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DETERMINANTS OF IMPROVED COWPEA VARIETY SEEDS ADOPTION IN BURKINA FASO

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ABSTRACT

To improve agricultural productivity to meet the food needs of a growing population, many improved seed varieties have been developed for several years through research and offered to producers. In Burkina Faso, several varieties of cowpea have been disseminated since the 1990s, without knowing their related prospect. This article intends to determine the current adoption rates and the factors that influence the adoption of seed of cowpea varieties by producers. Descriptive statistics of the data collected from 603 randomly selected farmers in five (5) regions indicate that improved seeds are widely adopted. These rates range from 22.22% to 88% in terms of adopters and between 59.7% and 78%, depending on the weight of the improved varieties in cowpea growing systems. The logit regression model estimation shows that the major determinants of adoption of seed of improved cowpea varieties are the level of education, the technical control of the producer, the variety cycle and the region. These results call on the actors and stakeholders involved in rural area to guide their actions towards these different aspects for a better promotion of improved cowpea seeds.

Keywords: Adoption, logistic regression, improved varieties, Cowpea, Burkina Faso.

1. INTRODUCTION

The climate of Burkina Faso is characterized by a large rainfall deficit, strong spatial-temporal rainfall irregularities and annual rainfall decreasing from south to north since the late 1960s (Somé and Dembélé, 1996, Ouédraogo et al., 2010). More than half of the country's surface area

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belongs to the Sahelian and Sudano-Sahelian agro-climatic domain. Since irrigated areas account for only 1% of the total area under cultivation, agriculture, the main economic sector (35% of GDP), remains very vulnerable to climatic hazards. On the other hand, soil degradation and continuing decline in soil fertility due to erosion and overexploitation without adequate organic and inorganic restitution limits the productivity and sustainability of production systems (Zougmoré et al., 2004; Sawadogo et al., 2008a, b; Bikienga, 2011). Approximately, much of the arable land is severely deteriorated and the risk of degradation is high in about 37% of the land (Sawadogo, 2006). The low productivity of cropping systems resulting from these conditions exposes agricultural producers to food insecurity and poverty.

To improve agricultural productivity to meet the food needs of a growing population many improved varieties of seeds have been developed for several years through research and offered to producers. These varieties are created according to the specific agro-climatic conditions of the different regions of the country. The agronomic and economic importance of improved varieties has been demonstrated by previous authors (Zoundi et al., 2007, Palé et al., 2009, Bakayogo et al., 2011). Therefore, their widespread adoption would improve food security and break the vicious cycle of poverty among Burkina Faso producers.

This article intends to analyze the determinants of the adoption of improved cowpea varieties to identify research prospects for mass adoption of these varieties. This analysis is all important as it will guide policy makers towards actions to effectively promote the high yielding varieties of crops.

2. SELECTION OF THE STUDY AREA AND METHODOLOGY

2.1. The study area

To consider the diversity of agro-climatic and socio-economic conditions and the weight of cowpeas in the farming systems in Burkina Faso, this study was carried out in four regions. These include the Southwest Region (very low cowpea production) between the 10 ° and 19 ° North parallels and the 3° and 10° West parallels, the Boucle du Mouhoun Region (average production) between the parallels 12° and 30 ° North and parallels 3° and 30° West, the Central-West Region between parallels 11° and 45° North and parallels 2° and 15° West, and the Central North Region (high production) located between parallels 13° and 15° North and parallels 1° west (Fig 1). On the agricultural side, the developments are quite different between these four regions. Indeed, the Boucle du Mouhoun Region is the largest cotton producing area in the country. As a result, through cotton inputs credits, the level of intensification of the cropping system is higher there than in other parts of the country. While the quantities of NPK fertilizer used varied between 17 and 27 tons in the Boucle du Mouhoun between 2003 and 2009, those in

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the Central West varied between 3 and 6 tons during the same period. The same differences exist in the amounts of urea used. Moreover, the producers of the Boucle du Mouhoun are the best equipped with agricultural tools. As a result, yields are higher in this region than in the other three ones. In each region, two provinces were selected based on the area sown in cowpea and on production. These include the Poni and Ioba provinces in the south-west, Kossi and Sourou in the Boucle du Mouhoun, Boulkiémdé and Sanguié in the Central West, Namentenga and Sanmatenga in the Central North. In each province, villages were selected randomly.

