



Analysis of Organizational Innovations Adoption: Cases of the Different forms of Maize-related Warrantage in Benin

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Authors' contributions

This work was carried out in collaboration between all authors. Author JE designed the study, wrote the protocol and ensured the implementation of the study. He performed the statistical analysis and wrote the first draft of the article in French. Authors MNB, RNY and RCT read and corrected the French version. Author JE joined critics of these two authors and translated the manuscript in English. Author RNY improved the English version. All these authors read and approved the final manuscript.

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ABSTRACT

This study analyzes the determinants of the maize-related warrantage as institutional innovation in Benin. Based on the different forms of warrantage, the districts of Kalalé, Sinendé and Zogbodomey were selected for this study. In each district, two villages were selected. The "snowball" approach was used to sample and investigate 308 households (including treatment households that participate in a warrantage form and control households that do not participate in warrantage). Data related to human, agricultural and structural factors were collected on each warrantage form based on a questionnaire and through semi-structured interviews. A binary Logit regression model was specified to identify the main driving forces of the adoption of each form of warrantage. As a result, it appears that the determinants of the adoption vary from one form of

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warrantage to the other. The positive and negative perceptions determine the marketing-based warrantage and the inputs-based warrantage, respectively. Agricultural factors are positively correlated with the inputs-based warrantage but negatively linked with the income generating activities-based warrantage and the marketing-based warrantage. From a policy perspective, these results show that human, agricultural and structural factors are to be taken into account for different forms of warrantage in order to ensure the sustainability or institutionalization of warrantage in Benin.

Keywords: Determinants; adoption; warrantage; maize; Benin.

1. INTRODUCTION

In the recent years, the adoption process of an institutional innovation has become a subject of controversy [1]. Talking about innovation, adoption broadly refers to the behavior change of an individual who moves from the first knowledge of the innovation to implement a new idea and confirm his acceptance or rejection decision [2]. Such behavior change can be observed at the organizational or individual levels within an organization [3]. At the organizational level, environmental and organizational conditions are the drivers that facilitate or inhibit the adoption of an innovation [4]. At the individual level, the innovation process can be considered as a success when the innovation is accepted by the members who integrate it within the organization and the individuals' behavior demonstrate that they will continue to use the aforesaid innovation [5]. In this case, several factors might influence the individual adoption of organizational innovation. These factors include the characteristics of the innovation itself (characteristics termed as structural factors) and those of individuals (characteristics termed human factors) [1,3,4].

After the implementation of structural adjustment policies in sub-Saharan Africa, the farmers' access to credit has become difficult in development countries [6]. The appropriation of innovations by the rural population is challenged [7]. Microfinance institutions (MFIs) have excluded the rural credit from their financial system due to higher operating costs and the risk associated to agriculture [8]. In Benin, about 51% of households engaged in agriculture did not use chemical inputs in 2013 [9]. Some households use loans at high interest rates to meet their social and agricultural needs [10]. Smallholder farmers are selling their products immediately after harvest to settle their debt or meet urgent needs [11]. They re-buy the same agricultural products during the period of food shortage at very high prices (increase of over 56%) [12].

Therefore, the rural households are maintained in a cycle that does not allow them to get a good crop yield, to engage income generating activities or to meet their basic needs.

The warrantage system is presented as a potential alternative to facilitate the access of farmers to credit in West Africa [13]. Warrantage is more a speculation tool to improve the average incomes of farmers than a tool to reduce the risk of agricultural products price decreases in East Africa and India [14]. In Bangladesh and Nigeria, the warrantage system can enable to obtain the credit for financing income generating activities (IGA), fattening of small ruminants, running small business and agricultural production [15]. In Niger, farmers have realized gains about 19% to 113% on their investment over six months through the warrantage system [16]. Thanks to the warrantage system, farmers adopted some technologies (microdose) to improve the agricultural productivity (ibid). Warrantage allows farmers to benefit from the agricultural inputs and the seasonal prices rise [14]. In Benin, warrantage is organized for maize which is one of the strategic sectors in the national agricultural policy [17]. It helps households to realize a gain about 29.4 FCFA¹ /kg of maize [11]. Nevertheless, farmers are reluctant to participate in the warrantage system oriented towards the marketing of agricultural products [18]. According to the annual report of the Service de Développement Economique Local (SDEL), the farmers' participation rate in the income generating activity (IGA)-based warrantage decreased by about 90% between 2011- 2012 and 2012-2013 in the department of Alibori [19]. Among the nineteen municipalities benefiting from the inputs-based warrantage, only farmers in Sinendé continued the operation [20]. As a result, there are so many forms of maize-related warrantage but few of them seem to fit with the households' characteristics or expectations.

