However, preserving agricultural biodiversity depends on fuller recognition of the importance and economic value of natural resources including soil and forests and the ecosystem services they provide. Attempts to place a monetary value on ES provided by agriculture underline its rising importance in ecological and economic terms [15].Valuable approaches for promoting biodiversity conservation are payments for environmental services (PES). PES provide financial transfers to landowners, farmers and communities whose land use decision may affect biodiversity values and create incentives for conservation of plant and animal species. However, if in theory, PES is an economic incentive mechanism for the provision of ES, analyzing their implementation especially in agricultural sector underlines the great dependence of their effectiveness on their social acceptability. Moreover, given the difficult task to evaluate the biodiversity through market mechanism, the compensation for biodiversity conservation is usually based on the opportunity cost of changing practices or to restrict use rights. However, by doing so, the amount and the nature of payments are not always sufficient to make the changes in agricultural practices accessible to farmers [16], [17]. Alternatives are then proposed, as taking into account the willingness to accept (WTA) of ES providers in the determination of PES structure [18], [19], and farmers’ perception of the importance of forests and their conservation practices that may be of great importance to design suitable incentive management schemes [20], [21]. Moreover, economic value of ES provided by farmers has not received much attention in Cameroon, and the lack of data on PES mechanism so as to study their profitability as well.

The study aims to identify criteria through which Barombi Mbo farmers perceive the negative effects of their practices on the environment, and to estimate farmers’ willingness to accept to supply ES through agroforestry or afforestation that contributes to sustain agriculture in the community using the Contingent Valuation Method. A positive WTA reveals their decision to participate. The study is organized in four sections. The next section presents the material and methods, including the contingent valuation approach, and the following presents and discusses the results. The final section consists of conclusion and implication.

2 MATERIAL AND METHODS

2.1 STUDY ZONE

Barombi Mbo community is situated in the Meme Division of Southwest region of Cameroon and is one of the villages at the periphery of Lake Barombi Mbo Forest Reserve (limited by black line in fig.1.), that was created in 1940 by Colonial government to protect the Lake and where natives of the village were given the rights to fish in the Lake and harvest cocoa in existing farms in the Reserve (RIS, 2008). However, as years passed, the resources attracted more people, leading to illegal farming, hunting, timber and NTFPs exploitation in the Reserve coupled with uncontrolled fishing [13], [14].

The major food crops cultivated are cassava (*Manihot esculentum*), plantain (*Musa paradisiacal*), Egusi melon (*Cucumis sativus*), maize, cocoyams, taro (*Colocasia antiquorum*). Cocoa, palm oil, rubber, are the major cash crops in the zone, characteristics of the humid forest agro-ecological zone of the South-West. Barombi Mbo has a typical equatorial climate with two major seasons which are made of a long rainy season (March-November) and a short dry season (December-February). The village was reputed hot with an average annual temperature varying from 20°c to 30°c (Delegation of Agriculture Kumba). However, the last survey revealed a mean annual temperature of approximately 18°c or even less as the altitude increase and an annual precipitation ranging from 1825 to 3000mm [22]. The area has been experiencing drastic climate changes as rains come sometimes earlier in March with unexpected rains during dry seasons. Rainfall was experienced right up to December in 2010 instead of October –November as was the case in the past, altering the planting and production seasons of cash and food crops, as well as other economic activities [14].

Furthermore, the area is made up of steep slopes prone to erosion and has a mixture of limon, laterite, sandy, clay and volcanic soils. These soils have a high content of andosols and are composed of volcanic materials, usually dark. They are generally fertile and favor the growth of food and cash crops. However, in deforested and degraded areas, soils are gradually losing fertility due to increased slash and burn, soil exposure, pollution, over cropping and leashing [14]. Agriculture is gaining more and more importance in the area at the expense of forest and result in the pollution of the lake by accumulation of fertilizers used.