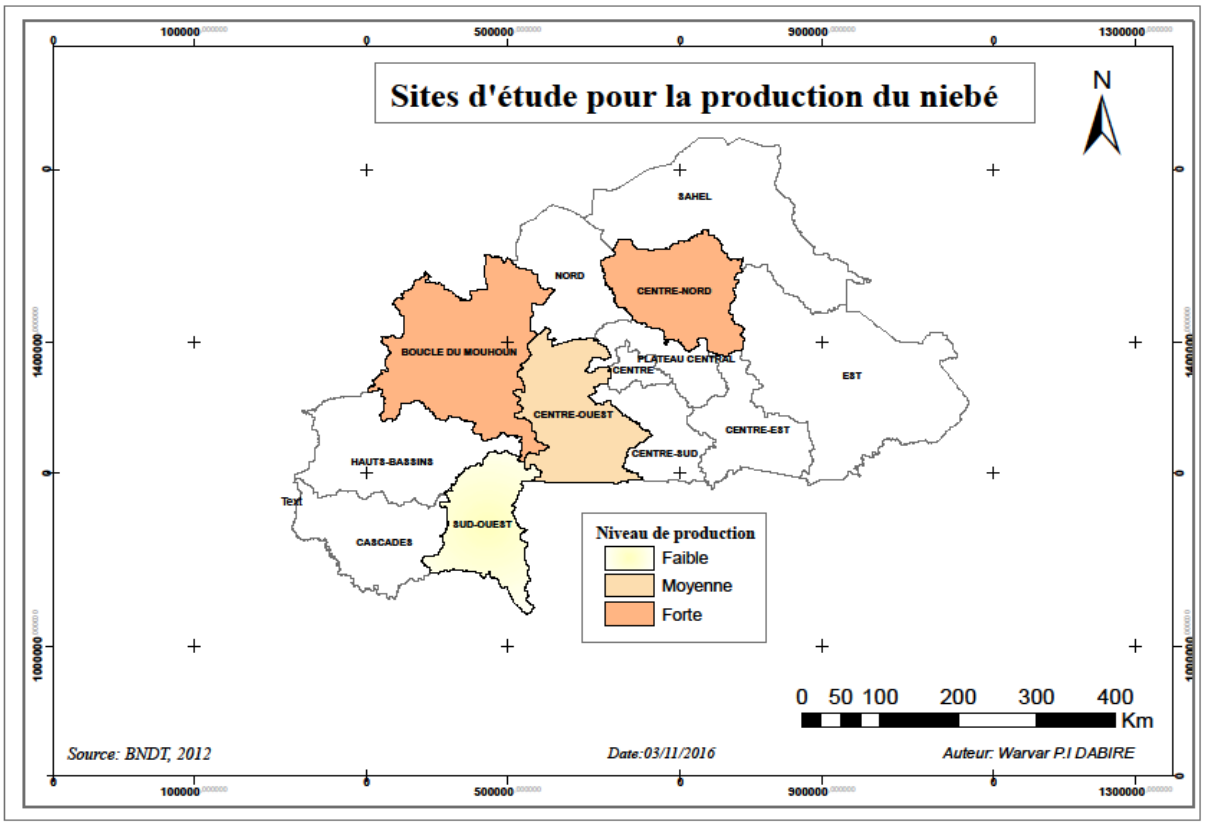

Fig. 1: The study area (Boucle du Mouhoun, Southwest, Centre-west, Central North)

2.2 Selection of the sample of producers and data collection

Based on the list of producers from the selected villages, a sample of 603 producers was randomly selected. The sample is made up of both men and women heads of households. Data were collected using an individual questionnaire administered to producers by investigators. The information collected deal with the socio-economic characteristics of producers, their practice in

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terms of seed use, fertilizers, technical production routes, and various supports they received including institutional aspects.

