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Analysis of the Economic Profitability and Determinants of The Adoption of Improved Cowpea Varieties Korobalen IT89KD374 in the Segou Region

Amadou K. dit Amobo WAÏGALO[1], Kalifa SISSOKO[2]

[1]University Of Ségou, University Institute of Professional Training (Institut Universitaire de Formation Professionnelle-IUFP), Ségou, Mali

[2]PhD Student, Gaston Berger University of Saint Louis

ABSTRACT: This study focuses on the adoption of improved cowpea varieties Korabalen. It involved 81 producers in the Commune of Sakoïba chosen randomly, more precisely those from the village of Zogofina. The data collected are both qualitative and quantitative. The econometric estimation for the analysis and interpretation of the data was done by Stata software. The study revealed that the adoption rate of the improved cowpea variety Korobalen is 14.81%. Non-adopters have a higher economic profitability than adopters. The adoption rate and economic profitability indicate that producers benefit more by adopting local cowpea varieties. The factors that positively and significantly affect the decision of the probability of adopting the improved cowpea variety are the area exploited and the practice of associated cultivation. These two factors favor the adoption of the improved cowpea variety Korobalen. On the other hand, household size negatively and significantly influences the probability of adopting local cowpea varieties. To promote wide dissemination and accessibility of the improved cowpea variety Korobalen, it is necessary to raise awareness and inform producers on good cultural practice measures, to restructure the average size of farms according to the producers' production objectives and to promote the valorization of associated cultivation to better optimize the yield of the various associated speculations.

KEYWORDS: Adoption, Korobalen, Cowpea, Economic profitability, Improved variety.

1. INTRODUCTION

In the world, cowpea (Vigna unguiculata Walp.) remains one of the most dominant grain legumes cultivated due to the extent of the cultivated areas allocated to it. Thus, Nigeria is the largest producer of cowpea in Africa and in the world, with respective supply levels of 61% and 58%. It is followed by Niger, Brazil and Mali with respective productions of around 650,000 tonnes, 600,000 tonnes and 110,000 tonnes (Aly & al., 2017). Cowpea is more cultivated in Asia and Tropical Africa, because of its adaptability to these two climates (Stoilova & Pereira, 2013). The crop is also suitable in lake areas where temperatures are between 28 and 30°C. Cowpea productivity is high in areas where temperatures vary between 500 and 1,200 mm per year. In sub-Saharan Africa and more particularly in the arid savannahs of West Africa, cowpea is an important food commodity for the human population. Cowpea seeds are very rich in vitamins and plant proteins. Sales of seeds and fodder provide an important source of income for producers. Seed and fodder sales markets are very dynamic in West Africa (Dugje & al., 2009).

Cowpea cultivation is favorable to Mali's climatic conditions. It constitutes a source of income diversification for women. Its production also helps meet consumers' needs for a nutritious and diversified diet (Sissoko & al., 2021). In Mali, cowpea is produced in all production areas of the country in rainfed, flood recession and irrigated production systems. The yields for cowpea production in intercropping and pure cultivation are respectively 475 kg/ha and around 700 kg/ha (MA & MEP, 2018). The most popular cowpea varieties in Mali are Korobalen, Sangaraka and Wilibali. The first two varieties were introduced in Mali in 1998. As for the Wilibali variety, its introduction in Mali dates back to 2011, more than a decade ago (Waithaka & al., 2019). The low yields observed in rural areas are due to the unsuitability of local varieties, climatic hazards and the low distribution of seeds in quantity and quality (Oumarou & al., 2017). Cowpea crop yields in Niger also remain very low. They vary between 297 and 332 kg/ha. The reasons for these productive weaknesses include : a low rate of supervision of producers, pressure from crop pests

(bugs, aphids and caterpillars). Added to this are the high costs of good quality pesticides, the use of alternative non-chemical methods and a low rate of adoption of high-performance cowpea genotypes which limit the production potential per hectare (Rabé & al., 2017).

