

# Farmers' Perception and Willingness to Pay for Climate Information in Burkina Faso

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## Abstract

This study highlights the perception and the option value of climate information in the sahelian and sudano-sahelian agro-climatic zones of Burkina Faso. From the sampled farmers only 21.78% have access to climate information, while 93% of them need climate information to guide through their decision in planning agricultural activities. Option value shows the interest granted by farmers using climate information. About 64% of the farmers are willing to pay an average of Francs CFA 546.34 to obtain climate information. The willingness to pay is determined by the farmers' ability to predict the climate, to use radio as a means of information, farmers' awareness of previous forecasts and early onset of rainy season. While farmers considered benefits from the use of climate information, it is clear that its contribution to farm income remains a field of research to explore. Thus it is necessary to experiment with individual farms and to evaluate the contribution of climate information to the value added in different crops and farmers' income.

**Keywords:** farmers, rainy season, climate information, willingness to pay

## 1. Introduction

The use of seasonal climate forecasts based on indigenous knowledge is a traditional strategy of West African farmers to reduce climate risks on their crop yields (Roncoli, 2006; Nyong, Adesina, & Osman, 2007). This traditional seasonal climate forecast, operating as an endogenous system of climate information, guides farmers to make choices on plots to cultivate, types of crop varieties and planting date. The main indicators of these endogenous seasonal climate forecasts are environmental (moon, cloud, wind), biological (animals, plants), magic and religious (Phillips, Deane, Unganai, & Chimeli, 2002). They are transmitted from one generation to another by oral tradition.

Despite their importance, these endogenous forecasts are becoming less reliable because of climate change over the past two decades (Ingram, Roncoli, & Kirshen, 2002; Roncoli et al., 2008). The length of rainy season is varying, with the number of rainy days changing from one year to the other (Sultan & Janicot, 2003; Traore, Corbeels, Van-Wijk, Rufino, & Giller, 2013). Seasonal rainfall amount, intra-seasonal rain-fall distribution and its onset and ending dates influence crop yields and determine the agricultural calendar (Marteau et al., 2011). Distortions in indicators transmission from one generation to the other question also the reliability of these forecasts (Roncoli et al., 2008). Therefore, farmers are looking for new strategies for seasonal climate forecasts to better plan seasonal crops production (Ingram et al., 2002).

Climate information is one of possible ways to mitigate the adverse effects of climate change on agriculture productivity (Hansen, 2002; Challinor, 2009). It consists of publishing seasonal forecasts from climate models to farmers (Klopper, Vogel, & Landman, 2006). These seasonal predictions usually provide information on the probability of the starting and ending dates of the rainy season, the length of the season, the number of rainy days, the annual cumulative rainfall, the average and maximum duration of dry spells during the rainy season (Traore et al., 2014; Goddard et al., 2010). Various studies showed that climate information are integrated in farmers' decisions especially in the United States (Carberry et al., 2002), Mexico (Adams et al., 2003), Argentina (Podesta et al., 2002), Lesotho (Ziervogel, Bithell, & Washington, 2005), Australia (Hammer et al., 2001),

Zimbabwe (Phillips et al., 2002; Patt, Suarez, & Gwata, 2005) and South Africa (Klopper et al., 2006). Though studies are rare for West Africa, the West Africa Food Security Capacity Strengthening and Research Program has been publishing forecast information since 1998 (Ogallo, Boulahya, & Keane, 2000; Hansen, Mason, Sun, & Tall, 2011). The researchers usually investigated on populations' perception of climate change (Ouédraogo, Dembelé, & Somé, 2010), endogenous ways of seasonal forecasts and farmers' demand in terms of climate information (Ingram et al., 2002; Tarhule & Lamb, 2003; Roncoli et al., 2008).

The purpose of this paper is to analyze the farmers' perception of climate information in Burkina Faso, a landlocked Sahelian country situated in West Africa, and to identify the determining factors of their option value. We formulated two research hypotheses. First, we assumed that most farmers perceive climate information as probative adaptation strategy to climate change. Second, we expected that the farmers' willingness to pay (WTP) for climate information depends on their ability to predict the climate through endogenous methods.