2.3 The theoretical approach of agricultural technologies adoption

Feartherstone et al. (1997) define the adoption of a technology as the degree to which it is used in balance with other activities over a long period of time, assuming that the farmer has complete information about the technology and its potential. Abadi-Ghadim et al. (2005), consider adoption as a dynamic decision-making process, involving the acquisition of information and know-how by producers, and depending on their management capacities, their risk preference, and their perception of the profitability and risk of innovation. As part of this study, adoption is defined as the producer's decision to use an improved variety of cowpea considering these characteristics and those of the seed. Agricultural technology adoption models are based on the producer's rational behavior theory which states that a farmer will adopt a new agricultural technology if the utility associated with it is greater than that of the old one and whether the new technology is adapted its socioeconomic and demographic conditions. Determinants of innovation adoption can be classified into two groups: factors relating to the individual characteristics of producers and those relating to the intrinsic characteristics of innovations (Batz et al., 2003, Blazy, 2011, Sotamenou, 2012, Sale et al., 2014). Factors related to producer characteristics are age, the producer’s status in the household, the farm size, education level, off-farm income, information, training, belonging to a social organization, participation in demonstration tests, and the producer’s experience in the field. The characteristics of the technology are mainly profitability, market orientation, investment, complexity and relative risk (Adesina and Baidu-Forson, 1995, Abadi-Ghadim et al., 2005, Shiferaw et al., 2008; Mabah Tene, 2013).

2.4 The econometric model for analyzing the adoption determinants

Four (04) model types were generally used to analyze the adoption decision: linear probability models, Logit, Probit and Tobit. But econometric specifications depend mainly on the purpose of the study and the available data. Tobit model is used for levels of technology use (Ransom et al., 2003, Shiferaw et al., 2008). Linear probability models, Logit and Probit are used when the decision variable is dichotomous (Adeoti et al., 2002; Asfaw and Admassie, 2004). The linear probability model has disadvantages because the probability can exceed one (1). As a result, Probit and Logit models remain the most used.

The binomial logit model was used in this study.The estimation method used herein is the maximum likelihood method. This model has been used by many authors (Nkamleu and Coulibaly, 2000, Adéoti et al., 2002, Sale et al., 2014) to analyze the determinants of adoption of

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agricultural innovations. In this model, the dependent variable (decision) takes the value 0 or 1 depending on the characteristics of the adopter. The adopter is defined as any producer who uses an improved variety of cowpea irrespective of the quantity. The objective of this model is to determine for a given producer the likelihood of adopting or not adopting an improved variety of cowpea.

Let Y be the observable dichotomous variable that takes the values 0 and 1. The values taken by Y are observed on the set of individuals (or households) indexed by i, i = 1, ..., n; n is the size of the sample.

Let Z be the latent variable underlying the phenomenon.

The model requires the following relation:

$$Z = Xb + \mu \quad (1)$$

where X is a set of so-called exogenous or explanatory variables.

The probability that producer i be in the case *Yi* = 1 is:

$$pi = P[Yi = 1] = P[Zi > 0] \quad (2)$$

$$= P[X_i\beta > \mu_i] = F(X_i\beta) \quad (3)$$

where F is a distribution function of -μ. The choice of the model on the choice of F (normal or logistic law).

As part of that work, F is taken as a distribution function of the logistic law.

The logistic theoretical model can be presented by the following equation:

$$P[Y = 1] = L(X\beta) = \frac{\exp(X\beta)}{1 + \exp(X\beta)} = \frac{1}{1 + \exp(-X\beta)} \quad (4)$$

2.5 Specification of variables

In this study, variables introduced into the Logit model are summarized in Table 1.

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Table 1: Variables introduced into the Logit model

Symbol in Equation	Description of the variable	Type of variable	Expected Sign
Sex	Sex respondent	Dummy variable : 1 if man and 0 si woman	Positive
Age	Age of respondent	Dummy variable : 1 if respondent un age < 47 years and 0 if not	Positive
Menastatu	Status of respondent in the household ménage	Dummy variable: 1 if household chief and 0 if not	Positive
Origine	Status of the respondent in the village	Dummy variable: 1 if native and 0 if not	Negative
Instru	Level of instruction of respondent	Nominal qualitative variable : 1 = primary ; 2= secondary ; 3= higher ; 4= literacy ; 5= Coranic Reference= illiteracy	Positive
OP	Respondent's membership in a peasant organization	Dummy variable: 1 if yes and 0 if not	Positive
Encadre	Benefit from advisory support on improved varieties	Dummy variable: 1 if yes and 0 if not	Positive
Taille	Number of persons in the household	Dummy variable: 1 if > 10 personnes et 0 si non	Positive
Foncier	Status of Land tenure of exploited lands	Dummy variable: 1 if the producer is est owner and 0 if not.	Positive
Charu	Possession of a plow	Dummy variable: 1 if yes and 0 if not	Positive
Charrette	Possession of a cart	Dummy variable: 1 if yes and 0 if not	Positive
Appaherb	Possession of a device for the treatment of weeds and insects	Dummy variable: 1 if yes and 0 if not	Positive
Magasin	Possession of a storage warehouse	Dummy variable: 1 if yes and 0 if not	Positive
Cycle	Cycle of the variety	Nominal qualitative variable : 1 = short cycle ; 2= medium cycle Reference= long Cycle	Positive

