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Study of Determinant Factors of Perceptions Influencing the Choice to Adopt or Not GAP by Vegetable Growers in Peri Urban Zone of Bobo Dioulasso, Burkina Faso

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

In Burkina Faso, vegetable production struggles to meet the needs of a rapidly growing population. This situation is largely explained by the low productivity of agricultural farms, which is due, among other things, to low rates of diffusion and adoption of innovations proposed by agricultural

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research. To identify the determinant factors of perceptions that influence the choice to adopt or not Good Agricultural Practices (GAP) by vegetable growers, a socio-economic and socio-demographic survey was conducted among 85 trained vegetable growers operating in the COMABO and Kotédougou sites in the municipality of Bobo Dioulasso. The study reveals that the use of GAP improves monetary income by 32.61% for cabbage and 71.17% for tomatoes. However, only 43% of vegetable growers perceive income improvement as the main result of adopting GAP. The econometric analysis of the survey data using a logistic model identified the factors that determine the probability of adopting the GAP technical package at 74.1%. Thus, in vegetable farming, gender, age group, ethnicity, and household head responsibility are determinants that have contributed to a significant increase or decrease in the probability of adopting GAP proposed by agronomic researchers. Indeed, the more a vegetable grower is male (significant at 5%) and older (young or adult) (significant at 10%), the more he tends to perceive income improvement as a favourable factor for adopting GAP. The diffusion and adoption of GAP could increase yields in vegetable production.

Keywords: Vegetable grower; good agricultural practices; diffusion and adoption; crop yields; Burkina Faso.

1. INTRODUCTION

The fruit and vegetable sector has been identified in many studies since the 1990s as a source of significant agricultural growth and poverty reduction. With an area of cultivation of about 30,000 hectares and current technology, this sector employs almost 400,000 individuals, including 100,000 women, out of a total active population of about six million. Out of the six million working people, 5.3 million are employed in agriculture. Fruit and vegetable production make up 16.5% of agricultural production and 10.5% of primary sector production. It generated nearly six billion FCFA in added value, contributing an average of 4.5% to the country's gross domestic product in 2002 [1].

Vegetables have high nutritional and commercial value, contributing significantly to improving people's diets and food balance [2]. During times of economic crisis, vegetable farming can provide a source of income and livelihood, particularly for urban populations [3,4]. Although vegetable farming is crucial to the country's economy, productivity remains low due to the low performance of the production system and intensification of vegetable crops [5]. One contributing factor to this low productivity is the farmers' reluctance to adopt high-yielding production technologies and techniques developed by agronomic researchers [6].

In Bobo-Dioulasso, like in many other towns in Burkina Faso, vegetable growing is common. However, growers often lack knowledge of all the technical procedures involved in the cultivation of these crops, particularly concerning soil fertilization and the use of pesticides. They use cultivation techniques that do not guarantee the sanitary quality of the harvested produce, pollute the environment and degrade the soil [7,8,9,10]. Consequently, meeting the growing demand for vegetables in cities through vegetable production in urban and peri-urban areas requires intensive agriculture that combines productivity and respect for the environment. According to Gnoumou et al. [11], proven techniques, practices, and strategies could help ensure sustainable agricultural production. These are innovations that combine classical agronomic tools as well as innovative production techniques such as precision agriculture [12]. Moreover, utilizing adapted innovative practices that conserve natural resources is the only alternative for the sustainability of production systems [13].

A variety of practices and techniques for sustainable natural resource management have been developed by researchers and successfully tested in the field [14,15]. Techniques for sustainable management of agricultural land have been grouped into technological packages known as Good Agricultural Practices (GAP) [14]. These methods have yielded persuasive outcomes on a small scale, yet they have often remained little known and little used by the majority of potential users [1,16].

The diffusion of good agricultural practices among vegetable growers is a potential strategy to make this activity more profitable and improve their income while respecting the environment. This is the context in which the present study was initiated, to contribute to the adoption of good agricultural practices in vegetable farming, to achieve food and nutrition self-sufficiency.