## 2. Materials and Methods

### 2.1 Study Area

The study was conducted in the Sahelian and Sudano-Sahelian areas of Burkina Faso (Figure 1). The Sudano-Sahelian zone is characterized by annual rainfall spanning from 900 mm down 600 mm and a rainy season lasting four to five months (June to October). In the Sahelian zone, annual rainfall ranges between 600 mm and 300 mm and is characterized by a very irregular spatial and temporal distribution. The rainy season lasts less than three months (July to September).

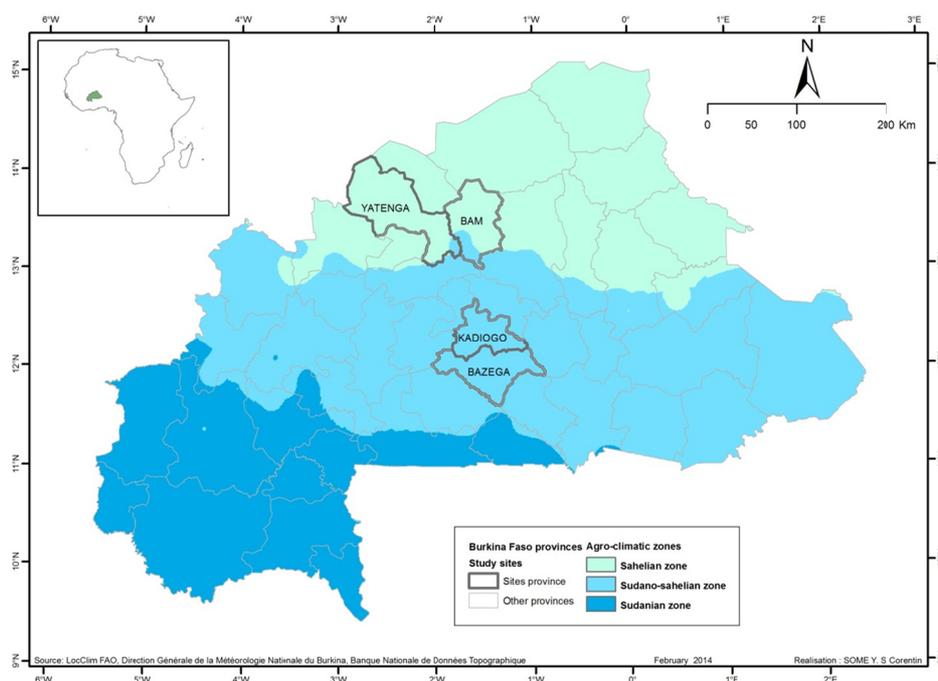


Figure 1. The four study sites in the Sahelian and Sudano-sahelian agro-climatic zones of Burkina Faso

Source: Adapted from national meteorology service.

With less than 70 days of rainfall, the Sahelian and Sudano-Sahelian zones are more subject to rainfall deficit because of dry spells during the rainy season than the South-Sudanian zone (SP/CONEDD, 2007). Many farmers consider climate information as a necessity to increase agricultural production and improve food security (Roncoli et al., 2008). Drought risk can be avoided through better crop management decisions made on planting date in combination with adapted varieties to current rainfall pattern (Traore et al., 2014).

### 2.2 Data Collection

Data were collected on the basis of stratified sampling at three levels chosen in collaboration with the team of the project for supplemental irrigation and climate information as well as the provincial department of the Ministry of Agriculture and Water Resources. The three levels are provinces, villages and farmers (Figure 1). Updated

data on the number of farmers per village were obtained from the permanent agricultural survey of the Ministry of Agriculture and Water Resources. According to this data base, 629 farmers located in 11 villages were surveyed from January to February 2014 in the provinces of Yatenga, Bam, Kadiogo and Bazega. In each village, a third of the farmers were randomly selected for the survey.