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Region	Region of the répondent	Nominal qualitative variable : 1 = Mouhoun ; 2= southwest ; 3= Centre-Ouest. Référence= Centre-Nord	Positive
Coupro	Total Cost of production	Variable quantitative discréditée : 1= 1 à 50000 ; 2= 50001 à 100000 ; 3= 100001 à 150000 ; 4= 150001 à 200000 Reference = 200001 à 250000	Positive

Referring to the results of studies on the adoption and spread of technologies, it appears that certain socioeconomic and institutional variables have in most cases a definite influence on the adoption of technologies (Rogers, 1983). These include the agro-ecological zone, age, gender, education level, household size, farm equipment, membership of a peasant organization. These variables influence positively or negatively the adoption decision of the producer.

3. RESULT

3.1. Socio-economic and demographic characteristics of producers

Cowpea producers in the study areas are predominantly male except for the Boucle du Mouhoun region (Appendix 1). Of the 603 producers surveyed, 360 (59.70%) are men. Cowpea production is mainly made by young people in all regions of the study. Out of the 603 respondents, 406 (67%) producers are under the age of 47 (Appendix 2). As cowpea is a secondary crop, young (dynamic) are more willing and able to combine this crop with main crops such as sorghum, maize and millet. 90% of surveyed producers are married (Annex 3). The production of cowpea is mainly carried out on plots belonging to the farmers.

57.8% of producers (349) grow cowpea on fields they own, and 26% rent land. However, these proportions vary per region (Appendix 4).

As for educational, 51% of the sample are educated. The Central West region has the largest number of educated people (Appendix 5).

In general, more than half of the producers (58.5%) belong to a farmer group. The highest rates are found in the Boucle du Mouhoun (97%) and in the Central North (72%) (Appendix 6).

3.2. Rate of adoption of improved cowpea varieties

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The results of the descriptive statistics indicate that improved varieties are more adopted in terms of number of producers and area sown than local varieties in most regions. In terms of the number of adopters, the adoption rate for improved varieties varies between 22.22 and 88% (Table 2).

Table 2: Frequencies of adoption of the different varieties of cowpea depending on the region

	Nom de la Région				
Type de variety	Boucle du Mouhoun	Central-west	Central-North	Southwest	**Total**
Local variety	18	43	84	119	264
Improved variety	132	109	64	34	339
T**otal**	150	152	148	153	603

Source : survey data of 2014

In terms of area, improved varieties occupy on average between 59.7% and 78% of the total area planted with cowpea (Table 3). They are more widely adopted in the Boucle de Mouhoun not only in terms of the area sown but also in terms of the number of adopters than the other regions. The adoption of improved varieties implies respect for the itinerary, particularly in terms of fertilizer supply and timing of the different cultivation operations. Producers of the Boucle du Mouhoun benefit not only from cotton inputs but also from the technical support of cotton technical agents. They therefore have a strong technical basis and are more apt and willing to adopt improved varieties. Although improved varieties dominate local seeds in the Central North and South-West Regions, most producers in these regions still grow local varieties. This result can be explained by the low accessibility of these producers to agricultural inputs. Indeed, there is no national policy to provide producers with agricultural inputs for food crops. Thus, in areas where cash crops do not attract the interest of a marketing enterprise, producers are limited in access to inputs.

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Table 3: Rate of adoption of improved varieties in cowpea growing systems per region

Name of region	Number	Average adoption rate (%)	Standard deviation
Boucle du Mouhoun	148	78,3	34,16
Central-West	152	66,8	44,38
Central-North	121	59,7	45,81
Southwest	105	74,5	40,61
Total	**526**	**69,9**	**41,84**

Source: survey data of 2014

3.3. Factors influencing the adoption of improved seeds

The chi-square test has assessed the quality of the model. This test indicates that the model is significant at the 0.1% level with $R^2 = 0.844$ (Table 4). The exogenous variables introduced into the model contribute together to explain the decision to adopt the improved varieties. Model estimation using the maximum-likelihood method allowed us to identify the factors that influence the choice of seeds of improved varieties by producers. The Wald statistic which is the test of significance of the partial regression coefficients allowed giving the level of significance of each coefficient.

