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# Socio-Economic and Institutional Determinants of the Adoption of Improved Pearl Millet Varieties in the *Centre-nord* and *Boucle du Mouhoun* Regions of Burkina Faso

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***Authors' contributions***

*This work was carried out in collaboration among all authors. Author SB designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors SB and MMDB managed the analyses of the study. Author SN managed the literature searches. All authors read and approved the final manuscript.*

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## ABSTRACT

The purpose of this article is to determine the socio-economic and institutional factors for the adoption of improved pearl millet varieties in the Boucle du Mouhoun and Centre-Nord regions of Burkina Faso. Data were collected from 300 producers. The Logit model was used for econometric regression. The results show that four (4) variables have a positive and significant influence on the adoption of improved millet varieties: the training received on improved varieties, the availability of improved varieties, the organoleptic characteristics of improved varieties and the North Central locality. In terms of recommendations, actions must be taken to intensify training for producers and especially the most vulnerable, make improved varieties available at all times and in all places. Breeders should integrate the organoleptic aspect into the design of the variety.

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## 1. INTRODUCTION

Burkina Faso is a predominantly agricultural country. The primary sector, including agriculture and livestock, employs about 85% of the workforce. It contributes 33% of gross domestic product and 80% of export earnings [1]. Agriculture is essentially a subsistence agriculture based on food cereals (sorghum, pearl millet, maize, rice). Cereals occupy more than 80% of cultivated land and play a crucial role in food security. Pearl millet occupies a very important place in Burkina Faso's current production system. The importance of pearl millet cultivation lies not only in its adaptation to the country's different agro-ecological zones but also in the wide range of uses that this staple cereal has for food security, diversification and improving the incomes of the various stakeholders. One of the causes of low pearl millet yields is the inadequacy of traditional varieties to the current agro-climatic context. In response to this phenomenon, improved millet varieties have been developed by the Institute for Environment and Agricultural Research (INERA). In Burkina Faso, at least a dozen improved millet varieties have been developed at INERA, including CIVT, IKMP 5, IKMV 8201, MISARI-1, HKP, IBMV 8402, ICMV IS 89305, SOSAT C-88, ZATIB, MISARI-2, [1] adoption of improved varieties is expected to increase millet yields. However, at the national level, the adoption rate of improved varieties for all speculation combined remained low at around 11.2% [2,3] What explains this low adoption rate for improved varieties, particularly concerning pearl millet? What are the factors that influence the adoption of improved pearl millet varieties in the Boucle du Mouhounand Centre-Nord regions of Burkina Faso? The purpose of this article is to identify and analyze the factors that influence the adoption of improved pearl millet varieties in two agricultural regions of Burkina Faso (Boucle du Mouhoun, Centre Nord). A better knowledge of the determinants of the adoption of improved varieties will allow better decision-making for the rural world.

## 2. LITERATURE REVIEW

### 2.1 Conceptual Framework

The conceptual framework is based on the theory of technology adoption and diffusion developed by Rogers in 1962. According to Rogers [4]. diffusion is a process by which an innovation is communicated at any time to the members of a social system through certain channels. The innovation diffusion model stipulates that a technology has circulated from its source to end-users through agents. In addition, the diffusion of this innovation by potential users is a function of the majority of the user's personal attributes. In 1995, Rogers identified five elements that would determine the adoption or diffusion of a new technology. These are relative advantage, compatibility, complexity, testability and observability. It should be noted, however, that each of these characteristics, taken individually, is not sufficient to predict the adoption of an innovation. Indeed [4], showed that a combination of these will increase the chances of adopting the innovation. In the econometric literature, three models are frequently used to analyze the adoption of new technologies. These are models with linear probability, the logistic function (Logit) and finally the functions with normal density (probit). These models use binary choice variables as dependent variables. Of these three models, we opt for the logit model. This choice is justified by the fact that this model facilitates the manipulation of results [5]. Indeed, two properties make the interest of the logistic distribution function in the modelling of discrete choices. These include its interval which is reduced to [0,1] and the possibility of being linearized by a logarithmic transformation. In this model, a variable y* is defined as follows:

$y_i^* = \alpha + X_i\beta + \varepsilon_i$, were $y_i^*$ represents the benefit to the producer of his commitment to the use of improved millet varieties; Xi is a variable that can influence practice; β the coefficients associated with the different variables of the model and the error associated with the variable. As the variable is not observable, it is necessary to generate an observable variable expressing the use of improved millet varieties by producers: Y = 1 if y* > 0 and Y = 0 if y* ≤ 0. According to Hurlin [5], the regression of the logit model characterizing adoption by a sample of producers is specified as follows:

$p_i = E(y_i) = F(\alpha + X_i\beta) = \frac{1}{1+e^{-(\alpha+X_i\beta)}}$, where the index "i" indicates the ith observation in the sample, pi is the probability that an individual will make a given choice, yi is the basis of the neperian logarithm, Xi is a vector of exogenous variables, α is a constant and βi are coefficients associated with each explanatory variable Xi to

be estimated. A positive coefficient means that the probability increases with the increase of the corresponding independent variable. The coefficients α and β in the logistic regression are estimated using the maximum likelihood method. Nevertheless, marginal effects are used to measure the sensitivity of this probability to the explanatory variables.A positive coefficient means that the probability increases with the increase of the corresponding independent variable. the coefficients of the explanatory variables are not directly interpretable, the only usable information is the sign of the parameters insofar as it indicates whether the associated variables influence the probability of the event upward or downward. However, to measure the sensitivity of this probability with respect to the explanatory variables, we use marginal effects. The signs of the coefficients indicate the effect of each explanatory variable on the explained variable.The logit model is appropriate.

## 2.2 Description of Variables of the Model

The adoption of an innovation is guided by a number of factors. The decision to adopt improved millet varieties depends on several factors:

- **Age of the farm manager (Age):** This is the number of years of the farm manager. Studies have shown that age has a positive and negative effect on technology adoption. We will consider the first case, i.e. that age had a positive effect on the adoption of improved varieties [6,7]. In other words, old producers seem to be more inclined to adopt technologies than young ones. Age is expected to have a positive effect on improved millet varieties
- **Membership to a farmers' organization:** this is a binary variable that takes the value 1 if the producer belongs to a farmers' organization and 0 if not. Several authors have shown that membership of farmers' organizations promotes the adoption of innovations [7-9]. A positive sign of this variable is expected for the adoption of improved pearl millet varieties.
- **Training attended on improved varieties**: this is a binary variable that takes the value 1 if the producer has received training on improved varieties and 0 if not. Many studies have shown that training has a positive effect on the adoption of innovations.The sign is expected to be positive.
- **Availability of improved varieties:** this is a binary variable that takes the value 1 if the improved variety is available and 0 if not. Many studies have shown that seed availability is an important factor in the adoption of improved varieties [10].
- **Good taste of improved varieties:** This is a binary variable that takes the value 1 if the improved variety tastes better than the local varieties and 0 if not. Many studies have shown that organoleptic characteristics have a positive influence on the adoption of improved varieties [11,12,7]
- **Locality:** Binary variable takes the value 1 if the locality is more exposed to the effects of climate change (Centre-North) and 0 if not (Boucle du Mouhoun). Many studies have shown that the rate of technology adoption is highest in the regions most affected by the effects of climate change. Growers in the Center-North are expected to adopt the improved varieties more than those in Boucle du Mouhoun. Rainfall is more capricious in the Center-North than in Boucle du Mouhoun.
- **Market value of improved varieties:** a binary variable that takes the value 1 if the improved variety has a higher market value than the local one and 0 if not [7].

# 3. METHODOLOGY

The methodological framework includes the study area, sampling, data collection and analysis.

## 3.1 Study Area

This study was conducted in the Centre-Nord and Boucle du Mouhoun regions of Burkina Faso. The Boucle du Mouhoun region is the largest agricultural region in Burkina Faso, covering 34,497 Km². It comprises six provinces, six urban counties and 41 rural counties with a total population estimated at 1,460,048 in the 2006 general population census, including 721,604 men (49.4%) and 733,444 women (50.6%). Its population is mainly rural, with 1,320,826 inhabitants living in rural areas, or 91.5%, compared to 60,933 in urban areas. Population projections for 2017 give the Region an estimate of 1,923,192 inhabitants. The Boucle du Mouhoun region is located in the Sudano-Sahelian zone. It receives an annual rainfall between 500 and 1000 mm. This region is considered as the breadbasket of Burkina

Faso due to its high level of agricultural production.