¹ 1 USD = 550 FCFA

In such a situation, what are the drivers that influence the adoption process of an organizational innovation? This study analyzes the drivers of the adoption of the different forms of maize-related warrantage in Benin in order to provide some answers to this question.

2. THEORETICAL BACKGROUND

The concept of innovation is polymorphous and complex provided that it is technical or non-technical [21]. Technical innovation refers to a product or a technical process whereas non-technical innovation includes services and non-technical process such as organizational innovation. Organizational innovation has a polymorphous content according to the fields of investigation [22]. Organizational innovation is captured following three main approaches where it is considered either as a prerequisite adaptation for the introduction of new technology, or as a prerequisite condition to the success of a new product or innovation of technical processes [21]. Whereas two of the approaches are oriented towards identifying the structural characteristics of an organizational innovation and its impact on how the change takes place [23,24], the third approach focuses on how organizational innovations emerge, develop and grow at the micro level within the organization [25]. The development and expansion refers to the acceptance of the organizational innovation by the target group through membership or participation of new members in the implementation of innovation.

The characteristics of a given organizational innovation and those of the individual influence the innovation adoption [4]. The innovation's characteristics of reveal its advantages, compatibility, complexity, feasibility and the related risks [3]. According to Ouedraogo et al., the perceptions can positively or negatively influence an individual's decision on whether to adopt or not an innovation [26]. In that respect, two types of perception can be distinguished: Negative perceptions and positive perceptions. Negative perceptions push the individual to reject an innovation whereas positive perceptions are incentives towards the adoption decision. The adoption of an organizational innovation at the individual level depends on the acceptance of innovation by the organization, the demographic characteristics of the individual and its experience, membership in a social network, availability of land, etc. [3]. Demographic characteristics include gender, age, education,

household size, etc. [27]. Younger and the more educated the household head is, the more he is likely to adopt innovation [26,28]. The level of prosperity, land acreage, household's experience and access to credit positively influence the innovation adoption process [28,29]. The individual membership to a network or an organization plays an important role in the adoption process as well [30]. Indeed, the more the individual exchange with others on an innovation through an organization, the more he accepts and integrates it into its practices [30]. The investment required by a given innovation is also an inhibitive factor in the adoption process [4]. Therefore, Kallas et al. identify five types of determinants: The farmer's characteristics (e.g. gender, education, age, experience, etc.), the farm structure (e.g. size, use of machinery, etc.), the farm management (e.g. use of inputs, crop diversification, etc.), the external factors (e.g. income, input prices, access to market or information, etc.) and the perceptions of the individual [27]. The adoption determinants can be grouped into three main factors: Human factors, agricultural factors and structural factors (Fig. 1). Human factors include the demographic and economic characteristics of the household. Agricultural factors are related to the land acreage, the number of cultivated crops, the maize quantities obtained, the maize quantities traded and consumed, etc. Finally, structural factors reveal the households' perceptions of on each form of warrantage.

3. RESEARCH METHODS

3.1 Study Area and Sampling

In Benin, three forms of maize related warrantage are implemented. These are: the IGA-based warrantage, the inputs-based warrantage and marketing-based warrantage [31]. IGAs-based warrantage is used as a tool to finance IGAs in a context of decentralization (cases of PA3D (*Projet d'Appui à la Déconcentration, à la Décentralisation et au Développement économique local*) and SDEL). It is characterized by the involvement of a few number of actors (FO, MFI, local community, SCDA (Secteur Communal de Développement Agricole)), by higher interest rates (2%), by the definition of the credit amount per bag of product and the non-consideration of risks associated with the operation. The particularity of this warrantage stands in the involvement of local communities. This is justified by the fact that such warrantage was initiated to strengthen the

local economy in a context of decentralization. In addition to the existing stores in each locality, new stores are built to shelter the products.

The inputs-based warrantage oriented towards a better access to agricultural inputs (case of PINC (*ProjetIntrants Non Coton*) of IFDC) is characterized by a strong involvement of several types of actors, a low interest rate and a guarantee fund to cover risk (deficits or losses of farm products, unwillingness of depositors, specific natural disasters and the risks on financial transactions, etc). Indeed, PINC created a special fund of about 168,989,250 Fcfa as initial deposit. This fund was raised through a signed agreement framework between the guarantor (IFDC) and the skylight MFI. The products are stored in existing locals or stores in each locality.

The marketing-based warrantage is orientated towards the flow of agricultural products on the market (case of UCP-Z). It is characterized by a reduced hierarchical structure (MFI, SCDA and FO). Technical support is provided by the promoter who hires some agricultural products marketing technicians. The financial parameters are standard. Products are stored in a central store.