Data were collected using a structured questionnaire referring to farmers' socio-economic characteristics and planted crop (Table 1). The data collection was also related to farmers' endogenous seasonal forecasts, their perception of climate information and WTP it.

### 2.3 Data Analysis

The chi-square test was used to compare farmers' perception of seasonal climate forecasts and potential users' socioeconomic characteristics at significance level  $p = 5\%$ . Analysis of variance and the Kruskal-Wallis test were used respectively to compare the average and median income in grain production and farmers' WTP threshold of significance  $p = 5\%$ . Average and median WTP were calculated excluding the true zeros.

Estimated true zeros are given WTP nulls by farmers because their agricultural productivity will not be improved even if they benefit from climate information. On the contrary, false zeros are WTP nulls per farmers when they need climate information to guide their decision making in planning agricultural production. According to Terra (2005), when the proportion of sample true zeros is small (10% threshold), the appropriate model for the analysis of the determinants of WTP is the Heckman (1979) model. Otherwise Tobin (1958) model is indicated. It analyzes the positive valuations ( $WTP > 0$  and true zeros) excluding false zeros.

Table 1. Predictors of farmers' need and WTP for climate information

Variables	Description	Notation	Assumptions	Expected effect
Age	Age of the farmer	Young: the farmer is young (age <45 years) Old: otherwise	Young farmers have more access to information compared to older ones (Diederer, Van, Arjan, & Katarzyna, 2003). Being better informed, they should have a greater need of climate information than ones.	+
Marital	Marital status of the farmer	Married: the farmer is married Other: otherwise	Unlike unmarried married farmers are supposed to have a greater need of climate information and contribute financially to benefit from it in terms of their family responsibility. We estimate the farmers to two spouses (INSD, 2010).	+
Education	Education of the farmer	Yes: the farmer is educated No: otherwise	The training of farmers promotes the adoption of agricultural innovations (He, Cao, & Li, 2007). Educated farmers are supposed to be more interested in the of climate information compared to the illiterate ones.	+
Organization	Participation of farmer to a rural organization	Yes: the farmer takes part in a rural organization No: otherwise	Farmers in a rural organization and those unorganized will all have climate information. Organized farmers more easily adopt agricultural innovations (Neupane, Sharma, & Thapa, 2002).	+/-
Endogenous	Farmers' ability to predict the climate from endogenous knowledge	Yes: the farmer is able to predict the climate from endogenous capacities No: otherwise	All farmers should need climate information prior to agricultural campaign. Their decisions are assumed to be independent from climate predictions by endogenous methods.	+/-
Information	Access to issued seasonal climate forecasts	Yes: the farmer has already received climate information prior to agricultural campaign No: otherwise	The need of climate information is assumed to be independent from climate forecasts received in the previous year.	+/-

Table 1. Continued

Variables	Description	Notation	Assumptions	Expected effect
Radio	Choice of radio as a means of climate information broadcasting	Yes: the farmer opts for climate information radio broadcasting No: another means (workshops, training, phone message, etc.)	The choice of the radio should affect demand of farmers for WTP in the use of climate information. In general farmers receive free radio information.	+
Start	Date of the beginning of the rainy season	Yes: the farmer needs from the date of onset of rains No: otherwise	Information on the date of the beginning of the rainy helps to choose the planting date (Traore et al., 2014). It is supposed to encourage farmers' WTP for climate information.	+
End	Date of the end of the rainy season	Yes: the farmer needs of the ending date of the rainy season No: otherwise	Information on date of the end of rainy season indicates the beginning of the harvest. It help choose varieties based on their cycle (Traore et al., 2014). It is supposed to encourage farmers' WTP for climate information.	+
Duration	During of rainy season	Yes: the farmer needs to know the during of rainy season; No: otherwise	Information on the during of the rainy season helps to choose types of varieties based on their cycle (Traore et al., 2014). It is supposed to encourage farmers' WTP for climate information.	+
Maize	Farmers' choice to grow maize	Yes: the farmer plans to grow maize No: otherwise	The choice of corn should encourage the farmer to pay for climate information as production contributes significantly to ensure their grain needs (MAH, 2012).	+
Millet	Farmers' choice to grow millet	Yes: the farmer plans to grow millet No: otherwise	Millet production contributes significantly to meet the needs of grain farming households (MAH, 2012). Millet should encourage farmers' need for the climate information and their WTP to receive it.	+
Rice	Farmers' choice to grow rice	Yes: the farmer plans to grow rice No: otherwise	The choice of rice should increase the farmers to need for climate information and their willing to pay for it as production helps ensure their food basis (MAH, 2012).	+
Sorghum	Farmers' choice to grow sorghum	Yes: the farmer plans to grow sorghum No: otherwise	Sorghum production contributes significantly to meet the needs of grain farming households (MAH, 2012). Sorghum farming should increase farmers need to pay for climate information.	+
Income	Income from all grain crops (maize, millet, sorghum, rice)	CFA Francs	Grain production is mainly for self-consumption. It is rarely sold especially since it generally covers their grain needs. Farmers are interested in and use the climate information but they will be reluctant to sell their produce to pay for it.	+/-
Off-income	Income from off-farm activities	CFA Francs	In contrast to income from grain production, the expected effect of off-farm income should be positive (Alavalapati, Luckert, & Gill, 1995).	+

