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# Reaching Out the Effects of forms of Warrantage on the Food Security of Rural Households in West Africa: Case of Benin

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The sale of agricultural products at low prices subjects rural households to food insecurity. This article analyzed the impact of warrantage forms around maize on the food security of rural households in Benin. The study was conducted three communes (Kalalé, Sinendé and Zogbodomey) on three forms of warrantage based on marketing, inputs and income generated activities. Two villages per commune were chosen to host the study given the large number of maize farmers. A total of 308 households (160 control households and 148 treatment households) were surveyed randomly. Data on socioeconomic characteristics, on experience in the warrantage, number of days o food groups consumption, etc. were collected using questionnaire during the direct interview. Data were analyzed using descriptive statistic and linear regression per warrantage form. The implementation of forms of IGA warrantage and inputs did not affect the food security of households taken in their socio-economic context. However, participation in marketing warrantage significantly reduces food security. Food security depends on the socioeconomic and demographic characteristics of households and on certain agricultural factors. The IGA warrantage and that of inputs are more suitable to facilitate households' access to credit without affecting their food security. Warrantage marketing can be profitable provided that it is directed towards crops which do not constitute the staple food of the populations. Significant contribution of warrantage to households food security depends on the form of warrantage and socioeconomic characteristics of households. Policy makers and extension services should adapt the forms of warrantage to socioeconomic characteristics and agricultural factors for improving the living conditions of households.

## 1. Introduction

The innovation adoption in agricultural area is an important challenge to improve the food security of households (Fikadu et al., 2025). The induced effects or the impact of an innovation are often questioned because of the inadequacy of these innovations to the socio-economic context of the target populations (Fikadu et al., 2025; Frambach & Schillewaert, 2002). The impact reveals the changes expected in the short and medium terms and effected in the target group through the implementation of an innovation (Ezemenari, Rudqvist, & Subbarao, 1999). The impact assessment of an innovation adoption becomes crucial to decide on the continuation of the innovation implementation (Fikadu et al., 2025; Touzard & Temple, 2012). The added value can be seen in income, livelihoods or food security. Nowadays, food security is becoming a new axiology of innovations for populations because it can be affected positively or negatively depending on the socioeconomic context of the target populations

(Egah et al., 2014a; Touzard & Temple, 2012). As a result, the evaluation of the impact of an innovation on the food security of target households is essential and raises questions. What can we learn from the impact of an institutional innovation on the food security of target households? The answer to this question is the concern of this article, which uses forms of warrantage to explain their impact on food security for rural households in Benin.

In the aftermath of the implementation of structural adjustment policies, difficult access to credit, especially in rural areas, constitutes a stumbling block for the appropriation of innovations in sub-Saharan Africa (Pichot & Faure, 2009). Microfinance institutions (MFIs) are very reluctant to invest in rural credit due to the increase in operational costs and the risk linked to agriculture (Andres & Lebailly, 2013). In Benin, there is no real policy to facilitate farmers' access to agricultural credit. About 51% of households did not use fertilizer for their food production in 2013 (Biaou, Dei, & Mathiassen, 2014). Some households in the departments of Alibori (20%), Borgou (17%) and Atacora (15%) used loans at high interest rates to buy agricultural inputs (Bongi et al., 2009). Other households sell agricultural products to gain access to agricultural inputs and buy the same products at very high prices following an increase of more than 50% (Egah, 2021). Rural households are therefore kept in a vicious cycle of food insecurity.

Warrantage is presented as a palliative to facilitate access to credit for rural farmers (Egah, 2021). Indeed, towards the end of the 2000s in Benin, warrantage was imported from Niger to northeastern Benin by ADECOI project (Projet d'Appui au Développement Communal et aux Initiatives Locales dans le Borgou) to combat food insecurity and enable communes to play their role in promoting the local economy (Gnimadi, 2013). This initiative produced the first results in 2011 with the support of PA3D project (Projet d'Appui à la Décentralisation, à la Déconcentration et au Développement Economique Local) in Benin. But before this experiment reached maturity, the NGO Louvain Coopération and the PINC project (Projet Intrants Non Coton (PINC)/ International Fertilizer Development Center) had implemented a form of warrantage in the North-West since 2002 and 2009. The warrantage allows the farmers to offer in warranty their food harvest for getting the credit from finance institutions. Extension services and chemical inputs suppliers support them by insurance quality of the maize in storage place. Food harvest mainly maize is secured in the storage before offering the credit to the farmers. Warrantage allows farmers to benefit not only from agricultural inputs, but also from the seasonal rise in prices (Egah, 2021). In Nigeria, it enabled depositors to benefit from the 55% price increase for rice, 81% for cowpea, 92% for soybeans, etc. (Othman et al., 2009). Loans can finance income-generating activities (IGAs), fattening of small ruminants, petty trade, agricultural production, etc. (Maiangwa, 2012). According to Egah (2021), warrantage is more a tool of speculation allowing to improve the average incomes of the farmers than a tool of reduction of the risk related to the fluctuation of the prices for reasons of the absence of the historical data on the price variations. In Benin, three forms of warrantage are implemented. These are IGA warrantage, input warrantage and marketing warrantage. Several types of actors (microfinance institutions (MFI), peasant organization, Communal Sector for Agricultural Development (SCDA), local communities, etc.) are involved in the implementation of the warrantage. Depending on the forms of warrantage, the value of the credit granted depends on the quantity of maize pledged as collateral in premises or warehouses. The depositors can withdraw their warranted product in the form after having settled or wait for the marketing of the product at the time of the price increase to reimburse the credit. According to these different forms, food security can be guaranteed or threatened. In 2022, around 25,5% of rural households were in food insecurity in Benin according to the Global Analysis of Vulnerability and Food Security (AGVSA) when the warrantage implementation gained several areas (World Food Program, 2022).