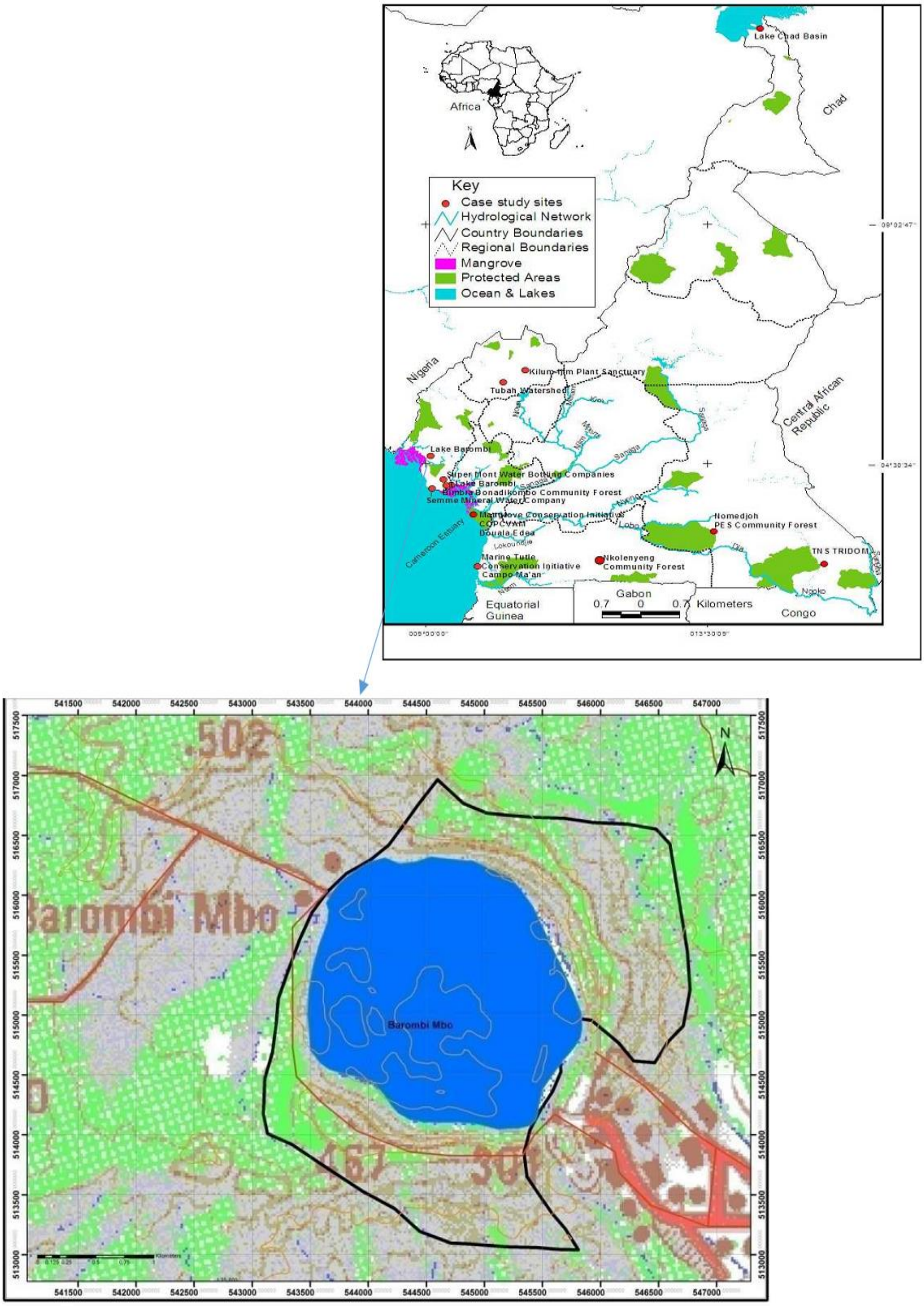

Fig. 1. Barombi Mbo village location (with red point) and Forest Reserve map in black line

2.2 Field Survey

Several types of sustainable agriculture practices have been promoted among farmers in the Meme Division by the Ministry of Agriculture and Rural Development (MINADER), including *farmer field school* and *farmer business school.* Through *farmer field school*, MINADER trained farmers on the good agricultural practices via cooperatives. Through *farmer business school*, agriculture is considered as a source of income with the promotion of agro-forestry. The institution provided farmers with the improved corn seedlings, maize seeds, cassava cuttings and some pesticides and fertilizers. However, the difficulties encountered by farmers to adopt agro-forestry practices were the unavailability of improved agro-forestry species or nursery and the insufficient available land for planting. Furthermore, Barombi Mbo village was not a targeted village due to its location closed to the reserve managed by the Ministry of Forestry and Wildlife (MINFOF), where people do farming and other illegal activities. Moreover, the lack of collaboration between the two institutions on the field, leads MINADER to do not give the opportunity to Barombi Mbo farmers to learn and benefit from agro-forestry practices.