Note. + expected positive effect; - expected.

Source: Own elaboration.

The Heckman (1979) model consists of two steps. In the first step, we calculate the inverse Mills ratio for each observation using the Probit model that separates the population into two parts: one is zero and the other positive WTP. The structure of the Probit model representing possible decisions  $y_i^*$  of farmer  $i$  to adopt climate information or not is:

$$y_i^* = \sigma + \delta x_i + \varepsilon_i \quad (1)$$

$y_i = 1$  if the farmer needs climate information (WTP > 0) and  $y_i = 0$  otherwise (WTP = 0) with  $\sigma$  the constant,  $\delta$  the vector of parameters to be estimated,  $x_i$  the explanatory variables and  $\varepsilon_i$  the term of error. Table 1 shows the hypotheses assigned to each variable.

The estimated Probit model using the maximum likelihood method provides an estimate of the coefficients  $\delta$  and the inverse Mills Ratio ( $\hat{\lambda}_i$ ).

$$\hat{\lambda}_i = \phi(\sigma + \delta x_i) / \Phi(\sigma + \delta x_i) \quad (2)$$

Where,  $\phi$  is the density function for a standard normal variable and  $\Phi$  the cumulative distribution function for a standard normal distribution.

The second step is to perform a regression on the ( $WTP > 0$ ) with different explanatory variables  $w_i$  and the inverse Mills ratio.

$$WTP(y_i = 1) = \gamma + \beta \lambda_i + \beta' w_i + \mu_i \quad (3)$$

Where  $\gamma$  is the constant,  $\beta$  and  $\beta'$  are the vectors of parameters and  $\mu_i$  the error term. The estimated regression model uses the ordinary least square method.

The Tobin (1958) model deals with positives WTP and true zeros excluding false zeros. The true zeros (nulls) of WTP are considered censored variables. The model equation is:

$$WTP_i^* = \alpha x_i + \mu_i \quad (4)$$

$$WTP_i = WTP_i^* \text{ if } WTP_i^* > 0 \text{ and } WTP = 0 \text{ if } WTP_i^* \leq 0 \quad (5)$$

Where  $x_i$  are the explanatory variables,  $\alpha$  the vector of parameters to be estimated and  $\mu_i$  the error term normally distributed  $[0, \sigma^2]$ .

Estimation of the model is done by maximizing the logarithm function given by the equation:

$$L(\beta, \sigma) = \prod_{WTP_i > 0} \frac{1}{\sigma} \phi[(y_i - \alpha x_i) / \sigma] \prod_{WTP_i > 0} \Phi(-\alpha x_i / \sigma) \quad (6)$$

Where  $\phi$  is the probability density function and  $\Phi$  the cumulative probability function of a normal distribution.