Several studies on warrantage targeted the participation determinants to warrantage (Agossadou & Yabi, 2023; Alokpaï et al., 2024; Egah et al., 2016) the organizational environment of warrantage, the rentability aspect of warrantage (Ogouvide et al., 2021), the efficacity of warrantage (Moustafa et al., 2022) and warrantage adaptation to climate change context (Egah, 2021). But the contribution of warrantage to household food security is missed in the literature. Le Cotty et al. (2023) tried to show how warrantage device could improve the food security. But the evidence of warrantage impact is not established by the studies concerning the food security aspect. Therefore, we wonder then what is the form of warrantage which guarantees the food security of rural households in the socio-economic and demographic context of these latter? The objective of this study is to model the impact of forms of warrantage around maize on the food security of rural households in Benin.

## 2. Theorical Framework

Impact assessment identifies or measures the changes that can be attributed to a given intervention or


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innovation (Ezemenari et al., 1999). It reveals not only the positive or negative social consequences, expected and unexpected of any intervention or innovation, but also any process of change brought about by innovation (Orieno et al., 2024). Impact assessment theory makes it possible to map the causal chain, to understand the context, to anticipate heterogeneity, to make a rigorous impact assessment using a credible counterfactual, to do a rigorous factual analysis and to use mixed methods (White, 2009). Being difficult to attribute change only to innovation, evaluation is dynamic to meet the needs of the community and specifically the target group (Bledsoe & Graham, 2005). Thus, it must take into account the socioeconomic status of the beneficiaries of the innovation (White, 2009). It starts from a counterfactual (control households) from which the differential of the effects brought by innovation is estimated (Delarue, 2007). It is based on complementary systemic methods (quantitative and qualitative) of information collection and analysis (Leguéné et al., 2012). In this study, these systemic methods formed the backbone of the "with-without" evaluation approach to obtain reliable results and conclusions (Leguéné et al., 2012). The linear regression often used to identify the determinants of food security has adapted well to this approach (Jones et al., 2013; Kabunga, Dubois, & Qaim, 2014). It made it possible to take into account the socio-demographic and economic context of households to explain the impact of each form of warrantage on household food security (Koch & Schermuly, 2021; Miller et al., 2022).

Recent studies have shown that adopting an innovation is not the only factor that can affect a household's food security (Kabunga et al., 2014). Indeed, participation in a food program, food expenditure and the profession significantly reduce household food insecurity unlike the level of household income, the age of the head of the household, the size of the household, the difficulties of '' access to credit and the low level of education of the household head (Jones et al., 2013; Kabunga et al., 2014). Unlike the latter, Osayande & Ada-Okungbowa (2014) reveal that household size, farm income and non-farm income positively influence food security. Food security does not depend on food production but rather on the uses of this production and the number of food crops (Tscharntke et al., 2012). Thus, there are socioeconomic characteristics of the household, agricultural factors (production, uses of production, etc.) and the adoption of an innovation are the drivers of food security.

A household is food secure when all its members have, at all times, physical, social and economic access to sufficient, healthy and nutritious food which enables them to meet their energy needs and their food preferences to lead a healthy and active life (FAO, 2009). The most effective indicators for measuring household food security combine macronutrients (basic calorie needs) and micronutrients (meat, fish, eggs, dairy, fruits and vegetables) (Gebrihet, Gebresilassie, & Gebreselassie, 2025). This is the case for the food consumption score (SCA) used in this study (Getaneh et al., 2022; Headey & Ecker, 2013; Kennedy et al., 2010). Food groups are grains and tubers (staple foods), legumes, vegetables and leaves, fruits, animal protein, dairy products, sugars, oils and condiments (Jones et al., 2013).

## 3. Materials and Method

### 3.1. Choice of Study Cases

In Benin, the IGA warrantage enabled households to benefit from credit at a monthly interest rate of 2% after depositing agricultural products as collateral to exercise IGAs, finance agricultural production or satisfy other needs (Egah et al., 2014a). As for input warrantage, the credit granted at a monthly interest rate of 1.25% against agricultural products is oriented towards the purchase of agricultural inputs. In the implementation of warrantage marketing, agricultural products are sold to their municipal apex which resells them during the lean season to return the relic to depositing households.