2.3 Contingent Valuation Approach

In the last decade, agricultural and/or forestry ecosystems have been recognized to offer potential to deliver four main ES that are carbon sequestration, biodiversity conservation, watershed protection and landscape beauty. Therefore, these ecosystems have contributed to deliver and maintain a range of valued positive externalities, and have been proven to be less vulnerable to shocks and stresses. From this view, positive externalities of production are supplied essentially by agents using environmental components and natural resources in their production process. Farmers and forest users are then implicitly considered as the main providers of ES and these ES are thus by-products of joint production (agriculture, forestry). But as these benefits are considered public goods, these agents generally have little motivation to supply them at optimal levels unless market incentives are established. Moreover, although sustainable agriculture gives opportunity to deliver ES and vis-versa, a standing forest usually represents a potential source of income that can be accessed through logging or farming in the case of sudden need. Farmers may thus be unwilling to introduce changes in their production systems that involve a loss of these means. Therefore, these positive environmental externalities should then be internalized. Due to the use values and non-use values of ecosystem services, and given that we are dealing with public goods where rights are held collectively, this is often not an easy task. If an individual, such as a farmer, has exclusive property or user rights over a good and is being asked to give up or restrict that entitlement in terms of exclusivity or transfer of user rights, then the correct measure within a contingent valuation framework is WTA [23]. In this sense, there is some evidence that farmers through exposure to agri-environmental schemes have become familiar with the trade-off between agricultural production and provision of environmental public goods [24], [25], [26], [27].

2.4 Survey Design And Data Collection

A population of 595 inhabitants was reported in March 2015, with 349 male and female above 15 years old by the Programme for Sustainable Management of Natural Resources in the Southwest region (PSMNR-SWR/ [14] The following formula: $n = \frac{N}{1+N\epsilon^2}$ was used to representatively select 200 farmers in the village, where N=349 is the number of individuals older than 15 years old[1] and $\epsilon = 4.6\%$ is the *margin error*.

Structured questionnaires were used as survey instrument and farmers were randomly selected in the village for face to face interviews.

Questionnaire design: Questionnaires included firstly information on the socioeconomic characteristics of farmers and farm characteristics, environmental variables in order to test the validity of CVM and to establish factors affecting the WTA, and secondly a hypothetical scenario describing the changes in the farm due to the current practices for the CVM exercise. Indeed, questions were related to age, gender, education level, family size, and origin of the farmer. Questions on the location and size of farms were also introduced as owning enough environmental strategic land could influence the farmer's participation. Moreover there were questions on the value of the present agricultural revenue from the farm, the types of fertilizers and pesticides used, in order to examine how the land opportunity cost or on-farm income could make the compensation or payments attractive in a potential PES programme. Farmers with higher profit levels from existing activities will generally demand higher levels compensation to entering any conservation scheme. This approach was design to minimize any tendency to overstate the compensation requirements. In addition, a question was related to the perception of the outcome of practices

[1] The selection of an age greater than 15 years allowed to account for farms that are owned or managed by youths when both or one of their parents are not around or still alive.

such as heavy use of chemical fertilizers, slash and burn that could lead farmers to adopt agroforestry with more positive impact on income and environment. Furthermore, questions related to the social, environmental and cultural values such as the importance of non-timber forest products (NTFPs) (that could favor forest conservation or afforestation), the environmental sensitivity, the access to information and knowledge of agroforestry and bio-fertilizers technologies, and the awareness to the PES mechanism were also introduced in the questionnaire. The description of the potential variables and their expected signs are given in

The questionnaires were first pretested with 28 farmers. The objective was to verify its well understanding by farmers and to determine the amounts to be proposed for the valuation question. To achieve this latter objective, an opened valuation question was used to measure the WTA of farmers for ES provision. After the presentation of the hypothetical scenario, the opened question was: W*hat would you expect as annual compensation for trees planted in or out of the Reserve?* After the test, the questionnaire was then revised to incorporate farmers' suggestions on the types and levels of activities carried out in the farm and reserve, and on the WTA for ES. The amounts obtained from the opened question allowed determining the distribution of WTA that was used to determine the amounts or offers proposed per year for final data collection. Rather than retaining the values between the 15th and 85th percentile and out of the tail of the distribution as recommended by [28] for WTP, we retained the two low amounts that were FCFA 10,000[2] and FCFA 15,000, due to the tendency of people to overstate their WTA as highlighted by [29]. Moreover, 1 or 2 amounts proposed are theoretically optimal [30] and a smaller number of bids are preferred to a larger number of bids, as it increases estimation efficiency and the power of statistical tests [31]. Each of the two amounts was then affected to 50% of the sample to ensure the equal-distribution of the offers. A WTA question to establish the minimum amount in cash or the compensation in nature the farmer would decide to accept for changes from the current land use to a productive agricultural system in the farm was presented using a simple close ended format. All this procedure allowed overcoming the bias of overestimation of WTA by respondents