The Wald statistic gives the level of significance of each coefficient. Table 4 displays the results of the estimation. The coefficients of the variables such as the level of education (primary level (Prim), literacy (Alpha), supervision (Frame), cycle (cycourt and cycmoyen), region (Mouhoun, Central West) are significant at 5% level, with Prob <0.05). These variables show a positive coefficient, with the same sign as expected. Variables such as sex, age, status on the farm, status in the village, household size, land tenure status, farm equipment and production costs have no influence on the probability of adoption of improved cowpea varieties; their respective coefficients are greater than 0.1 (Prob > 0.1).

Table 4: Results of the estimation of the binomial Logit model

Variables	dependante Variable = ADOP			
	Coefficients	**Wald**	**Probability**	**Exp (B)**
Sex	-1,605	2,214	0,137	0,201
Age	-1,038	2,196	0,138	0,354
Menstatu	0,704	0,504	0,478	2,021
Origine	-1,304	1,122	0,289	0,271

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Prim	2,838**	6,306	0,012	17,083
Secon	-0,214	0,039	0,844	0,807
Sup	11,890	0,000	1,000	145777,185
Alpha	3,548***	10,287	0,001	34,740
Coran	1,753	1,129	0,288	5,771
OP	-1,041	1,824	0,177	0,353
Encadre	2,523***	11,735	0,001	12,462
Taille	0,200	0,107	0,744	1,221
Foncier	-1,911	2,410	0,121	0,148
Charu	0,582	0,581	0,446	1,790
charrette	0,571	0,758	0,384	1,770
Appaherb	0,677	0,384	0,536	1,967
Magasin	2,644	0,711	0,399	14,070
Cyccourt	6,603***	28,861	0,000	737,113
Cycmoyen	2,898***	16,023	0,000	18,145
Coupro(1)	3,287	1,202	0,273	26,752
Coupro(2)	3,205	1,163	0,281	24,657
Coupro(3)	4,561	2,185	0,139	95,639
Coupro(4)	3,207	1,001	0,317	24,697
Boucle du Mouhoun	3,084**	3,954	0,047	21,839
Southwest	0,557	0,294	0,588	1,745
Central west	7,021***	11,411	0,001	1120,088
Constante	-4,929	2,070	0,150	0,007
-2log-vraisemblance	106,393			
R-2 (Cox & Snell)	0,552			
R-2 (Nagelkerke)	0,844			
Khi-Chi-deux	331,196			0,000

*** : Significant value at the level of 1 % ; ** Significant value at the level 5 % ; * Significant value at the level 10%

4. DISCUSSION OF THE RESULTS OF THE ECONOMETRIC MODEL

The Logit model estimation indicates that 84.4% of the variation in producer choice is influenced by the explanatory variables introduced into the model. The *primary level and literacy* dummy variables are positive and significant. These variables are therefore relevant in the explanation of the choice of seeds of improved varieties by the producers. This result indicates that those who

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have a primary level and those who are literate have a higher probability of adoption of improved seeds. This means that the farmer needs a minimum of education to facilitate his understanding of the seeds. Indeed, education improves the producer's openness towards new innovations through a great easiness to master the technical itinerary of innovation. This result corroborates that of Adéoti et al. (2002) in Benin that the level of education improves the likelihood of adoption of improved cowpea varieties. It also confirms the theories on the determinant role of the adoption of agricultural innovations demonstrated by the studies of Nkamleu and Coulibaly (2000) in Cameroon and Sale et al. (2014) in Kenya. Indeed, training facilitates the appreciation of agricultural technologies. Moreover, it is usually the only way to increase producers' ability to acquire, synthesize and respond to innovations in poor areas (Asfaw and Admassie, 2002).

The *supervision variable* is also positively and significantly associated with adoption. This variable therefore improves the probability of adoption of improved cowpea variety seeds. In other words, the more farmers receive technical support, the more they adopt the improved seed of cowpea. This result is consistent with those of Adéoti et al. (2002) and Ransom et al. (2003) who have shown a positive influence of the contact of the producer with the extension services on the adoption of the seeds of improved varieties in other countries. Indeed, the technical support through various tools makes it possible to master the technical itinerary of production of the improved variety as well as understanding the agronomic and economic consequences of its adoption. Numerous other authors have mentioned the relevance of this variable in improving the probability of adopting different agricultural innovations (Abadi-Ghadim et al., 2005, Kinané et al., 2007, Shiferaw et al., 2008, Blazy , 2011, Mabah Tene et al., 2013).