### 3.2. Area Study, Units of Research and Sampling Approach

The study was carried out in three communes: Kalalé, Sinendé and Zogbodomey. The units of research were the agricultural households representinted by the head. There were the beneficiery households and no beneficiery households. The used sampling approach was a multistage approach. The sampling steps are described as following:

**Choice of Case Studies**: Based on nine cases of warrantage around the maize in Benin (Egah, 2021), three case studies were selected using criteria (Pires, 1997). These criteria were theorical relevance, the examplarity, the possibility to learn of the case, and the possibility to access to information on the case and its social interest (Tableau 1) (Pires, 1997). The theorical relevance allowed to establish the linkage between the study goal and each case. For that, the


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case studies aimed to reach different goal for improving food security of rural households. The examplarity or typicity allowed to choose the cases of warrantage based on the different types of credit (credit for income generated activities, credits for inputs and credit for maketing). The possibility to learn was related to learn of the cases of different promoters like NGO, projects and farmers organization. Social interest established the geographic area in terms of number of reached persons with the case because the case implemented in whole country could allow to reach more people than other cases. The possibility to gather data on all cases was also important to make sure that the case could be analyzed. According these criterias, three selected cases were: inputs warrantage, marketing warrantage and income generated activities warrantage. The inputs warrantage aimed to improve the access to chemical inputs for the farmers. The marketing warrantage amied to get the markets for the maize.

**Communes selection**: Based on the selected cases studies, three communes were selected according the case implemented in the communes. Then, the communes of Kalalé, Sinendé and Zogbodomey representing income generated activities (IGA) warrantage, input warrantage and marketing warrantage respectively were studied. These communes were selected because warrantage was an successful experience during the study period.

**Choice of Villages**: Six villages (2 villages per commune) were selected according the importance of number of farmers participating to the warrantage arround the maize.

**Units of Research and Sampling**: The units of research were the households joining the warrantage or not. Sample size was 288 households basing on the following formula (Cochran, 1963):

$$= t^2 \times p \times (1\text{-}p) / m^2$$

- n: Minimum sample size
- t: Confidence level (the type value of confidence level 95% is 1,96)
- p: proportion of the population participating to the warrantage (25%) supposed with the warrantage promoters
- m: Margin of error (generally set at 5%)

According the samplze size, 148 households were randomly selected in the treatment group (farmers who joined the warrantage) whereas 160 households were randomly selected in the control group (farmers who did not joint the warrantage). These numbers were distributed proportionaly in the villages based on the number of farmers participating to the warrantage or not (Tableau 1).

**Tableau 1:** Cases Studies and Study Sample.

| Cases Studies | Cases Studies | | | | | |
|---|---|---|---|---|---|---|
| | Inputs Warrantage | | Marketing Warrantage | | Income Generated Activities Warrantage | |
| Theorical relevance | Input access Improvement | | Credit access facilitation | | Stimulate the activities generating income | |
| Examplarity | Input credit | | Credit for agricultural campain | | Credit for activities generating income | |
| Possibility to learn with the case | Implmentation by a project | | Implmentation by an farmers organization | | Implmentation by intercommunality | |
| Social interest and possibility to get information on the cases | National level | | Communal level | | Regional level | |
| Communes | Sinendé | | Zogbodomey | | Kalalé | |
| Villages | Sèkèrè | Yara | Agoïta | Dèmè | Basso | Bouca |
| Sample size per village | 62 | 74 | 38 | 36 | 74 | 24 |
| Treatment group | 31 | 37 | 20 | 14 | 37 | 11 |
| Control group | 31 | 37 | 18 | 22 | 37 | 13 |

### 3.3. Method of Data Collection and Analysis

The mixt method was used to gather and analyze the data. The collected data were the participation or not to the warrantage, number of years of experience in the warrantage, education level, food expenses, sex, socio-cultural group, religion, profession, age and number of producers organization (POs) in which households head belonged, level of household income, size and number of agricultural assets in the household, level of access to credit, maize production obtained during the season, the destinations of this production (consumption and marketing) and the quantities affected, the number of food crops grown in the previous season, the total area cultivated and those allocated to maize and food crops (rice, sorghum , yam, cassava, millet, etc.). Also, the number of days of consumption of cereals and tubers (staple foods), legumes, vegetables and leaves, fruits, animal proteins, dairy products, sugars, oils and condiments were collected over the last 7 days preceding the survey. All datawere collected using a quantitative method through a questionnaire during


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semi-structured individual interviews. However, the qualitative method was used based on the non structured interview during the focus groups. Qualitative data were analyzed using discoursis analysis to describe the process of warrantage and get the verbatims of the surveyed farmers.