2.5 ANALYTICAL MODEL

A simple Tobit model [32] was used to model farmers WTA using maximum likelihood estimation procedures. Tobit model constitutes the basic structure of the models with limited dependent variable that derive from the qualitative variables models, in the sense where one should model the probability for the variable to belong to the interval in which it is observed.

From the original model of [32], the WTA belongs to the interval $[0 + \infty[$ as there exists no negative compensation and this justifies the use of censored regression model. The choice is dichotomous: either the respondent agrees to participate, $WTA > 0$ or he does not accept, $WTA \leq 0$. The Tobit model was largely applied to the studies of technologies adoption or participation in conservation programmes [25], [30], [16]. The conceptual model is given by Eq.1 below:

$$WTA_i = \boldsymbol{X}_i\boldsymbol{\theta} + \boldsymbol{\mu_i} = \boldsymbol{E}(WTA_i^*) + \boldsymbol{\mu_i} \; (1)$$

Where, $\boldsymbol{X}$, is a row vector of explanatory variables that determine the respondent $\boldsymbol{i}$'s WTA or to participate in the sustainable agricultural or conservation programme, θ a column vector of the parameters to be estimated, $\boldsymbol{\mu}$ an error term with a normal distribution $N(0, \sigma_\mu^2)$, and with:

$$WTA_i = \begin{cases} WTA_i^* \, if \; WTA_i^* > 0 \\ 0 \, if \; WTA_i^* \leq 0 \end{cases} \; (2)$$

WTA_i^* follows a normal distribution and is a latent variable representing the observed WTA of individual i. The Tobit model is composed of two parts: a continuous part corresponding to a linear regression and a discrete part related to the censored point, equal to zero in this case. The probability that WTA_i^* takes a negative or a value equal to zero is given by:

$$Prob\,(WTA_i^* \leq 0) = \emptyset\left(-\frac{\boldsymbol{X}_i\boldsymbol{\theta}}{\sigma}\right) = 1 - \emptyset\left(\frac{\boldsymbol{X}_i\boldsymbol{\theta}}{\sigma}\right) \; (3)$$

And the probability for WTA_i^* to take on positive value is:

[2] The exchange rate US dollar or Euro /FCFA are as follow: $US1=FCFA500 (generally considered as average of fluctuations); €1=FCFA655.957.

$$Prob\ (WTA_i^* > 0) = 1 - \emptyset\left(-\frac{\boldsymbol{X}_i\boldsymbol{\theta}}{\sigma}\right) = \emptyset\left(\frac{\boldsymbol{X}_i\boldsymbol{\theta}}{\sigma}\right)\ (4)$$

The conceptual model (1) was estimated by maximum likelihood using Stata 13, with the log likelihood function given by Eq.5:

$$Log\ L = \sum\nolimits_{WTA_i>0} -(\frac{1}{2}Log2\pi + \frac{1}{2}Log\ \sigma^2 + \frac{1}{2\sigma^2}(WTA_i - \boldsymbol{X}_i\boldsymbol{\theta})^2)\ + \sum\nolimits_{WTA_i\leq 0} Log\ \left(1 - \emptyset\left(\frac{\boldsymbol{X}_i\boldsymbol{\theta}}{\sigma}\right)\right)\ (5)$$

2.6 EMPIRICAL MODEL

The dependent variable is WTA which takes positive values if a farmer accept the proposed amount to switch to sustainable practices and value zero if not. As far as the explanatory variables are concerned, we use insights from a considerable amount of empirical researches, that has sought to explain farmer's valuation of ES, adoption of agricultural technologies and participation in conservation programmes in both developed and developing countries [27], [33], [34], [35], [36], [37], [38], [39]. This allowed deriving questions in the design of questionnaires and then to explore the determinants of farmer participation or farmer's WTA as presented in