### 3.2 Data Collection and Analysis

Data were collected by individual questionnaire from 300 pearl millet producers in the two regions, with 150 producers per region. The reasoned method has been used, that is, selected respondents has to be necessarily pearl millet producer. Gender was also taken into account in the selection of producers. In each region a county was chosen and within which, three villages were selected. Thus, in the Centre-North region, the villages of Fatin, Tansobtenga and Yalgoweogo were selected in the county of Boussouma. For the Boucle du Mouhoun region, the villages of Dakuy, Digani and Konkuykoro were chosen in the county of Doumbala. This makes a total of 6 villages surveyed in the two regions, i.e. three villages per region. These villages were chosen because they are major growers of pearl millet. The data was then entered in SPSS and then analyzed with Stata and SPSS softwares. In this study an analysis with descriptive statistics and econometric modelling was used. The primary data was used to achieve descriptive statistics. Then econometric modelling, the logit model, was used to measure the influence of independent variables on the adoption of improved millet varieties.

## 4. RESULTS AND DISCUSSION

This part includes the socio-economic characteristics of the producers surveyed as well as the results of econometric estimates.

### 4.1 Socio-Economic Characterization of the Producers Surveyed

It is well known that the adoption of improved varieties depends on socio-economic, demographic and institutional factors of households. The study of behaviours cannot be done without taking into account the context in which individuals live. The age of adopters (46.5) is higher than that of non-adopters (44.84) according the results of the Table 2. The results of the descriptive statistics show that the agro-ecological zone influences the adoption of improved varieties at the 10% threshold according to Table 2. Variables such as membership of a farmers' organization, availability of improved varieties, training and good taste of the variety significantly influence the adoption of improved pearl millet varieties at the 1% threshold, as shown in Table 2.

### 4.2 Results of the Econometric Estimation

Significant variables are the training received on improved varieties, the availability of improved varieties, the good taste of improved varieties and the North Central area where the effects of climate change are more significant. All these variables positively influence the adoption of improved millet varieties. Variable <training on varieties> and the <taste of varieties> are significant at the 1% threshold while variables availability of improved varieties and locality are significant at the 5% threshold. The model is globally significant at the 1% threshold (Prob > chi2=0.0005).

#### 4.2.1 Producer's agro-ecological zone

It is a binary variable that takes the value 1 if the producer is from the Centre-Nord region of Burkina Faso where the annual rainfall is relatively low, between 400 and 700 mm (Sub-sahelian) and 0 if the producer is from the locality of the Boucle du Mouhoun, where the annual rainfall is relatively high, between 500 and 1000 mm (North-Sudanian). This variable positively influences the adoption of improved millet varieties at the 5% level. This means that being in an area with low rainfall, positively influences the adoption of improved varieties. The marginal effects show that being in an area with capricious rainfall increases the probability of adopting improved pearl millet varieties by 0.2508 units, all other things being equal. These results are similar to those found by authors [13-16].

#### 4.2.2 Training received on improved varieties

Training is an important aspect in the adoption of an innovation. Training enables producers to acquire knowledge and makes them open to innovation. This variable positively influences the adoption of improved millet varieties. It is significant at the 1% threshold. The marginal effects show that having received a training on improved varieties increases the probability of adopting improved pearl millet varieties by 0.4091 units, all other things being equal. These results confirm those found by Abdoulaye et al. [17-20].

**Table 1. List of model variables and expected signs of parameters**

| Variables | Description | Expected sign |
|---|---|---|
| | **Dependent variable** | |
| Adoptionvarammil | Binary variable, takes the value 1 if the producer uses improved pearl millet varieties and 0 if he does not | |
| | **Independent variables** | |
| Age | Age of farmer, continuous variable | Positive or negative |
| Apop | Binary variable, takes the value 1 if the producer belongs to a farmers' organization and 0 if he does not | Positive |
| Formationvaramelioree | Binary variable takes the value 1 if the producer has received training on improved varieties and 0 if he does not | Positive |
| Varameldisponible | Availability of improved pearl millet varieties. Takes the value 1 if the improved pearl millet variety is available and 0 if it is not | Positive |
| Varamelgoutconv | Good taste of improved millet varieties. Binary variable takes the value 1 if the improved variety tastes good and 0 if it does not | Positive |
| Zone agro-écologique | Agro-ecological zone of the producer. Binary variable takes the value 1 if the producer is from the Centre-North region and 0 if he is from the Boucle du Mouhoun | Positive |
| Varamelvalmarchande | Market value of the improved pearl millet variety compared to the local variety on the market. It is a binary variable that takes value 1 if the market value of the improved variety is higher than the local one and 0 otherwise | Positive |