The FCS was calculated doing from sum of the number of days of food groups consumption multiplied by their coefficient α (Headey & Ecker, 2013). The coefficient assigned to legumes, animal proteins and dairy products is 4 while basic foods are weighted by 2. Vegetables and leaves are weighted by unit (1). The weights assigned to fruit and sugar is 0.5. The weight assigned to the condiments is zero.

$$FCS = \sum \alpha i Fi$$

With $\alpha i$ is coefficient of food group I and $Fi$ is number of consumption days of food group $i$.

The linear regression allowed to estimate the effect of participation to warrantage on food security of households. In the model, the independent variables used were the participation to a form of warrantage, the number of years of experience, the level of education, food expenses, sex, number of POs membership and age of the head of household, income level, level of access to credit, number of agricultural workers and household size, production of maize, quantities of production affected for consumption and marketing, the total cultivated area and the allocated area to maize and food crops, and the number of food crops grown last season. All these variables did not appear in the model due to the automatic application of the principle of parsimony with AIC (Akaike information criterion) according to the MASS package of statistical software R (Appendix 2).

### 3.4. Specification of the Theorical Model

The linear regression of the FCS was written from the explanatory variables (Appendix 1) in the form:

$$FCS = \beta_0 + \beta_1 PARTIWA + \beta_2 NBRANEW\ \beta_3 AGE + \beta_4 NBROP + \beta_5 NBRACTIF + \beta_6 TAIMEN + \beta_7 ILLETRE + \beta_8 PRIMAI + \beta_9 SECOND + \beta_{10} ATPROB + \beta_{11} APROB + \beta_{12} ANPROB + \beta_{13} AEIMPRO + \beta_{14} SUPMAIS + \beta_{15} MAISCOM + \beta_{16} MAISCONS + \beta_{17} SUPVIVR + \beta_{18} SUPTOT$$

The expected sign of the coefficients of participation in a form of warrantage and the number of years of experience in warrantage is negative because if the households deposit their food crops as collateral, they could no longer access without repayment of the credit. Also, the quantity of sold maize can have a negative influence on the FCS unlike that consumed.

The expected sign of maize production, the total cultivated area and the allocated area to food crops in general and to maize in particular could be positive because they could allow the household to have enough maize to consume (Appendix 1).

The household size, which translates the number of mouths to feed can inhibit food security, thus imposing the negative sign on the coefficient in the model (Appendix 1).

The number of POs belonging and the number of agricultural workers can be positively affected FCS since they could allow the household to get more information on how to manage the production and to have the workforce to produce abundantly (Appendix 1).

The education levels (primary and secondary) and the age of the household head could allow the household to have more knowledge sufficient to reduce food insecurity than the illiterate (Koch & Schermuly, 2021). The sign of the coefficients of the primary and secondary levels should be positive while that of the illiterate can be negative (Appendix 1).

The likely or very likely level of access to credit may allow the household to have more potential for food security than the very unlikely level of access to credit. The expected sign of their coefficient in the model must be positive. However, extremely unlikely access to credit can negatively affect the FCS compared to the benchmark. Neither probable nor improbable access can have a neutral effect on the FCS. Its coefficient should not be significant in the model.

Households with an elderly head may be more exposed to food insecurity since the head no longer has enough physical strength to produce or feed household members. The expected sign of the age coefficient in the model must be negative (Appendix 1).

## 4. Results

### 4.1. Description of forms of Warrantage

#### 4.1.1. Inputs Warrantage

Inputs warrantage was implemented by the PINC (Projet Intrants Non Coton) of IFDC (International Fertilizer


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Development Center) in Benin. In inputs warrantage, producers express their food input requirements to their organizations, which pass them on to the communal umbrella organizations. The communal organization draw up the business plans based on the expressed needs of inputs. This organization provided the business plans to the credit's institution (Faîtière des Caisses d'Epargne et de Crédit Agricole Mutuel (FECECAM)) and to the inputs suppliers (Société Nationale pour la Promotion Agricole (SONAPRA)) for accessing to agricultural inputs. Based on the pro-forma invoice of expressed needs of inputs, the inputs were provided to the communal organization through the extension service (Secteurs Communaux de Développement Agricole (SCDA)) which forwarded the invoice to credit institution for payment with monthly interest rate of 1.25%. The inputs cost covered 80% of the value of the products stored at the market price at the time of collection. The inputs were distributed to the producers through the communal organization according to the warranted quantity of maize. Products are collected from December to February and stored in village warehouses. The warehouses were double-locked (one key with the credit institution and a second with the organization) to prevent unilateral opening or selling. The stores are monitored by the extension service in presence of credit institution and organization. The store was sold when the price increased. The credit was reimbursed to credit institution and the discounts were distributed to the producers according to the warranted quantity.