Given these critical assumptions for participation (WTA) from Table 1, the model estimated from Eq.1 above in this study is:

$$E(WTA_i^*) = \theta_1 + \theta_2 AGE + \theta_3 GEND + \theta_4 ORIGIN + \theta_5 EDU + \theta_6 FHSIZE + \theta_7 ONFINC + \theta_8 LOFARM + \theta_9 FASIZE + \theta_{10} ENVSTY + \theta_{11} AWPES + \theta_{12} BIOFERT + \theta_{13} OUTCPRA + \theta_{14} NTFPs\ (6)$$

The mean WTA is computing using the following formula adapted from Terra (2010) with tobit estimate:

$$\widehat{E}\ (WTA_i^*) = \boldsymbol{x}_i\widehat{\boldsymbol{\theta}}\ (7)$$

Where $\boldsymbol{x}_i$ represent the mean of variables that significantly influence the WTA and $\widehat{\theta}$ the estimated coefficients of those variables.

Table 1. Description of variables to be used in the regression and their expected signs

Variable	*Description*	*Expected signs*
AGE	*Age of farmer (CONTINUOUS)*	$(\pm)$
GEND	*Sex of farmer (DUMMY): 1 if male and 0 if female*	$(\pm)$
ORIGIN	*Origin of farmer (DUMMY): 1 if native and 0 if non-native*	$(+)$
EDU	*Education level of farmer (CATEGORICAL): 0 if None (never been to school), 1 if primary and 2 if high level (secondary, high school)*	$(+)$
FHSIZE	*Size of farm household (CONTINUOUS)*	$(\pm)$
ONFINC	*Average yearly on-farm income (CONTINUOUS)*	$(+)$
LOFARM	*Location of the farm (DUMMY): 1 if out of the reserve and 0 if otherwise*	$(+)$
FASIZE	*Size of the farm (DUMMY): 1 if more than 5ha and 0 if not*	$(+))$
ENVSTY	*Environmental sensitivity of farmer (DUMMY): 1 if sensitive to the role of forest to protect the environment and 0 if not*	$(-)$
AWPES	*Awareness of PES scheme (DUMMY): 1 if yes and 0 otherwise*	$(+)$
OUTCPRA	*Perception of the output of current practices by farmer (DUMMY): 1 if average (average, bad) and 0 if good (good, very good)*	$(\pm)$
BIOFERT	*Knowledge of Bio-fertilizers (DUMMY): 1 if farmer has knowledge on and 0 otherwise*	$(+)$
NTFPs	*Importance of NTFPs to the farmer: 1 if important and 0 otherwise*	$(+)$

3 RESULTS AND DISCUSSION

3.1 TRADITIONAL AND ENVIRONMENTAL PRACTICES IN THE FARM

Farmers have tried to improve their lands for many generations, using the means available to them at the time. shows the traditional and environmental practices used by respondents. Among the 200 farmers, 85 percent of the respondents indicated using chemicals in form of fertilizers and pesticides in their farm to improve soil fertility and to treat cocoa farms. Fungicides and insecticides were the most common type of pesticides used either out or in the reserve. As a technique to prepare soil before sowing, rotation technique was used by 53.5% of the respondents followed by slash and burn (34%). Although the villagers complained of not having enough land for cultivation of their crops, almost a majority (50.5%) of the respondents integrated bush fallow periods of varying lengths into their farms. While 24.5% of the respondents had their farms located in the reserve, a large majority (70.5%) thought that at least 75 percent of the reserve was destroyed due to fuel wood, timber and NTFPs exploitation coupled with farming. However, the negative impacts of these activities in the reserve coupled with deforestation and pesticides at the vicinity of the lake led to identify some practices used by farmers that protect the environment.