2. MATERIALS AND METHODS

2.1 Study Area

The town of Bobo-Dioulasso had a population of 489,967, of which 244,136 were male and 245,831 were female [17]. Indigenous ethnic groups in the area consist of the Bobo, Dioula, Sénoufo, and Bwaba. There is also a significant allochthonous population comprising the Fulani, Dogon, Samo, and Mossé.

According to the population census of the cities of Ouagadougou and Bobo-Dioulasso (Burkina Faso) carried out in 2020 by the *Institut National des Statistiques et de la Démographie* (INSD), the population of Kotédougou was about 7,121, with 44.39% men and 55.61% women. Within the Arrondissement N°5, the population of Sector 25 was 25,084, made up of 49.06% men and 50.94% women [18].

In the Kotédougou area and Arrondissement No. 5, women predominantly engage in vegetable growing. Tomatoes, cabbage, onions, peppers, okra, eggplants and carrots are the main vegetables grown. The *Direction Provincial de l'Agriculture du Houet* (DPAH) reported a decline in tomato and cabbage yields in recent years.

2.2 Sampling of Producers

The works of this study took place from April 2017 to June 2018, in the urban and peri-urban area of Bobo-Dioulasso. They consisted of the dissemination of GAP to vegetable growers to improve their vegetable yields and incomes. The vegetable growing sites of the *Coopérative Maraichère de Bobo-Dioulasso* (COMABO) in the urban area and Kotédougou in the peri-urban area were selected due to their location and the fact that they host the majority of vegetable growers who belong to associations and receive support from the *Fonds d'Appui à la Formation Professionnelle et à l'Apprentissage* (FAFPA) in the Bobo-Dioulasso commune. Our study sample comprises all the vegetable growers from the two selected sites. Consequently, 33 growers at the COMABO site and 71 at the Kotédougou site received GAP training.

2.3 Approach for Assessing the Perceptions of Vegetable Growers

A survey form consisting of an individual questionnaire was designed to be sent to each vegetable grower to collect their perceptions, their preference or choice in terms of agricultural practices, the effects observed, their opinion after trying out good agricultural practices in vegetable growing, and their beliefs and prohibitions regarding these innovative practices. The questionnaire concerned the state of vegetable growers' perceptions and preferences, as well as the feasibility and acceptability of good agricultural practices in vegetable farming.

2.3.1 Theoretical framework for the analysis of the determinants of GAP adoption

Logistic regression (Logit model) is employed to identify the factors that influence vegetable growers' selection of agricultural practices (GAP and Local Farming Practices). Following Adekambi [19], we hypothesise that vegetable farmers make adoption decisions to maximize usefulness to enhance income. This is the learner theory of the economic agent. Consequently, it is considered that for vegetable crops, the producer prefers GAP over LFP due to the higher usefulness it provides.

2.3.2 Socio-economic determinants of vegetable growers' perceptions

The adoption of an innovation refers to the decision to implement new technical proposals in a production system and increasingly improve their use [20]. This decision is contingent on the socio-economic characteristics of potential adopters, the information they receive, and how they utilize that information, as well as their interactions with innovation transfer-supporting institutions, such as agricultural popularization programs [21]. It also depends on the compatibility of the characteristics of the innovations with the institutional environment (standards, rules, values), the technological environment (existing technical systems, know-how, risks) and the economic environment (accessibility of the necessary factors of production) of the potential adopters and their perception of the characteristics of the innovations proposed to them and the consequences of the innovations for the improvement of their living standards [20].

To determine the probabilities of adopting GAP, the explanatory variables were entered into the logit as shown in Table 3 below.