### 4.1.2. Income Generated Activities Warrantage

Income generated activities warrantage was carried out by the PA3D (Projet d'Appui à la Déconcentration, à la Décentralisation et au Développement Economique Local) for enabling the municipalities to improve the local economic development for fighting food insecurity. The PA3D has provided financial and technical support to each municipality for the construction of two storage warehouses with a capacity of 200 to 300 tonnes. People express their intentions to apply for credit, and their needs in terms of IGA (income-generating activity) credit. Food products (corn, soya, groundnuts) were stocked in the store. The management committee prepares credit applications to enable producers to access credit at a general advance rate of 80% of the market price at the time of credit application. The warehouse was doubly locked (one key with the management committee and the second one with credit institution. The credit institution granted credit to farmers at a monthly interest rate of 2%, and collected 1% of the requested credit as a processing fee. The stock was monitored and maintained during regular visits by the credit institution and the SCDA packaging agent. When the price increased on the markets, the stock was sold to recover the loans and interest to credit institutions and the discounts were distributed to the farmers warranting their maize after deducing the cost of store occupation (200 F per bag of 100 kg).

### 4.1.3. Marketing Warrantage

Marketing warrantage had been implemented by UCP (Union Communale des Producteurs) to improve its members' income and the level of food security of the population through credit facilitation. In this warrantage process, producers deposited their maize. The credit institution granted credit to producers at a monthly interest rate of 2%. UCP made available its storage warehouse and facilitate the credit supplying by the credit institution for farmers based on the maize stored. The buyer (trader, institution) purchased the stored products and reimbursed the credit to the credit institutions which returned the discounts to the farmers.

Definitively, warrantage processus depends on the goals aimed by the stakeholders. There was some differences between the warrantage forms.

## 4.2. Characteristics of the Households Surveyed

The average age of the household heads surveyed, the size of the household and the number of agricultural workers were higher in Kalalé than in the other communes (Table 2).

- Concerning the IGA warrantage in Kalalé, the surveyed farmers were 46 years old. The households' size was about 14 persons with 5 agricultural assets. They belonged to alone farmers organization. The total cultivated area was 8 hectares with 2.8 hectares for maize. Each household sold around 2255.5 kg on the market whereas they consumed 487 kg of their maize production. About 48% of surveyed households who participated to warrantage had not gone at school. The food security score was 69.5. About 39% of households who participated to warrantage had likely access to credit.
- About the inputs warrantage in Sinendé, the surveyed farmers were 45 years old and belonged to two farmers organizations. There were 13 persons in their households with 4 agricultural assets. The total cultivated area was 13 hectares with 8.1 hectares for maize. Each household sold around 12571.2


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kg on the market and consumed around 2152.7 kg of maize production. About 87% of surveyed households who participated to warrantage had not gone at school. The food security score was 94.5. About 34% of households who participated to warrantage had Very unlikely access.

- Targeting the marketing warrantage in Zogbodomey, the surveyed farmers were 44 years old. There are 10 persons in their households and 3 agricultural assets. Belonging to two farmers organizations, the households cultivated the total area was 4.6 hectares with 3.2 hectares for maize. Each household sold around 1656.6 kg on the market whereas they consumed 1247.6 kg of maize production. About 72% of surveyed households who participated to warrantage were illiterate. The food security score was 67.4. About 62% of households who participated to warrantage had very unlikely access.

In summary, the total cultivated area, the total area of food crops, the maize area, the quantities of marketed and consumed maize and the FCS are higher in Sinendé than in the other communes. The number of belonging POs is lower in Kalalé than in the other communes. The number of years of experience in the warrantage is higher in Zogbodomey than in the other communes.

The proportion of households participating in the various forms of warrantage is slightly lower (50% at most) than that of non-participants (Table 2). Heads of households who have not been at school are strongly represented in each form of warrantage (48% at least) while the literate are the least represented (13% at most). Poor households dominated in Kalalé (39%) while in Sinendé, rich households are the most represented (39%). Households with limited access to credit are more represented in Zogbodomey and Sinendé (Table 2).

### 4.3. Effects of forms of Warrantage on Household Food Security

FCS varied among the forms of warrantage. In the inputs warrantage, FCS was about 94.5 whereas it was 67.4 with marketing warrantage (Table 2). Then, FCS of households was higher with inputs warrantage than other forms of warrantage. The effect of participation to warrantage on FCS and their determinants varied among the studied cases (Appendix 2).

#### i. IGA Warrantage

The model is globally significant at the 5% threshold with an explanatory power of 15% (Appendix 2). The coefficients of the household size and age of the household head were negative and significant at the threshold of 5%. Household size and age of the household head negatively affected the FCS at the threshold of 5%. If the household size and the age of the household head are higher, the FCS is lower. Households with a large size and whose head of household are older are more exposed to food insecurity.

The coefficients of the number of agricultural assets, the quantities of sold and consumed maize were positive and significant at the threshold of 5%. The number of agricultural assets, the quantities of sold and consumed maize had a positive effect on the FCS at the threshold of 5%. When, the number of agricultural assets and the quantities of sold and consumed maize are higher in the households, more the FCS of households is higher. Then, households that consume and market more maize production and have more agricultural assets are more food security.