### 3. Results and Discussion

#### 3.1 Farmers' Current Access to Issued Seasonal Climate Forecasts

From all the provinces combined together, only 21.78% of the respondent farmers had access to official seasonal forecasts prior to the agricultural campaign of 2012/2013 (Table 2). However, it is observed a huge information asymmetry between provinces ( $p < 0.001$ ). Compared to other provinces, farmers in the Yatenga province (40.48%) were aware of climate forecasts. This information asymmetry could be due to the presence other projects (non-governmental organizations) experimenting climate information with some farmers in the Yatenga province.

Despite this asymmetry, the information sources were not significantly different among farmers ( $p > 0.000$ ). Nearly 65.85% of the farmers in the sample received the seasonal forecast information prior to the agricultural campaign of 2012/2013 by listening to radio. Res, Vogel, and Brien (2006) showed that radio is an effective means of disseminating the seasonal climate forecast information to farmers. Farmers also have similar behavior towards the use of seasonal forecasts ( $p > 0.000$ ). Approximately, 76% of them considered the seasonal forecast information in their decision-making. They recognized that seasonal forecasts have supported their decisions in planning and implementing agricultural activities. Seasonal forecasts facilitate the choice on crop varieties and planting date (Traore et al., 2014; Klopper et al., 2006).

Table 2. Differential dissemination of seasonal forecasts

Characteristics of the access and use of the current forecasts	Sahelian provinces		Sudano-sahelian provinces		Total sample (629)	p-value
	Yatenga (n=198)	Bam (n=188)	Kadiogo (n=114)	Bazega (n=129)		
<i>Access to seasonal climate forecasts climate information</i>						0.000
No (%)	59.52	89.50	82.35	88.89	78.22	
Yes (%)	40.48	10.50	17.65	11.11	21.78	
<i>Information sources</i>						0.104
Radio (%)	58.72	90.00	82.35	66.67	65.85	
Other farmers	41.28	10.00	17.65	33.33	34.15	
<i>Taking seasonal climate forecasts to make decision</i>						0.874
No (%)	22.35	33.33	27.78	25.00	24.19	
Yes (%)	77.65	66.67	72.22	75.00	75.81	

Source: Author's survey (2014).

### 3.2 Farmers' Potential Needs for Climate Information

A large majority (93%) of farmers expressed interest of having climate information (Table 3). This fraction is equitably distributed between the provinces ( $p > 0.05$ ). The need expressed by farmers for climate information showed that they are really aware of climate risks on agricultural production (Tarhule & Lamb, 2003; Roncoli et al., 2008). Farmers' need include the starting period of rainy season (74.95%), its length (19.52%) and the ending date of the rainy season (5.52%). Strong aversion on sowing plants due to drought risk may justify the choice of the beginning of the rainy season by the majority of farmers ( $p < 0.001$ ). According to Hammer et al. (2001), nearly a quarter of farmers' planting failures are due to poor rains start. Farmers' perception of rainfall changes may explain the differences observed in their needs for climate information between the provinces (Zongo et al., 2015). The decrease in rainfall is received by 28.2% of farmers in the Sahelian zone and 45.6% in the Sudano-Sahelian zone (Ouedraogo et al., 2010).

Table 3. Farmers' need for climate information

Characteristics of the need of climate information	Sahelian provinces		Sudano-sahelian provinces		Total sample	p-value
	Yatenga	Bam	Kadiogo	Bazega		
<i>Farmers needing climate information</i>						0.451
No (%)	5.24	6.50	8.82	9.40	7.00	
Yes (%)	94.76	93.50	91.18	90.60	93.00	
<i>Types of climate information</i>						0.000
Start of rainfall (%)	58.29	86.63	93.55	65.63	74.95	
End of rainfall (%)	2.01	2.14	4.30	28.13	5.52	
Duration of season (%)	39.70	11.23	2.15	6.25	19.52	
<i>Broadcasting</i>						0.000
Radio (%)	52.76	75.40	40.86	73.44	60.96	
Other (%)	47.24	24.60	59.14	26.56	39.04	
<i>Broadcasting period</i>						0.000
April (%)	21.39	87.36	59.14	62.30	55.34	
May (%)	62.03	12.64	40.86	36.07	38.45	
June (%)	16.58	0.00	0.00	1.64	6.21	

Source: Author's survey (2014).