Short and medium cycles have a positive and significant influence on the likelihood of seed adoption. The long cycle being the reference, this result shows that the short and medium cycle varieties are significantly more adopted than those with a long cycle. Thus, the shorter the production cycle, the higher the likelihood of adoption of improved variety seeds.

In Burkina Faso, current conditions of production are characterized by variability of rainfall and in most cases early rainfall. The rainy season is getting shorter and shorter and the short-cycle varieties are the most suitable. The regions of the Boucle du Mouhoun and Central West are significantly and positively related to adoption. Seeds of improved cowpea varieties are significantly more widely adopted in these regions than in the Central North considered as reference regions in the analysis. In other words, the fact that a producer is in these areas increases the chances of adopting improved cowpea variety seeds. This result could be explained by the strong involvement of the Boucle du Mouhoun region in the cultivation of cotton. Producers in this region benefit from the technical support on the cultivation of cotton and thus

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have a certain openness on agricultural innovations. In addition, the area remains the biggest producer of cereals in the country.

5. CONCLUSION

The objective of this article is to analyze the determinants of the adoption of improved cowpea varieties to identify research prospects for mass adoption of these varieties.

The results show that improved cowpea variety seeds are widely adopted in most of the study areas. The Boucle du Mouhoun region has the highest rates in terms of the number of adopters and in terms of area under cultivation. The analysis of the results of the Logit econometric model showed that the geographic situation and the socioeconomics variables like education, technical support of the producers, as well as the variety cycle mainly determine the adoption of an improved variety of cowpea., It appears therefore, that the promotion of a large-scale adoption of improved cowpea seeds involves the improvement of the level of education of producers, which will facilitate the reinforcement of their capacity of the techniques through extension tools such as training, demonstration tests, guided tours in farms, video spots, etc. This producer capacity building needs to be increased in the low-adoption area of improved cowpea varieties. The creation of short-cycle varieties would involve financial support for research in plant breeding from national policies and development partners.

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Appendix 1: Household distribution by sexe and region

		Region				Total
		Boucle du Mouhoun	Central-West	Central-North	Southwest	
Sex of the producer	Man	31	133	102	94	360
	Woman	119	19	46	59	243
Total		150	152	148	153	603

Source : survey data of 2014

Appendix 2: Age of Producer by region

	Classe d'âge	Producers age							Total
		18-27	28-37	38-47	48-57	58-67	68-77	78-87	
Region	Boucle du Mouhoun	16	43	44	39	7	1	0	150
	Central-West	13	47	45	33	12	2	0	152
	Central-North	23	52	37	22	8	5	1	148
	Southwest	13	37	36	37	20	9	1	153
Total		65	179	162	131	47	17	2	603

Source : survey data of 2014

Appendix 3: Marital status of producers by region

		Marital status of producers by region				Total
		Married	Single	Widower	Divorced	
Region	Boucle du Mouhoun	133	6	10	1	150
	Central-West	139	8	5	0	152
	Central-North	148	0	0	0	148
	Southwest	145	1	6	1	153
Total		565	15	21	2	603

Source : survey data of 2014

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Appendix 4: Status of land by region

		Status of land			Total
		Private owner	Tenant	Not defined	
Region	Boucle du Mouhoun	44	104	2	150
	Central-West	143	5	4	152
	Central-North	148	0	0	148
	Southwest	104	49	0	153
Total		439	158	6	603

Source: survey data of 2014

Appendix 5: Level of instruction of producers by region

		Nom de la Région				Total
		Boucle du Mouhoun	Central-West	Central-North	Southwest	
Level of education (%)	Primary	31,5	41,4	2,7	24,3	100
	Secondary	18,2	54,5	6,1	21,2	100
	Higher	50,0	50,0	0,0	0,0	100
	literacy	10,2	4,4	68,6	16,8	100
	koranic	45,5	9,1	27,3	18,2	100
	Illiteracy	27,8	26,4	14,6	31,2	100
Total		24,9	25,2	24,5	25,4	100

Source: survey data of 2014

Appendix 6: Membership in a peasant organization by region

		Membership in a peasant organization			Total
		Member	Not member	Not defined	
Region	Boucle du Mouhoun	145	5	0	150
	Central-West	30	122	0	152
	Central-North	68	80	0	148
	Southwest	110	40	3	153
Total		353	247	3	603

Source: survey data of 2014