#### ii. Inputs Warrantage

The model is globally significant at the 5% threshold with an explanatory power of 18% (Appendix 2). The coefficients of size of the household, the number of Pos in which the household head belonged, of illiterate and primary education of household head were positive and significant at the threshold of 5%. The size of the household and the number of Pos in which the household head belongs increase with the FCS. Also, households where the head has never been to school or primary education had a better FCS than the households whose head is literate or at secondary level. Households with a large size and whose head has never been to school or at a primary level and belongs to more POs are more food secure.

#### iii. Marketing Warrantage

The model is globally significant at the 5% threshold with an explanatory power of 24% (Appendix 2). The participation in the warrantage, the number of POs in which the head of household belonged and the area sown for food crops had a negative coefficient which was significant at threshold of 5%. The participation in the warrantage had a negative impact on the FCS. Households participating in warrantage are more at risk of food insecurity than non-participants. The number of POs in which the head of household belongs and the area sown for food crops negatively influenced


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the FCS. The FCS decreases when the number of POs of the household head and the area sown for food crops increases. Households whose head of household belongs to several POs and who have participated in the warrantage and sown more area for food crops are more exposed to food insecurity. The coefficients of "unlikely access to credit" and "total area cultivated" were positive and significant at threshold of 5%. Households with unlikely access to credit improved the FCS more than that of other households' categories. The FCS increases with the total area cultivated. Households having cultivated more area and whose level of access to credit is improbable are more food secure.

**Table 2**: Descriptive Characteristics of Households Surveyed.

| Variables Continues | | IGA warrantage (N=98) | | Inputs warrantage (N=136) | | Marketing warrantage (N=74) | |
|---|---|---|---|---|---|---|---|
| | | Mean | St dev | Mean | St dev | Mean | St dev |
| Age (years) | | 46.2 | 11.5 | 44.8 | 10.0 | 43.8 | 12.0 |
| Household size | | 14.2 | 8.8 | 13.2 | 8.2 | 9.7 | 4.2 |
| Number of agricultural assets | | 5.0 | 4.7 | 4.2 | 3.0 | 3.3 | 2.6 |
| Number of POs belonging | | 1.2 | 0.7 | 2.1 | 0.9 | 2.3 | 2.0 |
| Maize area (ha) | | 2.8 | 2.3 | 8.1 | 8.6 | 3.2 | 2.2 |
| Total cultivated area (ha) | | 8.1 | 4.9 | 13.5 | 12.5 | 4.6 | 2.8 |
| Food crop area (ha) | | 5.6 | 3.2 | 10.7 | 10.2 | 4.5 | 2.7 |
| Quantity of maize marketed (kg) | | 2255.5 | 2829.5 | 12571.2 | 20885.0 | 1656.6 | 3208.5 |
| Quantity of maize consumed (kg) | | 486.9 | 1072.9 | 2152.7 | 4398.3 | 1247.6 | 1922.6 |
| FCS | | 69.5 | 17.1 | 94.5 | 17.6 | 67.4 | 12.4 |
| Number of years of experience (years) | | 1.2 | 1.2 | 1.3 | 1.3 | 2.2 | 2.6 |
| Frequency (%) | | | | | | | |
| Participation in warrantage | No | 51.0 | | 50.0 | | 56.8 | |
| | Yes | 49.0 | | 50.0 | | 43.2 | |
| Educational level | Illiterate | 48.0 | | 87.4 | | 71.6 | |
| | Primary level | 19.4 | | 6.6 | | 16.2 | |
| | Secondary level | 19.4 | | 5.1 | | 6.8 | |
| | Literate | 13.3 | | 0.7 | | 5.4 | |
| Accès au crédit | Very likely access | 13.3 | | 18.4 | | 1.4 | |
| | Likely access | 38.8 | | 23.5 | | 5.4 | |
| | Neither probable nor unlikely access | 4.1 | | 15.4 | | 14.9 | |
| | Very unlikely access | 30.6 | | 33.8 | | 62.2 | |
| | Extremely unlikely access | 13.3 | | 8.8 | | 16.2 | |

Source: Field survey.

## 5. Discussion

Household food security depends mainly on socioeconomic characteristics and agricultural factors.

### 5.1. Socioeconomic Characteristics of Households and Food Security

The age and size of the household negatively affected food security in the area of implementation of the IGA warrantage. Indeed, the old heads of household can no longer provide for the food needs of household members because the heads could not have a capacity to provide food to the members of their households. This result aligns on Getaneh et al. (2022) and Kahsay & Mulugeta (2014) who revealed that age expose households to food insecurity in Ethiopia. In the other hand, it is contrary the assertion from Koch & Schermuly (2021) who explained that nutrition knowledge increase when the age progress In Germany (Koch & Schermuly, 2021). Also, when there are more members of the household, the household has difficulty to satisfy their food needs. This finding confirms that of Getaneh et al. (2022) who showed that the family size and marital status negatively determine food security of households in Ethiopia. According to Jones et al. (2013) and Kabunga et al. (2014), the size of the household, the difficulties of access to credit and the low level of education expose households to food insecurity. Difficulties in accessing credit do not allow households to have the resources to produce and feed their members (Getaneh et al., 2022). Then, access to credit allow the households to improve their agricultural production by buying the agricultural inputs and paying agricultural labor before using the rest to get food for eating. According to Getaneh et al. (2022), access to credit helps to increase food security of households. For these authors, the credit could be invested in income generating activities which could increase the economic or financial capacity of the households (Getaneh et al., 2022). Miller et al. (2022) notified also when they studied in 185 countries from 1990 to 2018 that education level did not influence food


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security in sub–Saharan Africa. These results shows that how food security of households is complex to be explained in different context.