The radio was the most appreciated media for disseminating the climate information, mentioned by 60.96% of farmers (Table 3). All provinces are covered by the national radio. Radio stations are also located in provinces

(Bam and Yatenga). Differentiated choice of radio ( $p < 0.000$ ) as a means of information on climate information between provinces is related to the rate of possession of radios by farmers and their financial power to purchase rechargeable batteries (Roncoli et al., 2008).

Concerning the best period for getting climate information, 55.54% of the surveyed farmers chose April. This month is the start of agricultural activities: zai, bunds, application of organic manure in the fields. The heterogeneity choices of broadcasting periods ( $p < 0.001$ ) derives from farmers' agricultural practices and the beginning of the rainy season of the previous campaign between the provinces (Ingram et al., 2002).

### 3.3 Profile of Farmers Potential Users of Climate Information

We found that characteristics of farmers interested in climate information are similar despite the considered province ( $p > 0.001$ ) (Table 4). Indeed, the analysis revealed that the majority of climate information potential users were found among young farmers (57.98%), married farmers (93.85%) and educated farmers (60.34%). Furthermore, the minority of potential users of climate information is found among organized groups of farmers (30.09%), farmers able to predict the climate forecasts from endogenous resources (32.65%) and farmers who received the weather forecast during farming campaign 2012/2013 (20.85%).

Table 4. Profile of the farmers potentially using of climate information

Variables	Sahelian provinces		Sudano-sahelian provinces		Total sample	P-value
	Yatenga	Bam	Kadiogo	Bazega		
<i>Age</i>						0,105
Young (%)	50.75	71.51	61.96	44.34	57.98	
Old (%)	49.25	28.49	38.04	55.66	42.02	
<i>Marital</i>						0.667
Married (%)	95.98	90.37	97.85	92.45	93.85	
Other (%)	4.02	9.63	2.15	7.55	6.15	
<i>Education</i>						0.894
No (%)	60.30	51.34	62.37	74.53	60.34	
Yes (%)	39.70	48.66	37.63	25.47	39.66	
<i>Organization</i>						0.176
No (%)	61.81	57.75	92.47	86.79	69.91	
Yes (%)	38.19	42.25	7.53	13.21	30.09	
<i>Endogenous</i>						0.173
No (%)	58.29	74.33	58.06	80.19	67.35	
Yes (%)	41.71	25.67	41.94	19.81	32.65	
<i>Maize</i>						0.362
No (%)	26.13	62.57	6.45	11.32	31.97	
Yes (%)	73.87	37.43	93.55	88.68	68.03	
<i>Millet</i>						0.373
No (%)	0.50	12.30	2.15	60.38	15.38	
Yes (%)	99.50	87.70	97.85	39.62	84.62	
<i>Rice</i>						0.334
No (%)	91.96	96.79	87.10	91.51	92.65	
Yes (%)	8.04	3.21	12.90	8.49	7.35	
<i>Sorghum</i>						0.954
No (%)	25.63	3.21	0.00	10.38	11.62	
Yes (%)	74.37	96.79	100.00	89.62	88.38	
Income (CFA)*	316,959.30	288,589.82	225,401.55	119,077.95	256,283.78	0.000
Off-income (CFA)*	198,992.01	247,112.50	153,719.30	76,285.71	169,027.38	0.214

Note. \* indicate Francs CFA 655,957 = 1 €.

Source: Author's survey (2014).

Sorghum (88.38%), millet (84.62%) and maize (68.03%) were the main crops grown on their farmlands during the agricultural year 2012 /2013. The production of these crops is only the staple food of the rural populations (Janin, 2010). Rice is rarely cultivated (7.35%) because soils are not favorable.