With respect to these forms of warrantage, three representative districts were selected for this study. These are the areas of Kalalé, Sinendé and Zogbodomey. Table 1 gives an overview of the different forms of maize-related warrantage.

In each municipal area, two villages were selected according to the number of maize depositors. The "snowball" approach was used to

investigate all depositors (treatment group) in each village. It consisted to identify others depositors from one key informant. Non-depositors (control group) were also identified through the same approach. However, the total number of non-depositors investigated was slightly higher than that of depositors in each village for statistical reasons. Research units are households represented by the head. A total of 308 households were surveyed (Table 2).

3.2 Data Collected, Collection and Analytical Tools and Techniques

Data collected are related to human factors (age and education level of the household head, income level of the household, access to credit, size and number of agricultural workers in the household, number of farmers organizations the household's members belong to), agricultural factors (land acreage of maize, number of cultivated crops, maize production obtained, quantities of marketed and consumed maize, land acreage of other crops cultivated by the household) and structural factors (perceptions of household head on each warrantage form). The main negative perceptions included in the model are the lower prices of products, the constraining requirement of MFIs and constraining formality as the respondent while positive perceptions are the channel operation to access easily to credit or input, the channel flow of agricultural products and the opportunity to benefit from rising prices for agricultural products. These data were collected using a questionnaire applied through semi-structured interviews with selected household heads.

Table 1. Characteristics of the different forms of maize-related warrantage

Municipal areas	Warrantage forms	Financial settings			Actors
		Interest rate	Maximum credit	Risk garant	
Kalalé	IGA-based	2%	10000 FCFA/bag of maize	Depositors	MFI, SCDA, traders, FO
Sinendé	Inputs-based	1,25%	80% of the stock	Sponsor	FO, SCDA, MFI, IFDC
Zogbodomey	Marketing-based	2%	100% of the stock	UCP-Z	FO, MFI

FO: Farmers Organization; SCDA: Communal Sector of Agricultural Development, Source : [31]

Table 2. Sample structure

Villages	Kalalé			Sinendé		Zogbodomey			Total	
	Basso	Bouca	Total	Sèkèrè	Yara	Total	Agoïta	Dèmè		
Non depositors	37	13	50	31	37	68	20	22	42	160
Depositors	37	11	48	31	37	68	18	14	32	148
Total	74	24	98	62	74	136	38	36	74	308

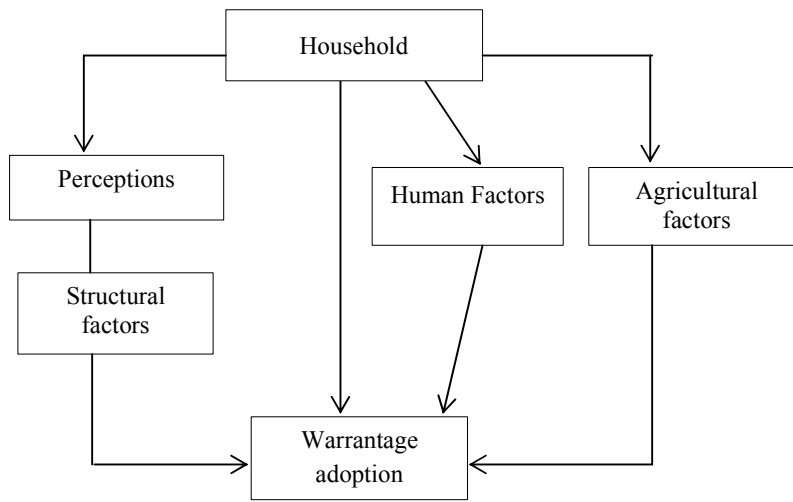


Fig. 1. Analytical framework of the study

Data collected were entered into Excel and analyzed by using SPSS software. Descriptive statistics were used to make a descriptive analysis of the characteristics of treatment and control households. Then, a binary Logit regression model was run to identify the determinants of adoption of each warrantage form. Here, adoption refers to the participation of household in one of the warrantage form since the starting year of warrantage in the village. Accordingly, the dependent variable is the adoption of warrantage while the explanatory variables are the human, agricultural and structural factors presented above.