### 5.2. Agricultural Factors Facing Food Security

The marketing and consumption of maize production are factors favorable to food security in the area where the IGA warrantage is implemented. Indeed, maize production is more geared towards marketing in this area of high consumption of yams. The income from the production of maize allow the household to access to food supplements. This result confirms the assertion of Tscharntke et al. (2012) who revealed that food security does not depend on food production but rather on the uses of this production. The allocation of a large area to food crops is therefore not an assurance for food security.

In addition, the total area positively influenced food security in an environment of implementation of marketing warrantage. This result was obtained in Nigeria by Babatunde & Qaim (2010) according to which the area of cultivated land improves household food security.

### 5.3. Warrantage and Food Security

The forms of IGA collateral and inputs do not affect household food security. In contrast, warrantage marketing exposes households involved in food insecurity. This difference observed between the impact of forms of warrantage is justified by the fact that marketing warrantage is assimilated to a form of sale of maize production. In the areas of implementation of the input warrantage or IGA (Sinendé and Kalalé), the basis of the food is mainly yam which is not taken into account by the warrantage system. On the other hand, maize, speculation at the heart of warrantage, is the staple food of households that participate in marketing warrantage. Households sell their maize to their municipal apex (PO) during the period of abundance to wait for the rebates in the event of a rise in the price of maize. They find themselves in basic feeding difficulties during the lean season. These results are contrary to that of Kabunga et al. (2014). According to the latter, the adoption of banana tissue culture improves food security for adoptive households. This difference is justified by the fact that warrantage is an organizational innovation that allows households to pledge their agricultural products to benefit from credit. Tissue culture technology improves the yield of banana production, which is the staple food of people in central and eastern Kenya.

The forms of IGA warrantage and inputs therefore do not affect food security. To this end, innovations do not always have social consequences as Egah et al. (2014a) revealed. According to the latter, the implementation of an innovation is likely to have positive or negative consequences (Egah et al., 2014a). Allogni, Coulibaly, & Honlonkou (2008) and Zoundi et al. (2007) align themselves behind this assertion by revealing that the adoption of improved cowpea varieties allows households to increase their food consumption and generate income to buy food supplements. Unlike these improved cowpea varieties, warrantage marketing has had a negative impact on household food security. According to Coulter & Mahamadou (2009), the input warrantage generates a gain which varies from 19% to 113% on the capital invested in six months in Niger. Warrantage allows farmers to benefit from agricultural inputs and the seasonal rise in prices (Egah, 2021). However, the effects of input warrantage and IGA on food security remain less perceptible. The effects of an organizational innovation like warrantage on food security need to be qualified. These effects may be linked to the characteristics of the innovation (Douillet & De Maillard, 2008). The socio-economic and agricultural context of households affects their food security both positively and negatively (Egah et al., 2014a).

## 6. Conclusion

The studied warrantage forms presented the difference in terms of goals, the stakeholders involved and monthly interest rate. It is noticed that most of the participants to warrantage forms had not been at school while the literate are the least represented (13% at most). Households with limited access to credit are more represented in Zogbodomey and Sinendé. The implementation of forms of IGA warrantage and inputs does not affect the food security of households taken in their socio-economic context. However, participation in marketing warrantage significantly reduces food security. Food security depends on the socioeconomic and demographic characteristics of households and on certain agricultural factors.

Ultimately, the IGA warrantage and the input warrantage are more suited to facilitate households' access to credit without affecting their food security. Warrantage marketing can be profitable provided that it is directed towards crops which do not constitute the staple food


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of the populations. Socioeconomic characteristics and agricultural factors must be taken into account to adapt forms of warrantage to the living conditions of households. Extension services and decision makers should adapt the warrantage form to socioeconomic realities of the agricultural farmers.