Producers' choices to adopt or not to adopt a new technology are based on several criteria that can be technical, economic or social. Farmers have a preference for an innovation whose economic efficiency (technical and allocative efficiency) is proven (Adesina & al., 1989). Adoption is based on a deliberate desire to choose an innovation, that is to say something new, in order to take advantage of the best economic opportunities it offers (Rogers, 1983). Indeed, the introduction of cowpea varieties in the Bam province, the main cowpea producing area in Burkina Faso, has increased the productivity of women producers. By adopting improved cowpea varieties in 2000, their average production increased by 300 kg more compared to the old varieties whose average yield was 200 kg per hectare in 1980 (Savadogo, 2019). The cultivation of improved cowpea varieties in the central plateau of Burkina Faso is a profitable activity. However, insufficient operating capital is a constraint on adoption for producers. Access to credit or a financial market is an alternative that could resolve this constraint (Ouédraogo, 2003). The main constraints related to the adoption of improved cowpea varieties in northern Cameroon are financial and communicational. Added to this is a lack of supervision of producers through technical support and advice at the grassroots level (Kosma & al., 2014). The adoption of improved cowpea varieties (IT90K 372-1-2, IT99K 573-1-1 and KVX 30 309 6G) by producers in the Maradi and Zinder regions of Niger is encouraged by the establishment of farmer field schools (FFS). The participatory approach of involving producers in the various experiments through the FFS has had the impact of a large rate of adoption and dissemination of improved cowpea varieties. However, the adoption rate has been favored by producers' accessibility to credit (Rabé & al., Opt.cit).

In Benin, cowpea attacks by plagues and pests before harvest and during storage are major production constraints (Gbaguidi & al., 2015). The adoption of improved cowpea varieties by households in the savannah and transition forest areas of Benin has made it possible to induce a significant difference in terms of yield. The adoption therefore positively impacts household yield. This has increased their income and ensured their food security (Nouhoheflin & al., 2003). At the end of this study, the research question relating to the adoption of the improved variety IT89KD374, locally called Korobalen, will allow us to highlight the profitability of its production and the factors determining its adoption. In short, the research question we will be interested in is the following: it is a question of highlighting the socio-economic and institutional factors which significantly influence the decisions of adoption of the improved Korobalen variety by producers in the Ségou region?

2. STUDY AREA AND METHODOLOGY

This part concerns the presentation of the study area and the methodology followed for the estimation and analysis of the data. The presentation of the study area concerns the administrative organization, the description of the physical environment which includes the climate, the relief, the hydrography, the soil and the vegetation

2.1- Study area

The area covered by the study is the village of Zôgôfina located approximately 5 km from the city of Ségou. The village of Zôgôfina falls under the rural commune of Sakoïba which is located 13 km from the urban commune of Ségou, the regional capital. The rural commune of Sakoïba was created by law n° 96-059 of 04/11/1996. Located in the Sahelian zone, the rural commune of Sakoïba is part of the inter-river communes of the Ségou circle between the Bani and the Niger. It bears the name of the village which is the capital of the commune. The rural commune of Sakoïba is located in the Ségou circle in the Ségou region. It is bordered: to the north by the urban commune of Ségou; to the southwest by the rural commune of Soignebougou; to the east by the rural commune of Sébougou; and to the west by the rural commune of Pélengana and Tesserela. It has 30 villages that belonged to the central district of Ségou. According to the General Population and Housing Census (RGPH5), the rural commune of Sakoïba has 27 308 inhabitants, including 13,557 men and 13,751 women.