Table 2. Traditional and environmental practices by farmers

Modality	Description	Frequency of "yes"	% of the respondents
Chemical use	Overall	170	*85*
	Fungicides	94	*55.29*
	Insecticides	22	*12.94*
Soil preparation techniques	Slash and burn	68	*34*
	Rotation	107	*53.50*
Bush fallow practice		101	*50.50*
Tree conservation	NTFPs	47	*43.12*
	Timber	31	*28.44*
	Fruit trees	21	*19.27*
Afforestation and Origin of seedlings	Fruit trees	70	*67.31*
	NTFPs	27	*27.96*
	From own nursery	48	*46.15*
	Buy	29	*27.88*
	Donation	22	*21.15*
Forest cover destroyed in the reserve	More than 75% of forest destroyed	141	*70.50*
Agro-forestry knowledge		32	*16*
Bio-fertilizers knowledge		61	*30.50*

A majority of the respondents has been practicing conservation by keeping old and big trees in their own farms. The main species of trees kept were NTFPs, and timber, followed by fruit trees. Most of the farmers (52%) planted fruit trees, NTFPs and other species in their farms. The seedlings were obtained mainly from their own nursery or were bought. The planting of trees do not only prevent soil erosion but it also protects the environment.

Agro-forestry is not commonly practiced and this is because of limited awareness on its importance. Only a small proportion of the respondents (16%) have heard about agro-forestry or bio-agriculture. The information has been obtained from various sources ranging from school, village meeting to *farmer field school* initiative of MINADER.

Most of the farmers thought artificial fertilizers are the answers to the declining soil fertility. But what they need is some enlightenment on local ways of preserving the soil from erosion, soil infertility and local ways of making and applying manure on their farms. Therefore, only 30.5% of the respondents have knowledge on the bio-fertilizers. Each of the respondents was invited to explain what is understood by bio-fertilizers.

3.2 FARMERS' PERCEPTIONS

Almost all the respondents (95.5%) highlighted the importance of forests in providing ecosystem services such as climate regulation, flood control, erosion control, wildlife habitat, landscape beauty, cultural and spiritual sites. As far as watershed protection was concerned, most of the respondents (97.5%) perceived a positive relationship between forest cover and water quality. However, only 27% was aware of the PES mechanism. Nonetheless, given their ability in planting different tree species in their own farms, one would expect a full participation of the village communities in the PES scheme if they were given incentives to plant and preserve trees.

3.3 Response Rates To The Amounts Proposed Under The Contingent Valuation

Most of the respondents (87.5%) have given a “yes” response to the two proposed amounts for the afforestation programme in and out of the reserve and at the border of the Lake as illustrated in figure 2 below.

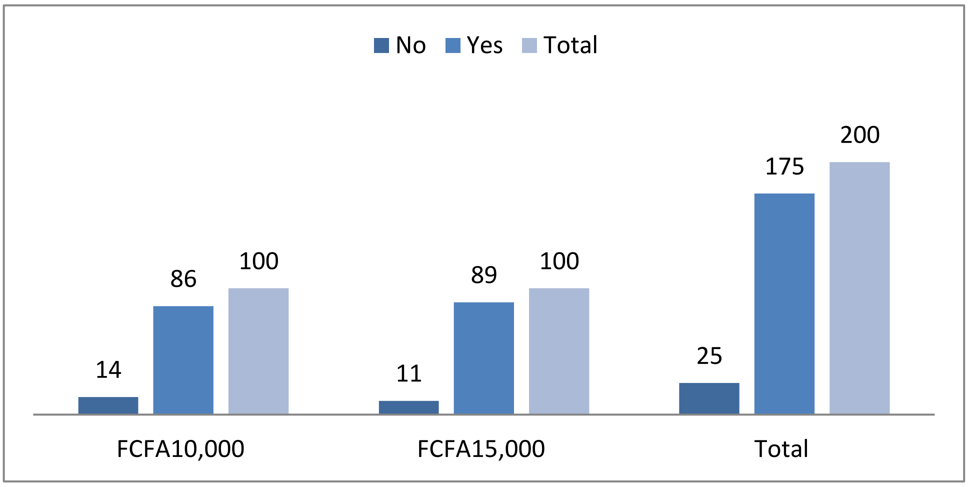

Fig. 2. Response rates to the amounts proposed

Furthermore, the merits of agro-forestry were discussed with the respondents during the survey and 8.5% of those who are close to the lake expressed their willingness to adopt this practice. In addition, they committed themselves to stop using chemicals within 8 meters from the lake, if they are given seedlings for agro-forestry as well as offered training opportunities on the same.

The descriptive statistics of the variables used in the empirical model are given in table 4. below.