2.3.3 Determining characteristics of vegetable growers that influence GAP adoption

The adoption of an innovation can be conventionally modelled as a choice between two alternatives: to adopt or not to adopt. For this study, adoption refers to the decision to either accept or reject the "GAP" technology package taught based on income improvement. A Logit model is proposed based on previous works by researchers including [20,13,22]. The model calculates the likelihood of a vegetable grower considering income improvement as the primary motivating factor for adopting GAP and calculates its determinants (socio-economic and demographic variables considered as explanatory). This is how the variables in the GAP diffusion and adoption model are defined, as shown in Table 1, assuming that vegetable growers' perceptions of the different attributes of GAP depend on these variables.

2.4 Data Collection and Statistical Analysis

To analyze the determinants of perceptions that influence the diffusion and adoption of GAP, the data were processed using IBM SPSS.23 software. IBM SPSS.23 was used for descriptive statistics based on the calculation of statistical parameters such as numbers, averages, frequencies, standard deviations and the construction of tables. It also allowed us to determine, through the logistic model (Logit), the signs (positive or negative) of the characteristics that affect the decision of the vegetable farmer to adopt GAP because of its capacity to improve income. The Hosmer-Lemeshow test helped to know the explanatory variables for the adoption of GAP at 5% and 1% levels of significance.

Data collection on the socioeconomic determinants of perceptions influencing the diffusion and adoption of Good Agricultural Practices (GAP) by vegetable growers was conducted via a survey administered from September 2017 to April 2018. The people interviewed were vegetable growers from the COMABO and Kotédougou sites in association, who received support from the partner FAFPA. Eighty-five vegetable growers were interviewed, comprising 21 from the COMABO vegetable growing site (19 women and 2 men) and 64 from the Kotédougou vegetable growing site (29 women and 35 men). The vegetable growers interviewed were the ones present during the survey.

Data were collected through a questionnaire that gathered information about the socio-economic and demographic characteristics of vegetable growers, their use of GAP, their perceptions of the factors that promote or limit the use of GAP, an assessment of their level of knowledge about GAP, their opinions after experimenting with GAP in vegetable production, identification of the factors that determine their perceptions, and analysis of the impact of these perceptions on the level of GAP adoption.

Table 1. Defining variables in the GAP diffusion and adoption model

Variables	Description	Expected effects
Variable dependent on GAP diffusion and adoption		
GAP adoption	1 if income improvement motivates GAP adoption, 0 if no	
Explanatory variables		
Gender	1 for man, 0 for woman	±
Age group	1 for young people aged 15 to 38, 2 for adults aged 39 to 50, 0 for old people aged 51 and over	+
Marital status	0 if single, 1 if monogamous, 2 if polygamous	+
Educational level	0 if uneducated, 1 if literate, 2 if primary, 3 if secondary	+
Household size	Number of people in the household	±
Experience	1 if more than 5 years experience in market gardening, 0 if no	+
Ethnic group	1 if bobo/dioula, 0 if other	-
Main activity	1 if vegetable growing is the main activity, 0 if other	+
Surface area	Surface area farmed by the respondent	-
Head of household	1 if respondent is head of household, 0 if no	-

3. RESULTS

3.1 Characteristics of the Vegetable Growers Interviewed

Table 2 displays descriptive statistics regarding the experimenters' characteristics. At the COMABO vegetable growing site, women formed the largest group (19 women out of 21 farmers), while at the Kotédougou site, the number of women was slightly smaller (35 men and 29 women). For both locations, women accounted for 56.47% of those interviewed. This might be due to the greater interest of women in urban areas toward vegetable growing than men. In regards to age, over half of the interviewed vegetable growers were between the ages of 39 and 50. In total, 55.56% of the 45 vegetable growers who attended school had primary education, while 47.1% had neither attended school nor learned to read and write.

With an average vegetable growing experience of 10.5 years on both sites, each grower cultivates an average of only 69.52 square meters on the COMABO site and 3686.61 square meters on the Kotédougou site. On average, households consist of 7 people, with limited agricultural assets. Only 12 of the 85 vegetable farmers are single, and only 5 have vegetable farming as their main activity. The majority of the interviewed vegetable growers belong to the Bobo and Dioula ethnic groups (76.5%).