3.3 Specification of the Regression Model

The model

The general form of the Logit model is:

$$Y = f(Z) \tag{1}$$

In this equation, Y is the dependent variable and Z the set of explanatory variables. Following the previous considerations, let us denote the adoption variable, the human factors, the agricultural factors, and the structural factors by ADO, HF, AF, and SF, respectively. Thus, Equation (1) becomes;

$$ADO = f(HF, AF, SF) \tag{2}$$

In a more explicit way, Equation (2) can be expressed as:

$$ADO_i = \beta_0 + \beta_1 AGE_i + \beta_2 NIVINST_i + \beta_3 NIREVE_i + \beta_4 NICREDI_i + \beta_5 NBROP_i + \beta_6 NBRCULTU_i + \beta_7 SUPMAIS_i + \beta_8 PRODMAIS_i + \beta_9 MAISCOM_i + \beta_{10} MAISCONS_i + \beta_{11} SUPAUTRE_i + \beta_{12} NBRACITIF_i + \beta_{13} BAIPRI_i + \beta_{14} EXIGIMF_i + \beta_{15} EXIFORMA_i + \beta_{16} CACREDI_i + \beta_{17} CANECOUC_i + \beta_{18} PROHAUS_i + e_i \tag{3}$$

The definitions of the explanatory variables are summarized in Table 3. In Equation 3, *i* stands for a respondent; β are the coefficients or parameters to be estimated; and *e* is the error term. The parameters β are estimated by using a Maximum Likelihood (ML) through a Logit regression model. One Logit model was run per form of warrantage, implying based on each municipal area.

Hypotheses to be tested

Age (AGE), level of educational (NIVINST) and level of income (NIREVE) can positively affect the adoption decision of each warrantage form [28,29]. Thus, positive relationships (i.e. estimated coefficients) are expected between these explanatory variables and the adoption variable.

Access to credit (NICREDI) can be affected by a negative coefficient because the higher the probability of access to credit is, the less the household will be interested to participate in the warrantage system. Hence, a negative relationship is expected between access to credit and warrantage adoption decision.

Maize obtained production (PRODMAIS) during the last season is expected to show a positive coefficient in the model because the more the production is important, the more the household will have the ability to participate in the warrantage.

Negative perceptions such as the lower prices of products (BAIPRI), the constraining requirement of MFIs (EXIGIMF) and constraining formality (EXIFORMA) are expected to show negative coefficients. On the other hand, positive perceptions such as the channel operation to access easily to credit or input (CACREDI), the channel flow of agricultural products (CANECO) and the opportunity to benefit from rising prices for agricultural products (PROHAUS) are expected to show positive coefficients.

The number of FO (NBROP) to which the household belongs is expected to have a positive relationship with the adoption decision. Indeed, belonging to more organization is a sign of strong social involvement that enable the household to be more exposed and opened to innovation [28].

Maize land acreage (SUPMAIS) and number of agricultural workers (NBRCTIF) are expected to show positive coefficients given that maize is the main crop of warrantage. In that respect, land acreage of other crops (e.g. sorghum, millet, groundnut, cowpea, etc.) (SUPAUTRE) may show a negative coefficient because these crops are less valued in warrantage.

Given that warrantage is a speculation tool to reduce market risk and a way of collective marketing [32], the quantity of maize sold out (MAISCOM) and auto-consumed (MAISCONS) per household may show negative coefficients.

Crop diversification measured through the number of food cultivated crops last season (NBRCULTU) is expected to have a positive coefficient because the more the household's production is diversified, the more it can consume other products (e.g. cowpea, groundnut, rice, etc.) and deposit maize.

4. RESULTS

4.1 Characteristics of Households Surveyed

Age, level of education, level of income, level of access to credit and number of agricultural

workers are slightly the same between the treatment and control households (Table 4). Hence, both groups of households presented more or less the same socio-demographic and economic characteristics.

The level of crop diversification is the same between the treatment and the control households of IGA-based and marketing-based warrantage. On the other hand, the treatment households participating in the inputs-based warrantage cultivated on average less crops than their fellow (4 crops against 6 crops) (Table 4). The average land acreage of maize is higher in the control group than in the treatment group for the inputs-based warrantage (9.13 ha against 7.14 ha) whereas the opposite trend is observed for the marketing-based warrantage (2.81 ha in the control group 3.63 ha in the treatment group). The total land acreage of other crops is slightly higher for the control households than that of the treatment households, regardless of the warrantage form. Considering the IGA-based and marketing-based warrantage forms, the maize production obtained by the treatment households the previous season is higher than that of the control households (Table 4). Yet, the quantities of maize allocated to the market and the household consumption by control households are higher than that of the treatment households for the IGA-based and inputs-based warrantage forms (Table 4).

4.2 Perceptions on Warrantage Forms

The requirements of MFIs in the implementation of warrantage IGA are important constraints for about 68% and 77% of the control and treatment households, respectively (Table 5). The decline of maize prices through the warrantage is mostly perceived by the treatment households involved in the inputs-based warrantage. The three forms of warrantage are perceived by the majority of the surveyed households as channels to have access to credit or inputs (Table 5). The marketing-based warrantage is mostly perceived as a channel facilitating the access to market (Table 5).