Table 3. Descriptive statistics of the variables used in the model

Variable	Mean	Standard Deviation	Min	Max
AGE	41.605	11.58317	18	80
GEND (%)	67	0.4713927	0	1
ORIGIN (%)	85	0.3579675	0	1
EDU	1	0.6649895	0	2
FHSIZE	5.61	2.434654	1	14
ONFINC	1,791,465	1,876,656	20,000	10,000,000
LOFARM (%)	75.5	0.4311665	0	1
FASIZE (%)	35	0.4781665	0	1
ENVSTY (%)	98.5	0.1218575	0	1
AWPES (%)	27	0.4450735	0	1
OUTCPRA (%)	48	0.5008535	0	1
BIOFERT (%)	30.5	0.4615628	0	1
NTFPs (%)	35.5	0.4797141	0	1

3.4 Estimation Results Of WTA And Discussions

The results of the censored tobit regression model are presented in table 5. In addition to the maximum likelihood estimates, their standard deviations and their t-statistics, this table also contains the likelihood ratio statistic, the number of censored observations. The likelihood ratio statistic in this study is 29.96 with 13 degree of freedom and greater than the critical value 22.4, indicating that taken jointly, the coefficients for this model specification are significantly different from zero at 1% level. Five variables were significant in explaining the WTA for afforestation and agroforestry: AGE, ORIGIN, ENVSTY, AWPES, and BIOFERT.

The influence of AGE on the WTA was not clear. The negative sign and the significance at 5% level of coefficient suggest that older farmers are less willing to participate in the afforestation programme. This may be because they are often less disposed in trying new innovations (PES), and/or have less physical strengths and short horizon planning to be involved in tree planting and monitoring. Moreover, regarding the statistic about tree planting in the farm, afforestation is done mostly by respondents aged between 26 to 50 years. This result corroborates with that of [36] that found older farmers to be less willing to participate in agro-forestry technology through the adoption of alley farming, and by [35] in conservation practices of tillage.

The ORIGIN was expected to be positively associated with the participation or WTA. Its coefficient is positive and significant at 10%. This suggests that natives are more willing to participate in the afforestation and agroforestry than the migrants. The reason may be that natives own enough land at their disposal and assured secure long-term control over land than non-natives. This therefore increases the likelihood of the WTA. The more respondents are native the higher is the WTA. This result corroborated with that of [36], where migrants were less willing to adopt agro-forestry due to land constraints.

The influence of ENVSTY was expected to be positive on the WTA. The coefficient is positive and significant at 10%. This suggests that farmers that are sensitive to the protection of environment in its various dimensions (climate, water, wildlife, nature) are more willing to participate in the afforestation programme. Descriptive statistics illustrated that almost all the respondents highlighted the importance of forests in providing ecosystem services. The result corroborates with that of [27] and [16] in the case of agri-environmental scheme where farmers sensitive to environment were more willing to receive compensation to supply ES.

Table 4. Econometric results of factors determining the farmer's WTA for afforestation and agroforestry programme in Barombi Mbo – Cameroon

Variable	Parameter estimate	Standard Error	T-values
AGE (age of farmer)	-91.8859	39.68315	-2.32**
GEND (sex of farmer)	1288.36	803.2158	1.60
ORIGIN (origin of farmer)	1827.739	1062.933	1.72*
EDUC (education level of farmer)	-834.3919	599.0788	-1.39
FHSIZE (size of farm household)	-44.1821	183.4847	-0.24
ONFINC (yearly on-farm income)	-0.0001287	0.0002217	-0.58
LOFARM (location of farm)	86.02045	903.224	0.10
FASIZE (size of farm)	-400.689	842.0968	-0.48
ENVSTY (environmental sensitivity)	5397.789	3254.811	1.66*
AWPES (awareness of PES scheme)	1867.686	846.8506	2.21**
OUTCPRA (output of current practices)	489.006	739.8209	0.66
BIOFERT (knowledge of bio-fertilizers)	3069.288	830.6054	3.70***
NTFPs (importance of NTFPs)	-374.0964	822.4327	-0.45
CONSTANT	6657.821	3805.091	1.75*
LR chi2 (13) = 29.96 Prob > chi2 = 0.0048 Pseudo R2 = 0.0084			

****, **, * significant respectively at 1%, 5%, 10% level*

The influence of AWPES was also expected to be positive on WTA. Its coefficient is positive and significant at 5%. This suggests that farmers that have heard about PES scheme are more willing to participate. This may be explained by the importance of accessing and processing information on the net economic benefits of the PES. From the Abstract statistics, 38.6% of respondents with high education level were aware of PES while only 23.5% with low level were aware. This result corroborates with that of [38] where access to information significantly determined the invitation of the farmers to participate in the conservation, afforestation and sustainable forest management under PES in Costa Rica.