3.2 Assessment of GAP Factors

The numbers and percentages of acceptance of the different items of the GAP package are recorded in Table 3. Vegetable growers show the highest percentage of acceptance for the use of compost and manure (100%). Integrated pest management (96.47%) and compliance with crop technical itinerary (95.29%) come second and third, respectively. The rational use of mineral fertilizers (76.47%) is the least adopted. Of the 85 vegetable growers interviewed, only 3.53%, 4.71% and 23.53% of the farmers, respectively, still do not adhere to integrated pest management, compliance with technical itineraries and rational use of mineral fertilizers in vegetable growing.

Table 2. Descriptive statistics on the characteristics of vegetable growers and their farms

Qualitative variables		**Size**	**Frequencies** (%)
Experimenter's age group	young (< 39years)	12	14.1
	Adults [39-50years]	56	65.9
	Old (>50years)	17	20
Gender	Man	37	43.5
	Woman	48	56.5
Main activity	Vegetable growing	5	5.88
	Other than vegetable growing	80	94.12
Marital status	Single	12	14.1
	Married monogamous	43	50.6
	Married polygamous	30	35.3
Educational level	None	40	47.1
	Literate	5	5.9
	Primary	25	29.4
	Secondary	15	17.6
Ethnic group	Bobo/Dioula	65	76.5
	Other ethnic group	20	23.5
The position of the head of household	Head of household	33	38.82
	Simple member	52	61.18
Perception of improved income as a motivating factor for GAP adoption		37	43.5
Quantitative variables		**Average**	**Standard deviation**
Household size		7 peoples	4.67
Surface area farmed	COMABO	69.52 m²	18.16
	Kotédougou	3686.61 m²	3324.29
Experience in vegetable growing		10.46 years	9.26

Table 3. Size and percentage of vegetable growers adopting the GAPs taught

Good agricultural practices	Size		Percentage (%)	
	Yes	No	Yes	No
Use of compost and manure	85	0	100	0
Integrated crop pest management	82	3	96.47	3.53
Compliance with technical itineraries	81	4	95.29	4.71
Rational use of mineral fertilizers	65	20	76.47	23.53
Adoption of the GAP package	63	22	74.1	25.9

Table 4. Estimation of the contribution of vegetable growers' characteristics by the logit model in the adoption of GAP in vegetable growing

Independant variables	Coefficient	Standard error	Probability
Gender	3.307	1.564	0.034**
Age group	0.976	0.553	0.078*
Marital status	0.309	0.534	0.563 ns
Educational level	0.227	0.26	0.383 ns
Household size	0.074	0.06	0.217 ns
Experience	0.025	0.03	0.41 ns
Ethnic origin	-2.54	1.053	0.016**
Main activity	1.575	2.225	0.479 ns
Surface area	-5.6E-05	1.43E-04	0.694 ns
Head of household	-3.838	1.647	0.02**
Constant	-1.882	1.533	0.22
Dependant variable	Improvement in income is a main characteristic of GAP adoption		
Logistic regression			
Number of observation	85		
-2Log Likelihood	84.645		
Nagelkerke Pseudo R^2	0.40		
Hosmer-Lemeshow test	0.40		
Predictive accuracy	75.0%		
Overall significance of the model	0.001		

******significant at 5% level, *****significant at 10% level, **ns**= non-significant*

It is evident that the highest percentage of adhesion is recorded for the use of compost and manure by vegetable growers (100%), followed by integrated pest management with 96.47%, then compliance with the technical itinerary of the crop with 95.29% and finally the rational use of mineral fertilizers (76.47%). The rate of adhesion to the GAP package by the vegetable growers interviewed is 74.1%. Of the 85 interviewed, only 22 do not adhere to 1, 2 or 3 items of the GAP package.