4.3 Determinants of the Adoption of Warrantage

The main determinants of the adoption of warrantage vary from one warrantage form to the others.

Table 3. Definition of the variables used in the model

Variables	Name in the model.	Type ^a	Terms	Expected sign	
Adoption decision of warrantage	ADO	N	Yes= 1 ; no= 0		
Age	AGE	C	-	-	
Level of education	NIVINST	O	1 = No education; 2 = primary level; 3 = secondary level; 4 = university level	+	
Level of income	NIREVE	O	1 = Your income is not really enough, so you need to borrow to satisfy your expenses; 2 = Your income is not enough, so you need to use your savings for your expenses; 3 = Your income just meets your expenses; 4 = Your income allows to save a bit; 5 = your income allows you to boost your savings (much)	+	
Level of access to credit	NICREDI	O	1 = Extremely unlikely (approximately 0%); 2 = very unlikely (about 25%); 3 = Neither likely or unlikely (50%); 4 = likely (about 75%); 5 = very likely (100% chance)	-	
Number of FO membership	NBROP	C	-	+	
Number of food crops grown last season	NBRCULTU	C	-	+	
Land acreage of maize of the current season (ha)	SUPMAIS	C	-	+	
Maize production of the last season (kg)	PRODMAIS	C	-	+	
Quantity of maize sold out (kg)	MAISCOM	C	-	-	
Quantity of auto-consumed maize (kg)	MAISCONS	C	-	-	
Land acreage of other crops (ha)	SUPAUTRE	C	-	-	
Number of agricultural workers	NBRACTIF	C	-	+	
Perceptions on warrantage	Lower prices of products	BAIPRI	N	Yes= 1 ; no= 0	-
	Constraining requirement of MFIs	EXIGIMF	N	Yes= 1 ; no= 0	-
	Constraining formality	EXIFORMA	N	Yes= 1 ; no= 0	-
	Channel operation to access easily to credit or input	CACREDI	N	Yes= 1 ; no= 0	+
	Channel flow of agricultural products	CANECOUC	N	Yes= 1 ; no= 0	+
	Opportunity to benefit from rising prices for agricultural products	PROHAUS	N	Yes= 1 ; no= 0	+

^a C= continuous ; O= ordinal ; N= nominal

Table 4. Descriptive statistics of ordinal and continuous variables

Variables	IGA-based warrantage				Inputs-based warrantage				Marketing-based warrantage			
	Control households		Treatment households		Control households		Treatment households		Control households		Treatment households	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Age (years)	49.32	13.93	42.98	7.15	45.04	10.97	44.46	9.09	41.79	10.98	46.47	12.88
NIVINST	2.08	1.38	2.15	1.37	1.16	0.44	1.31	0.92	1.36	0.76	1.72	1.28
NBRACTIF	5.14	5.81	4.79	3.24	4.49	3.42	3.83	2.53	2.76	1.65	4.03	3.42
NIREVE	3.36	1.06	3.04	1.17	2.25	0.92	2.61	1.35	3.36	1.06	2.88	0.94
NICREDI	2.98	1.33	2.85	1.34	2.57	1.29	3.25	1.21	4.02	0.81	3.66	0.75
NBROP	0.96	0.67	1.40	0.68	1.78	0.69	2.40	0.99	2.00	2.16	2.72	1.78
NBRCULTU	3.44	1.07	2.81	1.50	5.60	1.49	4.09	1.51	2.83	1.17	2.69	1.12
SUPMAIS (ha)	2.78	2.31	2.89	2.20	9.13	10.13	7.14	6.71	2.81	1.46	3.63	2.79
SUPAUTRE (ha)	3.03	2.18	2.54	1.70	3.05	2.03	2.15	2.64	1.52	1.19	1.21	1.13
PRODMAIS (kg)	4140.00	3081.01	7441.67	6661.16	27785.29	42753.00	16654.41	16817.04	2271.43	1506.89	4679.69	7826.21
MAISCOM (kg)	2679.46	2676.86	1813.97	2943.27	16666.63	27734.84	8475.73	8695.29	1118.87	1143.10	2362.46	4648.32
MAISCONS (kg)	626.04	1254.99	341.96	831.53	2769.16	4339.66	1536.24	4401.71	939.80	616.47	1651.52	2811.53