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# Appendix

**Appendix 1**: Description of the Variables and the Expected Sign in the Model.

| Variables | | Name in Model | Type[a] | Description of the Modalities of the Nominal Variables | Expected Sign |
|---|---|---|---|---|---|
| Food consumption score | | FCS | C | | |
| **Warrantage Variables** | | | | | |
| Participation to warrantage | | PARTIWA | N | Have participated in warrantage this year | - |
| Number of years in the warrantage | | NBRANEW | C | | - |
| **Socioeconomic Variables** | | | | | |
| Age | | AGE | C | | - |
| Number of POs belonging | | NBROP | C | | + |
| Number of agricultural assets | | NBRACTIF | C | | + |
| Household size | | TAIMEN | | | - |
| Educational level | Illiterate | ILLETRE | N | Never having been to school | - |
| | Primary level | PRIMAI | N | To have done only primary studies | + |
| | Secondary level | SECOND | N | Having completed high school | + |
| | Literate | ALPHAB | N | Having done literacy without going to formal school | [b] |
| Level of access to credit | Very likely access | ATPROB | N | About a 100% chance of borrowing money from any source | + |
| | Likely access | APROB | N | About a 75% chance of borrowing money from any source | + |
| | Neither probable nor unlikely access | ANPROB | N | About a 50% chance of borrowing money from any source | ? |
| | Very unlikely access | ATPPROB | N | About a 25% chance of borrowing money from any source | [b] |
| | Extremely unlikely access | AEIMPRO | N | Have no chance (around 0%) of borrowing money from any source | - |
| **Exogenous Variables Linked to Production** | | | | | |
| Area of cultivated maize (in ha) | | SUPMAIS | C | | + |
| Quantity of marketed maize (kg) | | MAISCOM | C | | - |
| Quantity of consumed maize (kg) | | MAISCONS | C | | + |
| Food crop area (ha) | | SUPVIVR | C | | + |
| Total cultivated area (ha) | | SUPTOT | C | | + |

[a] Legend: [a] C= continuous; N=nominal, [b] Modality of reference, Source: Authors


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**Appendix 2:** Determinants of Food Security According to forms of Warrantage.

| Exogenous variables | Income Generated Actvities Warrantage | | | | Input Warrantage | | | | Marketing Warrantage | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Estimate | Std. Error | t value | Pr(>\|t\|) | Estimate | Std. Error | t value | Pr(>\|t\|) | Estimate | Std. Error | t value | Pr(>\|t\|) |
| (Intercept) | 77,537*** | 8,302 | 9,340 | 0,000 | 50,437*** | 18,953 | 2,661 | 0,009 | 67,891*** | 3,310 | 20,509 | 0,000 |
| Household size | -0,613** | 0,271 | -2,260 | 0,026 | 0,924*** | 0,271 | 3,408 | 0,001 | | | | |
| Number of agricultural assets | 1,229** | 0,478 | 2,570 | 0,012 | -0,949 | 0,678 | -1,401 | 0,164 | | | | |
| Age (years) | -0,284* | 0,163 | -1,744 | 0,085 | | | | | | | | |
| Illiterate | | | | | 29,841* | 17,435 | 1,712 | 0,090 | | | | |
| Primary level | | | | | 32,860* | 18,380 | 1,788 | 0,076 | | | | |
| Secondary level | | | | | 12,425 | 18,789 | 0,661 | 0,510 | | | | |
| Number of POs belonging | | | | | 3,400* | 1,870 | 1,818 | 0,072 | -1,602** | 0,704 | -2,276 | 0,026 |
| Likely access [b] | | | | | | | | | 8,355 | 6,269 | 1,333 | 0,187 |
| Neither probable nor unlikely access [b] | | | | | | | | | 11,898*** | 4,000 | 2,974 | 0,004 |
| Very likely access [b] | | | | | | | | | -1,809 | 11,792 | -0,153 | 0,879 |
| Extremely unlikely access [b] | | | | | | | | | 0,682 | 3,853 | 0,177 | 0,860 |
| Participation in warrantage | -0,682 | 5,229 | -0,130 | 0,897 | -2,667 | 5,712 | -0,467 | 0,641 | -6,690 | 5,712 | -1,171 | 0,246 |
| Number of years of experience in warrantage | 2,578 | 2,288 | 1,127 | 0,263 | 2,587 | 2,301 | 1,124 | 0,263 | 0,290 | 1,116 | 0,260 | 0,796 |
| Quantity of sold maize (kg) | 0,001* | 0,001 | 1,918 | 0,058 | | | | | | | | |
| Quantity of consumed maize (kg) | 0,004** | 0,002 | 2,326 | 0,022 | | | | | | | | |
| Maize area (ha) | | | | | 0,777 | 0,604 | 1,286 | 0,201 | | | | |
| Total cultivated area (ha) | | | | | -0,648 | 0,430 | -1,506 | 0,135 | 9,677* | 5,326 | 1,817 | 0,074 |
| Food crop area (ha) | | | | | | | | | -9,091 | 5,457 | -1,666 | 0,101 |
| $R^2$ | 0,151 | | | | 0,179 | | | | 0,238 | | | |
| $R^2$ ajusted | 0,085 | | | | 0,111 | | | | 0,130 | | | |
| ddl | 7; 90 | | | | 10; 120 | | | | 9; 64 | | | |
| F-statistic: | 2,286 | | | | 2,623 | | | | 2,217 | | | |
| p-value: | 0,0344 | | | | 0,0064 | | | | 0,0321 | | | |

Legend: *= significant at the threshold of 10%; **= significant at the threshold of 5%; ***= significant at the threshold of 1%
[a] Modality of reference: Literate
[b] Modality de reference: Very unlikely access
Source: Authors


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