Of all the vegetable growers interviewed, all believe that GAPs are not more demanding in terms of land and water, nor costlier than PPs, but they are appropriate and achievable. According to them, they enable them to improve income and increase production, and are not incompatible with their habits and customs.

3.3 Factors Influencing the Decision to Adopt GAP Based on Vegetable Growers' Perceptions

All of the vegetable growers interviewed perceive profitability, adaptability, ease of implementation and non-complexity of GAP in vegetable farming as factors influencing the likelihood of adopting GAP.

Table 4 illustrates that over half of the vegetable growers (56.5%) did not view the income improvement through GAP as a motivator in their choice to adopt it for vegetable growing.

The plausibility test indicates that the estimated model is globally significant at a 1% level. This suggests that the variables introduced into the model contribute globally to explain the adoption of GAP by vegetable growers. The Hosmer-Leme show test is significant, indicating that the

model is well specified. Furthermore, the model has a 75% percentage of predictive accuracy, demonstrating its capacity to accurately predict the choice of vegetable growers to adopt or not adopt GAP. As a result, the vegetable growers' characteristics selected as variables significantly explain the shaping of the perception of adopting GAP through their ability to improve income. Of the ten (10) variables entered in the logit model, four (04) are statistically significant at the 5% or 10% levels. Which means that these variables individually explain the adoption of GAP by vegetable growers. Of these four (04) variables, two (02) significantly and positively impact the perception of GAP adoption by vegetable growers. These variables are gender (significant at 5%) and the age group to which the grower belongs (significant at 10%). Therefore, being male improves the perception of vegetable growers. Similarly, the older a farmer is (young, adult), the more likely he is to perceive income improvement as a factor favoring adoption of GAP. The variables of grower ethic origin and head of household's status (both significant at 5%) had a negative influence on grower perception. Thus, Bobo and Dioula ethnic groups tend not to perceive income improvement as a factor in GAP adoption, unlike other ethnic groups (Mossi, Gourounsi, etc.). Also, the fact that a grower is the head of the household does not necessarily lead him to perceive income improvement as a factor in adopting GAP.

4. DISCUSSION

This study highlighted the advantages of the technical package over the LFP. Vegetable growers, through the Farmer Field School (FFS), had a better understanding of the advantages of GAP. However, the results show that 25.9% of respondents only partially adopt the proposed technical package. They chose one, two or three of the four components of the technical package. These results are confirmed by the work of Mabah et al. [20].

Analysis of socio-economic determinants showed that vegetable growing is practiced as a main activity by only 6% of the respondents. Therefore, the majority of the interviewed vegetable growers dedicate little of their time to vegetable growing activities. These results align with [23]. work, which demonstrates that farms with agricultural production beyond vegetables have less time to devote to vegetable growing, and therefore have a greater impact on vegetable growing practices due to lack of available time. Vegetable growing is mostly a woman's activity, particularly in urban areas, and few have achieved secondary school education [9]. also observed this among vegetable growers in Benin.

The rainfall deficit in 2017 resulted in a shortage of water, preventing vegetable growers from reproducing the experiment over multiple seasons. Consequently, water availability, an exogenous factor in GAP, did not allow vegetable growers to intensify GAP. According to Schilter [24], diseases that destroy crops rapidly arise due to a lack of water and heat. To identify and analyze the main factors that determine perceptions of GAP adoption, it is important to note that the early drying up of wells and streams observed between February and March 2018 limited the development of their vegetable growing activities.

Profitability, adaptability, ease of implementation and non-complexity of GAP in vegetable farming are perceived by the respondents as catalytic factors in the decision to adopt GAP. These factors positively influence the perception of the vegetable growers interviewed. These results are confirmed by the work of [19, 25, 26,13, 22] who have shown that the perceptions of an innovation are based on characteristics such as profitability, adaptability, profitability and efficiency. Vegetable growers adopt GAP when they themselves perceive the benefits of GAP in vegetable growing. According to the results of the study by Nouhoheflin et al. [27], the more farmers perceive the benefits of the innovation, the greater its adoption.