Source: Survey data, July 2014

Table 5. Frequency of households according to the perceptions

Warrantage forms	Households groups	Perceptions on warrantage																	
		Exigimf			Baipri			Exiforma			Cacredi			Canecou			Prohaus		
		No	Yes	Total	No	Yes	Total	No	Yes	Total	No	Yes	Total	No	Yes	Total	No	Yes	Total
IGA-based	Control	32.0	68.0	100.0	74.0	26.0	100.0	92.0	8.0	100.0	24.0	76.0	100.0	64.0	36.0	100.0	58.0	42.0	100.0
	Treatment	22.9	77.1	100.0	66.7	33.3	100.0	85.4	14.6	100.0	10.4	89.6	100.0	47.9	52.1	100.0	58.3	41.7	100.0
Inputs-based	Control	100.0	0.0	100.0	95.6	4.4	100.0	100.0	0.0	100.0	13.2	86.8	100.0	89.7	10.3	100.0	83.8	16.2	100.0
	Treatment	100.0	0.0	100.0	23.5	76.5	100.0	97.1	2.9	100.0	13.2	86.8	100.0	85.3	14.7	100.0	75.0	25.0	100.0
Marketing-based	Control	57.1	42.9	100.0	61.9	38.1	100.0	69.0	31.0	100.0	38.1	61.9	100.0	21.4	78.6	100.0	76.2	23.8	100.0
	Treatment	43.8	56.3	100.0	84.4	15.6	100.0	56.3	43.8	100.0	21.9	78.1	100.0	12.5	87.5	100.0	65.6	34.4	100.0

Source: Survey data, July 2014

4.3.1 Adoption of IGA-based warrantage

The adoption of IGA-based warrantage is positively determined by the number of FO memberships, the number of agricultural workers and the maize production obtained during the previous season (Table 6). The more the household head belongs to many OF the more he is likely to adopt the IGA-based warrantage. Again, the higher the maize production obtained during the previous season and the number of agricultural workers are, the higher is the probability to adopt the IGA-based warrantage.

Age, number of cultivated crops, quantities of maize sold out and auto-consumed and land acreage of other crops negatively influence the adoption decision of IGA-based warrantage.

4.3.2 Adoption of inputs-based warrantage

Age, number of agricultural workers, land acreage of maize the current season, quantities of maize sold out and auto-consumed are positively correlated with the adoption of the inputs-based warrantage (Table 6). Indeed, higher values of these variables are associated with higher probabilities to adopt the inputs-based warrantage. Also, the more the household head perceives the inputs-based warrantage as an operation in which maize prices decline or increases, the more he is willing to participate and hence to adopt warrantage.

Diversification of crops cultivated the previous season does not favor the participation of household in warrantage (Table 6). The more a household diversified crops, the less it adopts warrantage. The perception that the inputs-based warrantage is a flow channel of agricultural products does not favor its adoption

4.3.3 Adoption of marketing-based warrantage

Age, access level to credit and maize production obtained during the previous season are positively correlated with the adoption decision of the marketing-based warrantage (Table 6). Positive perceptions such as access channel to credit or inputs, flow channel of maize and opportunity to benefit of rising prices of agricultural products positively influence the adoption of marketing-based warrantage. On the other hand, level of educational level, number of food crops cultivated during the previous season, land acreage of maize in the current season quantities of maize sold out and auto-consumed are negatively correlated with the adoption

decision of marketing-based warrantage (Table 6).

In sum, human, agricultural and structural factors influenced both positively and negatively the adoption of the inputs-based and marketing-based forms of warrantage. Structural factors have not influenced the adoption of the IGA-based warrantage.

5. DISCUSSION

5.1 Human Factors as Determinants of the Adoption of Warrantage

Age was found to be positively correlated with the adoption decision of the inputs-based and marketing-based forms of warrantage while a negative correlation is found between age and the adoption decision of IGA-based warrantage. Indeed, younger household heads are more likely to adopt the IGA-based warrantage. This result can be explained by the fact that younger of household heads are mostly interested by credits to engage or develop economic activities, purchase transport means or farm machinery, etc. Other priorities for younger household heads include building own houses and manage social issues such as education of children, family health, marriage, etc. Older household heads are more concerned by issues of inputs to improve their agricultural production or by having a better access to the market. This result is consistent with that of Kabunga et al. according to which older household heads are more likely to adopt innovation than they counterparts younger in Kenya [28]. Considering IGA-based warrantage, the hypothesis about the negative influence of age on the adoption of warrantage is confirmed. The effect of age on the adoption depends warrantage forms.

The positive correlation between level of access to credit and marketing-based warrantage is explained by the fact that producers need to sell out their products to pay off debts. The more farmers have accessed to credit, the more they seek market access of their agricultural products. This result is opposite to that of Kabunga et al. according to which access difficulties to credit encourage the adoption of banana tissue culture in Kenya [28].