The influence of BIOFERT was expected to be positively associated with the WTA. The coefficient of the variable is positive and significant at 1%. This suggests that farmers with knowledge on bio-fertilizers are more willing to participate in the afforestation programme. This may be explained by various advantages of bio-agriculture which includes improvement of output and soil fertility, prevention of soil erosion and protection of the environment. The rapid growth of agro-forestry species considerably explains this result. The result is in line the literature which considers a prior knowledge on mechanism or technology as an important factor of participation.

Although some variables were not significant, the signs of their coefficients could give some guidelines for decision making. Thus, the positive sign of GEND coefficient indicates that males were more willing to participate than females.

3.5 COMPUTATION OF THE MEAN WTA

It is conventional in contingent valuation to compute the mean WTA. The mean WTA for ES provision was then computed using the formula in eq.7. Thus,

$$Mean\ WTA = 4{,}487.89551\ FCFA/year$$

As 175 individuals gave a positive WTA, the total WTA or the total cost for afforestation was then computed as:

$$Total\ WTA = 4{,}487.89551 \times 349 \times \frac{175}{200} = FCFA1{,}370{,}491.09\ /year$$

Hence, the total cost of the afforestation programme is estimated at FCFA 1,370,491.09/year.

4 CONCLUSION AND IMPLICATION

The criteria through which Barombi Mbo farmers perceive the negative effects of their practices on the environment have been identified as well as the estimated value of the WTA and its determinants. Almost all the respondents highlighted the importance of forests in providing wildlife habitat and in regulating the climate. Therefore, from this farmers' view, deforestation negatively affects the environment. Besides, agro-forestry and bio-fertilizers were still not subject of a common knowledge. From the contingent valuation scenario used, a large majority of respondents expressed a positive WTA for afforestation programme, while some were willing to adopt agro-forestry at least at 8 meters from the Lake to reduce the chemical used at its vicinity. From the econometric model results, variables AGE (-), ORIGIN (+), ENVSTY (+), AWPES (+) and BIOFERT (+) provide some insights into necessary conditions for programme participation. Thus, younger farmers are more likely to participate than older ones; native farmers are more likely to participate than migrants; participation or WTA is higher with the sensitivity to environment and with awareness of PES scheme; and higher with knowledge on bio-fertilizers. The CVM therefore allows concluding of potential participation of Barombi Mbo farmers to a payment for biodiversity and carbon sequestration programme through afforestation and agroforestry. The Mean WTA is estimated at FCFA 4,488/year and the total cost of the programme at FCFA 1,370,491/year.

The results of this study have important implications for policy-making and further researches. Firstly, it provides insights from a field survey and farmers preferences of the cost of PES programme that could be implemented by the government. Indeed, as stated in the country 2014's report to Convention on Biodiversity, the involvement of communities and farmers in PES schemes is of fundamental importance. The study is therefore prospective of potential PES suitability. Secondly, besides the estimated cost to the government, the study provides key information for the initiative to be successful and effective as incentives to adopt sustainable agricultural practices in a way to an agro-allied industrialization. As a matter of fact, the main approaches for biodiversity conservation, including PES, are often combined without a clear and systematic understanding of the perceptions and expectations of some actors. The implementation of an economic incentive mechanism that is socially acceptable from farmers' point of view must be encouraged. Thirdly, field survey and farmers' responses suggest that there is need to provide farmers with training and good seeds or seedlings material for those species that are of interest to them. The constraint to the adoption of agro-forestry promoted by MINADER and tree planting highlights the lack of knowledge and seeds and an absence of collaboration between the ministry of forestry and wildlife and the ministry of agriculture and rural development. Moreover, policies with focus on native young farmers and that aim at improving the level of sensitization on PES mechanism, bio-fertilizers advantages, and environmental sensitivity could promote the provision of ES that sustain agricultural production and natural resources management in Cameroon and Barombi Mbo in particular. Finally, the study provides researchers with information on the criteria farmers use to evaluate the effects of their practices on the environment. The study also expands the range of explanatory variables used in participation programme by including the knowledge of bio-fertilizers (advantage of the agro-forestry) as an independent variable. The significance of this variable at 1% provides some insight on necessary conditions for the participation in agro-forestry technology.

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