However, income improvement is a characteristic of GAP that is not perceived by the majority of vegetable growers as one of the main factors motivating the adoption decision in vegetable growing in our study area. The results of the logistic model show that the decision to adopt GAP based on perception is determined by the following variables: gender, age, ethnic origin and the fact of being head of household. These variables had the expected sign.

Determinants such as gender and age group have a positive influence on the decision to adopt GAP. The positive coefficient sign of gender and age group variables (young and adult) indicates that men, young and adults are more likely to adopt GAP because of the income improvement effect. In addition, adult vegetable farmers are more experienced (10 years on average) and have more information about LFP, which allows

them to better assess the value of GAP and limit their uncertainty. The studies conducted by Nouhoheflin and Nacro [27,13] have reported identical outcomes. They showed that producers' interaction with agricultural advisors and their experiences have a positive impact on the adoption of new rice production techniques.

The negative influence of age (old) on adoption in the present study is consistent with the findings of a study in Cameroon which reports that age negatively influences the adoption of soil fertility restoration practices [28,20]. The higher probability of adoption among younger producers may be explained by their tendency to be more innovative due to their longer-term planning horizons. These results are also in agreement with the work of [5], which showed that socio-economic variables play a decisive role in the adoption of new rice in the Central African Republic.

The Bobo and Dioula ethnic groups in this study are the indigenous and predominantly animist vegetable growers. The negative coefficient sign of the ethnic origin variable indicates that the Bobo and Dioula are inclined to dis-adopt GAP, unlike the other Mossi, Gourounsi, Bissa, etc. ethnic groups (non-indigenous), who are generally open to innovations. This result shows that these ethnic groups are reluctant to innovate, probably for cultural reasons or because of their reluctance and mistrust. What is more, they have had no experience other than that of their native environment. This is in consistent with the work of [22], which showed that a grower's attachment to his culture is a limiting factor in the adoption of the improved seeds of néré proposed by researchers in Niger. Certains items of farm structure, such as cultivated area, household size and membership to an ethnic group, have negative effects on the probability of adoption [28]. The head of household's decision is influenced by these elements of the household's farm structure. The fact that a vegetable grower is the head of the household means that he is not in favor of adopting GAP. This could be explained by burdens such as the size of the household and the diversity of the family's farming activities. A FFS group made up of Bobo and Dioula heads of household would be much more reluctant to diffuse and adopt GAP. As a result, when forming FFS groups during the dissemination of an innovation to vegetable growers on these sites, these characteristics need to be taken into account in order to reduce the effects of unfavorable adoption characteristics [29,30].

5. CONCLUSION

This study made it possible to highlight the benefits of Good Agricultural Practices in vegetable growing.

Despite the lack of water on the sites which is recognized as the main factor limiting the adoption of GAP, the characteristics of the technical package such as adaptability, profitability and non-complexity to implement were favorably perceived by all vegetable growers. However, the majority of vegetable growers did not perceive the income improvement as being the main factor encouraging adoption. Logistic model analysis shows that age (young and adult) and gender (male) are the determinants that significantly increase the probability of adopting the vegetable-growing technical package. On the other hand, the variables with a significant negative impact on the probability of adoption were ethnic origin (Bobo/Dioula) and the head of household’s status. These results confirm the fourth hypothesis, which states that the socio-economic characteristics of farmers influence the adoption of GAP in vegetable growing.

At the end of this study, it is clear that vegetable growers can improve their income by adopting GAP. This adoption requires better dissemination of GAP, which takes into account these socio-economic characteristics of producers in the establishment of groups of vegetable growers in the popularization tool (FFS).

The study has two main limits. Firstly, the data were collected on the basis of self-reporting, which may lead to subjectivity in the answers provided by the respondents. Secondly, the study was carried out over a single vegetable-growing season, which makes it difficult to see how the number of people adopting GAP changes over time, and to convince those who are reluctant to adopt these agricultural practices.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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