Increases in the number of agricultural workers positively influence the adoption of IGA-based and inputs-based forms of warrantage. These results confirmed the departure hypothesis and are consistent with the findings of Kristjanson et al. and Shiferawa et al. [33,34]. Agricultural

workers are an important source of family labor which contributes to increase the land acreage, implying the need of more inputs. Furthermore, the number of agricultural workers in a household reassures that it can produce abundantly to repay the credit obtained through warrantage.

The household head's membership in multiple FO influences positively the adoption of IGA-based warrantage; confirming initial hypothesis. Indeed, FO membership enables individuals to have access to information on warrantage and shows that the household head is opened to exchange with its neighbors [30].

Contrary to the initial hypothesis, the level of education is a barrier for adopting marketing-based warrantage. This result is contrary to that of Kabunga et al. and Matuschke & Qaim [28,30]. According to them, education is a favorable factor for the adoption of innovation. In fact, the more educated household heads are more likely to adopt banana tissue culture than the less educated household heads [28]. Education facilitates the adoption of hybrid millet in India [30]. The result in this study can be explained by the fact that the less educated farmers have more difficulties to access agricultural markets. The marketing-based warrantage marketing is therefore an opportunity for less educated farmers to market their products.

5.2 Agricultural Factors as Determinants of the Adoption of Warrantage

Crop diversification influences negatively the adoption of the three forms of warrantage, invalidating the initial hypothesis. In this study indeed, maize is the major crop of warrantage. Provided that land and other production resources are sometimes limited, the cultivation of several crops does not allow the household to have a large maize production; and hence an important maize quantity to be deposited. Nevertheless, Kallas et al. showed that crop diversification is an essential factor in the adoption of innovation [27].

The adoption of the IGA-based or marketing-based forms of warrantage slowed down by the marketing and consumption of the produced maize, confirming the initial hypothesis. The more households sell out or consume their maize production, the less they have an important quantity of maize to deposit and the less they participate in IGA-based and marketing-based

warrantage. However, strong marketing or consumption of maize facilitates the adoption of the inputs-based warrantage. The objective of this warrantage form is to get inputs for increasing agricultural production. Thus, the more households have access to market, the more they reassure to sell out their products and the more they are motivated to get the inputs. This corroborates the assertion of Sunding & Zilberman that the market is an essential driver of adoption of the inputs-based warrantage [35].

The maize production obtained influences positively, like all expectations, the adoption of the IGA-based and marketing-based forms of warrantage. Given that the amount of credit to receive depends on the maize quantity deposited, households producing more maize are more likely to deposit larger quantities of maize and therefore to participate more in the IGA-based and marketing-based forms of warrantage. The deposit of maize is the investment which increases the credit value for depositors. Thus, contrary to Sahi et al. and Sunding & Zilberman in which the investment is a barrier to adoption, investment promotes the adoption of innovation [1,35]. The inputs-based warrantage is not affected by the maize production obtained because it is not the only source of supply of agricultural inputs to farmers. Producers who grow cotton access to inputs that they also use for maize.

The land acreage of maize determines positively the adoption of inputs-based warrantage but influences negatively the participation in marketing-based warrantage. As expected, the more the household land acreage is, the more it needs inputs and the more it deposits maize to benefit of agricultural inputs as is the case of banana tissue culture in Kenya [28]. Also, maize cultivated area is it the main driver of the adoption of Bt maize in Germany [36]. On the other hand, the cultivated area is not a constraint to sell maize through marketing-based warrantage, but rather a source of expenditure. Households who have cultivated more land have needs of funds for operations of plowing, sowing, etc. They are forced to sell their product before the collection period products (January-March). This result is similar to that of Ouedraogo et al. according to which land acreage affects negatively the adoption of new varieties, soil and water conservation technologies and planting dates [26]. The influence of the land acreage of maize varies according to the types of warrantage; qualifying the initial hypothesis.