**Table 2. Socio-economic characteristics of producers**

| Variables | Average of non-adopters of improved varieties of pearl millet | Average number of adopters of improved pearl millet varieties | Total | Differences | T | Probabilities |
|---|---|---|---|---|---|---|
| Agro-ecological zone | 0,4578 | 0,5727 | 0,5149 | -0,114 | -1,9223 | 0,0555* |
| Age | 44,84 | 46,5 | 46,723 | -1,657 | -0,9848 | 0,3255 |
| Membership of a farmers' organization | 0,136 | 0,618 | 0,567 | -0,481 | -9,9684 | 0,0000*** |
| Availability of improved varieties | 0,611 | 0,833 | 0,7985 | -0,222 | -2,8044 | 0,0058*** |
| Training on improved variety | 0,042 | 0,7 | 0,6194 | -0,65 | -17,0908 | 0,0000*** |
| Market value | 0,5625 | 0,6176 | 0,6044 | -0,0551 | -0,5531 | 0,5811 |
| Taste of the improved variety | 0,833 | 0,97 | 0,9328 | -0,137 | -2,9354 | 0,0039*** |

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

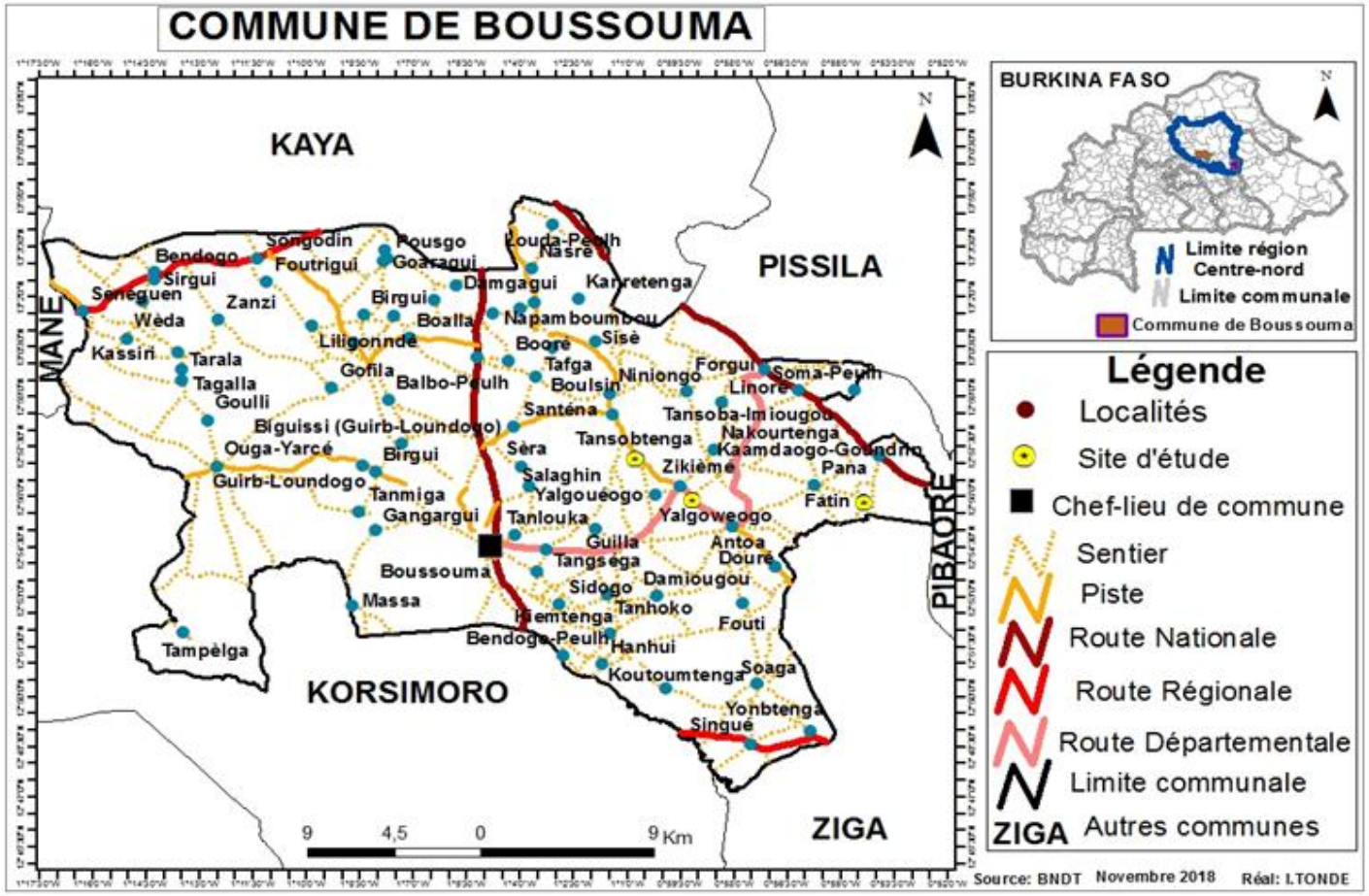


**Fig. 1. North central regionstudy sites**

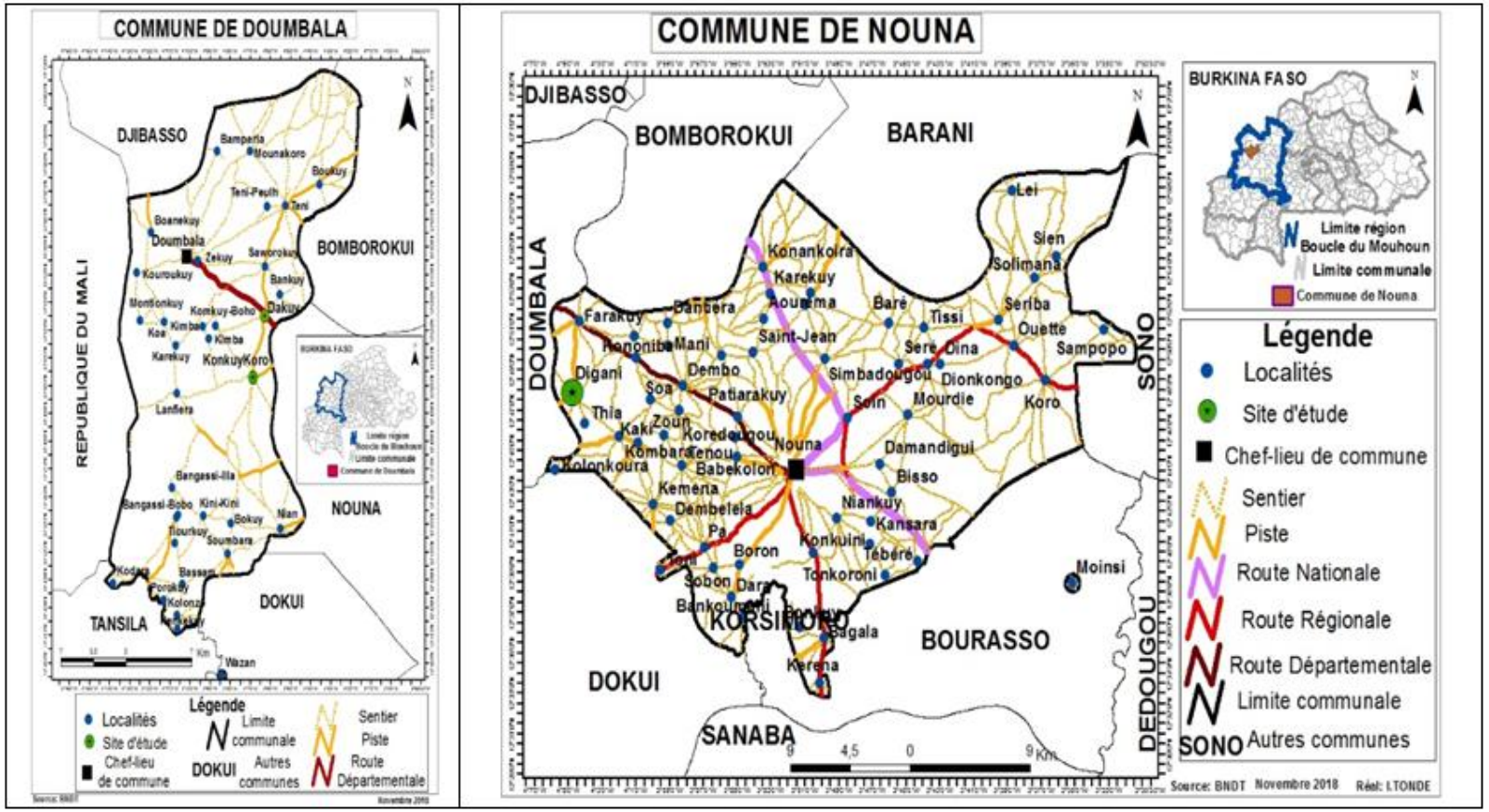


**Fig. 2. Study sites of the boucle du mouhoun region**

**Table 3. Result of logistic regression and marginal effects**

| Variables | Coefficients | Standart Error. | P-value | Marginal Effect |
|---|---|---|---|---|
| Constante | -2,881 | 1,225 | 0,019 | |
| Age | -0,038 | 0,027 | 0,149 | -0,00479 |
| Apop | 0,330 | 0,734 | 0,653 | 0,04179 |
| Formationvaramelioree | 2,647 | 0,862 | 0,002*** | 0,4091 |
| Varameldisponible | 1,204 | 0,594 | 0,043** | 0,1905 |
| Varamelgoutconv | 2,569 | 0,793 | 0,001*** | 0,5265 |
| Zone agroécologique | 1,916 | 0,846 | 0,024** | 0,2508 |
| Varamelvalmarchande | 0,456 | 0,516 | 0,377 | 0,0588 |

*Logistic regression Number of obs=300*
*Wald chi2(7)=25,94*
*Prob > chi2=0,0005*
*Pseudo R2=0,3223*
*Log pseudolikelihood=-49,920862*