The average of off-farm income is estimated at Francs CFA 169,027.38 per farmer. The average income of grain production (maize, millet, sorghum, rice) is estimated at Francs CFA 9,842.12 per farmer. Unlike previous features, the Kruskal-Wallis test shows that the income from the grain production is significantly different within and between agro-climatic zones ( $p < 0.001$ ). This difference could be related not only to the irregular distribution of rainfall (Balme, Galle, & Thierry, 2005) but also to crop management techniques adopted by farmers (Ouédraogo et al., 2010).

### 3.4 Farmers' WTP for Climate Information

The analysis showed that the majority of the farmers are ready to contribute financially to benefit from the climate information in order to reduce climate risks on agricultural productivity (Table 5). About 64% of the farmers showed a strictly positive WTP. However, 29% of the farmers need climate information but are not willing to pay for it.

Only 7% of farmers do not want to integrate climate information in their decision process for agricultural production. These behaviors are recurrent within and between climate zones ( $p > 0.000$ ). The mean of WTP is estimated as CFA 546.34 Francs per farmer. The median WTP shows that 50% of farmers in Yatenga, Bazega and Bam provinces are willing to pay Francs CFA 200 to benefit from the climate information compared to CFA 300 Francs in Kadiogo. Although they are not significantly different within and between agro-climatic zones ( $p > 0.000$ ), the average and median WTP revealed the interest of farmers in using climate information (Kenkel & Norris, 1995). Hanemann (1984) recommended using median WTP to measure the economic level because average WTP can be very sensitive for small changes in the distribution of WTP, while the median is much more robust to these effects.

Table 5. Farmers' WTP for climate information

Farmers' WTP	Sahelian provinces		Sudano-sahelian provinces		Total sample	P-value
	Yatenga	Bam	Kadiogo	Bazega		
<i>Farmers needing climate information</i>						0.316
True zeros (%)	5.24	6.50	8.82	9.40	7.00	
False zeros (%)	33.81	26.50	23.53	27.30	28.59	
WTP > 0 (%)	60.95	67.00	67.65	63.30	64.41	
<i>Central values</i>						
Average WTP	659.05	525.50	450.78	463.25	546.34	0.137
Median WTP	200	200	300	300	200	0.235

Source: Author's survey (2014).

### 3.5 Factors Affecting Farmers' Households' Option Value for Climate Information

The Heckman model (1979) was used to analyze the determinants of farmers' WTP because the proportion of false zeros is greater than the true zeros. The results reveal a difference between the determinants of demand for climate information and WTP (Table 6). The variables significantly affecting farmers' demand for climate information are farmers' age, their literacy level, their marital status and practice of maize and sorghum production and the income from production. The farmers' ability to receive climate forecast from main radio, farmers' awareness on previous forecast and early starting period of rainfall are the variables determining farmers' WTP to benefit for climate information.

The education of farmers significantly influences the demand for climate information at 5% threshold. This can be explained by the fact that education increases the farmers' ability to understand the necessity of climate information to make their decisions in terms of agricultural production in the context of climate change. The effect of education on the use of climate information is in line with the finding of Lybbert, Barrett, McPeak, and Luseno (2007) in Kenya and Ethiopia. Marriage also has a significant impact on the use of climate information

by farmers at 5%. It increases the size of farmers while increasing their grain needs through the number of marriages and annual births (INSD, 2009). This increase in grain needs and increases married farmers' need for climate information to better organize grain production. However young farmers (age < 45 years) negatively affect the demand for climate information at a threshold of 10%. Indeed, young farmers showed indifference towards the use of climate information as they were more interested in non-agricultural activities that provide higher cash income (Thune, 2011). Moreover, a farmers' membership to a group impacts favorably on the use of climate information. The farmers' grouping facilitates their access to seasonal forecasts provided by agricultural services. According to Tarhule and Lamb (2003), discussion between agriculture organized groups allows them to better understand the issues related to climate change in the agricultural sector.