Table 6. Determinants of the adoption of warrantage

Explanatory variables	IGA-based warrantage				Inputs-based warrantage				Marketing-based warrantage			
	Coef	Erreur standard	Wald	Sig.	Coef	Erreur standard	Wald	Sig.	Coef	Erreur standard	Wald	Sig.
Age	-0.145**	0.064	5.201	0.023	0.100*	0.059	2.863	0.091	0.083**	0.041	4.100	0.043
Nivinst	-0.550	0.404	1.850	0.174	0.468	0.735	0.404	0.525	1.080*	0.559	3.732	0.053
Nireve	0.364	0.494	0.543	0.461	0.717	0.527	1.847	0.174	-0.818	0.500	2.676	0.102
Nicredi	0.692	0.432	2.561	0.110	0.410	0.357	1.318	0.251	-1.909***	0.712	7.179	0.007
Nbractif	0.215**	0.102	4.459	0.035	0.431*	0.220	3.832	0.050	0.193	0.175	1.212	0.271
Nbrop	3.209***	1.235	6.757	0.009	0.295	0.654	0.204	0.652	0.104	0.219	0.228	0.633
Nbrcultu	-1.441**	0.650	4.906	0.027	-1.527***	0.547	7.778	0.005	-1.192*	0.667	3.195	0.074
Supmais	-0.462	0.386	1.430	0.232	0.492	0.299	2.704	0.100	-0.603*	0.363	2.762	0.097
Prodmais	0.002***	0.001	13.363	0.000	0.000	0.000	0.758	0.384	0.005*	0.003	3.558	0.059
Maiscom	-0.002***	0.001	13.291	0.000	0.000**	0.000	6.397	0.011	-0.006*	0.003	3.172	0.075
Maiscons	-0.003***	0.001	11.950	0.001	0.000**	0.000	4.048	0.044	-0.005*	0.003	2.977	0.084
Supautre	-0.709**	0.276	6.623	0.010	-0.068	0.491	0.019	0.890	0.440	0.566	0.606	0.436
Baipri	-1.364	1.375	0.985	0.321	9.478***	2.441	15.079	0.000	-0.973	1.223	0.633	0.426
Cacredi	0.902	1.376	0.430	0.512	-2.711	1.709	2.515	0.113	4.207***	1.603	6.887	0.009
Canecou	0.993	1.592	0.389	0.533	-3.002*	1.727	3.023	0.082	3.737*	1.996	3.505	0.061
Prohaus	-1.906	1.483	1.652	0.199	4.158***	1.556	7.142	0.008	4.933**	1.991	6.137	0.013
Exigimf	-0.167	1.321	0.016	0.899	1.317	0.996	1.747	0.186
Exiforma	0.515	1.451	0.126	0.723	16.124	27679.349	0.000	1.000	-0.706	0.823	0.735	0.391
Constante	4.801	3.888	1.524	0.217	-6.347*	3.655	3.016	0.082	-1.804	3.931	0.211	0.646
R ² de Cox & Snell	0.612				0.655				0.486			
Khi-Chi-deux	92.660***				138.323***				49.319***			
ddl	18.000				17.000				18.000			
Sig.	0.000				0.000				0.000			

Legend: * significant at 10%; ** Significant at the 5%; *** Significant at the 1%
Source: Field survey, July 2014

Land acreage of other food crops influences negatively the adoption of IGA-based warrantage. The more the household allocates land to other food crops, the less it has land for maize and therefore participates less in IGA-based warrantage.

5.3 Structural Factors as Determinants of the Adoption of Warrantage

Structural factors did not influence the IGA-based warrantage. Positive perceptions favor the adoption of marketing-based warrantage, confirming the initial hypothesis. If the household head perceives the inputs-based warrantage as an operation in which maize prices decline or increase, he is willing to participate to this form of warrantage. The perception that the inputs-based warrantage is a flow channel of agricultural products does not favor its adoption. Perceptions and interpretations of the members of an organization play a lot on the adoption of an organizational innovation [37]. Indeed, the adoption of an organizational innovation at the individual level depends on the acceptance of innovation by the organization as it is the case of warrantage in this study [3]. Furthermore, this study confirms that positive perceptions of households on warrantage motivate the adoption of marketing-based warrantage because they reveal the warrantage importance to the household. Likewise, Ouedraogo et al. showed that the main determinants of adoption of adaptation strategies in Burkina Faso are the perceptions [26]. The decline and the profit of the increase of maize prices during the marketing constitute an asset for the adoption of inputs-based warrantage because it allows the collective commercialization of maize.

In sum, the determinants of the adoption of warrantage are found to be both economic and non-economic [27]. They include the production objectives (consumption and marketing), the opinions on the given innovation (perceptions) and the household's characteristics.

6. CONCLUSION

The driving forces underlying the adoption of maize-related warrantage in Benin vary according to warrantage form. The most important human factors in the warrantage adaptation decision process include age, level of educational, number of agricultural workers, farmers organization membership and level of access to credit. The positive and negative

perceptions affect the marketing-based warrantage and the inputs-based warrantage, respectively. Agricultural factors affect mostly and positively the inputs-based warrantage; and negatively the income generating activities-based and marketing-based forms of warrantage. Finally, this study highlights that the determinants of the adoption of maize-related warrantage in Benin vary from one warrantage form to the others. Such result suggests that specific factors are to be taken into account for different forms of warrantage in order to ensure the sustainability or institutionalization of warrantage in Benin.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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