**Significant at 10% threshold, ** Significant at 5%, *** Significant at 1%*

#### 4.2.3 Availability of improved varieties

The availability of improved varieties positively influences the adoption of improved pearl millet varieties at the 5% threshold. The problem of variety availability is often mentioned by producers who want to acquire varieties which are not always available. Marginal effects show that the availability of improved pearl millet varieties leads to an increase of the probability of adopting them by 0.1905 units, all other things being equal. These results are in line with those found by other authors [20-22] Seed availability is crucial for the adoption of improved varieties for several reasons. Traditionally, and even now, food crop seeds usually come from farmers' production. Each farmer thus ensures his own seed supply or, if necessary, benefit from seed exchange and donations, or purchases in his immediate environment. Therefore, the challenge is to make improved seeds available and accessible to the vast majority of farmers through packaging and prices that farmers can afford.

#### 4.2.4 Good taste for improved varieties

This variable positively influences the adoption of improved pearl millet varieties at the 1% threshold. A variety that does not taste good has no chance of being adopted because organoleptic characteristics are important factors in the adoption of improved varieties. The marginal effects show that the fact that an improved variety tastes better than local onces, increases the probability of adopting the improved pearl millet variety by 0.5265 unit, all other things being equal. Similar results had already been found by Napasintuwong and Pray [23,24] confirming the influence of organoleptic quality on the adoption of improved varieties. The good taste of the improved variety is a response to consumer expectations. The final opinion of consumers is essential, because we need a type of grain that meets the tastes of the family and the criteria of the market.

Variables age, membership in a farmers' organization and the market value of improved varieties do not have a statistically significant influence on the adoption of improved millet varieties in the Centre-North and the Boucle du Mouhoun regions.

## 5. CONCLUSION

The objective of this paper was to identify and analyze the socio-economic and institutional factors that influence the adoption of improved varieties from two regions with contrasting agro-climatic characteristics in Burkina Faso. Descriptive statistics and logistical econometric modelling were used to identify and analyze the factors that influence the adoption of improved pearl millet varieties. The results showed that four (4) variables influence the adoption of improved millet varieties in these parts of Burkina Faso. These are the agro-ecological zone variables, the training received on improved varieties, the availability of improved varieties and finally the goodtaste of the improved variety. All these variables positively influence the adoption of improved millet varieties.

The implications of these results are to create varieties considering the taste of producers, to make varieties available and to place emphasis on training producers in the use of improved pearl millet varieties. One of the ways to achieve food security is through high adoption rate of improved varieties.

## CONSENT

As per international standard or university standard, participant's written consent has been collected and preserved by the authors.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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