Table 6. Results of the Heckman Model

Variables	Probit model for needing climate information (First step)			Regression model on the WTP for climate information (Second step)		
	Coefficients	Std. Error	P-value	Coefficients	Std. Error	P-value
Age	-0.224*	0.116	0.053	110.7271	113.598	0.330
Marital	0.563**	0.225	0.012			
Education	0.355**	0.121	0.003			
Organization	0.230*	0.126	0.069			
Endogenous Information	-0.176	0.121	0.145	222.0637*	116.388	0.056
Radio				204.972*	122.249	0.094
Start				-317.006**	105.385	0.003
End				-307.142**	136.304	0.024
Duration				-343.234	222.852	0.124
Maize	0.294**	0.122	0.016			
Millet	0.141	0.165	0.393			
Rice	-0.282	0.214	0.187			
Sorghum	0.359**	0.174	0.039			
Income	-5.91E-07**	1.88E-07	0.002	-10.4 E-05	19.24 E-05	0.589
Off-income	-5.91E-07**	1.88E-07	0.002	-10.4 E-05	19.24 E-05	0.584
Constant	-0.563*	0.319	0.078	1445.125***	207.295	0.000
Mills Ratio	-555.371*	313.846	0.077			
Rho	-0.526					
Sigma	1056.175					

Number of observations = 573 ; Observations uncensored = 388; observations censored = 185;

Wald chi2(6) = 23.197; Prob > chi2 = 0.000.

Note. \*\*\*, \*\* and \* respectively denote significant levels of 1%, 5%, and 10%.

Source: Author's survey (2014).

The farmlands of maize and sorghum positively affect the demand for climate information by agricultural farmers at the threshold of 10%. Farmers believe that corn is very sensitive to drought compared to other grain crops. This reason justifies the use of climate information to plan its production. The important contribution of the sorghum production to supply grain needs by the farmers may explain its positive impact on the demand for climate information (MAH, 2012). The analysis shows however, that the income from grain production negatively affects the demand for climate information as if farmers were reluctant to inject their grain income into expenditure allowing them to get climate information. Grain production is intended for food consumption of

farmers. Farmers rarely sell grain production as they usually cover their food needs (Janin, 2010). Unlike grain revenue, off-farm income positively affects the demand for climate information of farmers. Farmers consider paying for the benefit of climate information from incomes generated by activities such as gold mining, trade, masonry.

Broadcasting of climate forecasts during the rainy season of 2012/2013 has a positive impact on the value of WTP for climate information. Producers believe that the expectations have guided their decisions during the planning of agricultural activities. These reasons justify the value placed on the climate information through their WTP. The use of radio as a means to be informed about climate information affects the value of farmers' WTP. Indeed farmers believe that climate information should be free if they are broadcasted by radio channel (Lybbert et al., 2007). Therefore, they are not willing to pay for climate information. They prefer to pay if climate information is issued by other means of communication such as telephone and agricultural services. Broadcasting forecasts on the starting dates of rainfall affected farmers' WTP for climate information at the threshold of 10%. Indeed predicting the rainfall starting dates allows farmers to plan the sowing date (Klopper et al., 2006). However, they are not willing to pay for only the dates of rainfall. Rather they want to pay for a package of climate information constituted by starting dates of rainfall, length of the season and its end.

#### 4. Conclusions and Recommendations

This study analyzed the perception and the option value of climate information in the sahelian and sudano-sahelian agro-climatic zones of Burkina Faso. It showed that the climate information is asymmetrically distributed to a minority (21.78%) of the sampled farmers. The analysis revealed that the majority (93%) of the farmers need climate information to guide their decision in planning agricultural activities. The determining factors of the demand for climate information are the farmers' age, their literacy level, marital status, their maize and sorghum production and also the added value of grain production. Option value shows the interest granted by farmers using climate information. About 64% of the farmers willing to pay would pay an average of CFA 546.34 Francs to obtain climate information. The WTP is determined by the farmers' ability to predict the climate, to use radio as a means of information, farmers' awareness on the previous forecast and early onset of the rainy season. While farmers considered benefit from the use of climate information, it is clear that its contribution to farming income remains a field of research to explore. Thus it is necessary to experiment with individual's farmlands and to evaluate the contribution of climate information to the added value of different crops and farmers' income.

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