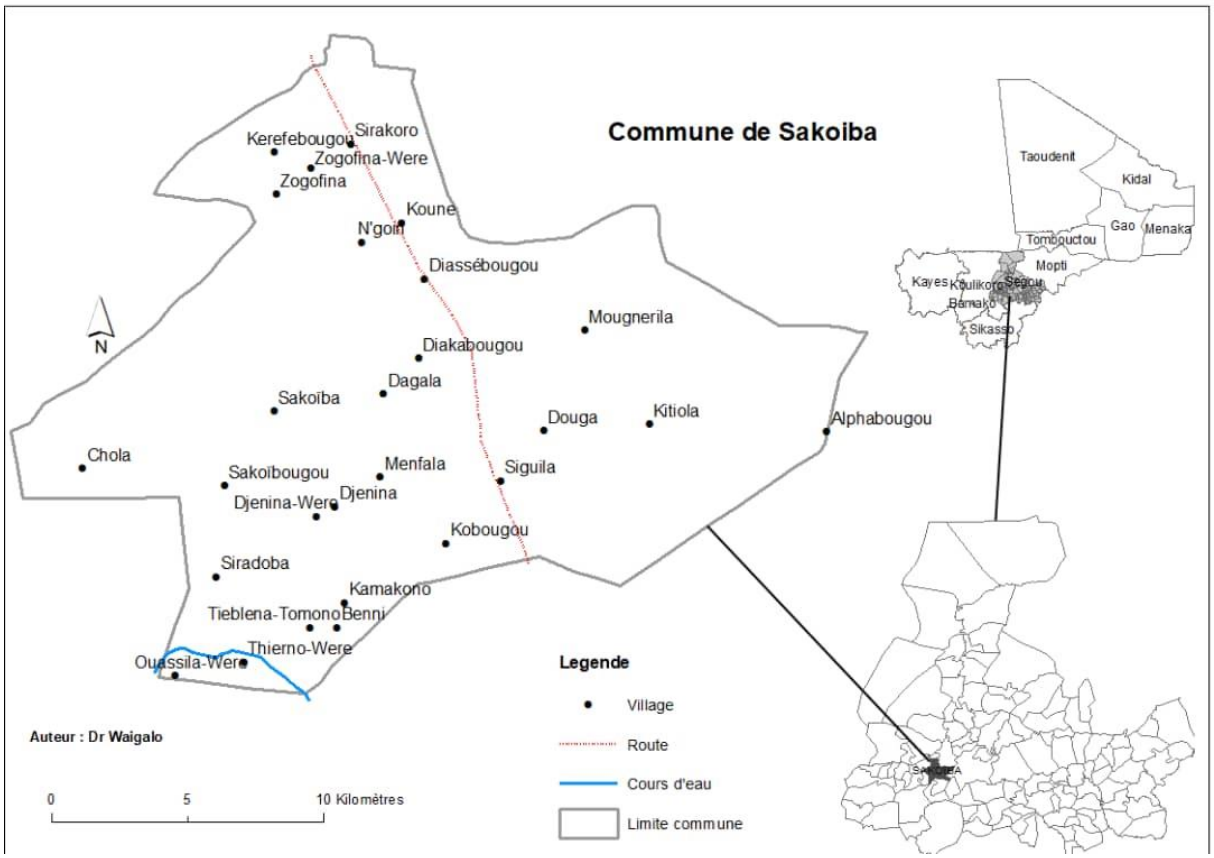

Figure 1: Map Of Rural Commune Of Sakoïba

2.2- Methodology

2.2.1- Data collection and sampling

For data collection, the producers chosen for sampling in the commune of Sakoïba are those from the village of Zogofina. The latter is known to be a cereal production area and particularly for the cultivation of cowpea. The agro-ecological and climatic conditions are favorable for the production of cowpea. Before the final data collection, a test survey was carried out in order to determine whether the questionnaire developed meets the needs of the study. This test survey concerned five producers. It proved adequate in relation to the different information to be collected and data to be collected. The latter concerned eighty-one (81) producers chosen randomly from all the producers in the village growing cowpea. The data collected are both qualitative and quantitative.

2.2.2- Data processing and analysis

First, all the information collected and data collected were processed in order to avoid errors of interpretation and estimation. The coding of the questionnaires facilitated the entry and the constitution of the database in Excel. The econometric estimation for the analysis and the interpretation of the data was done by the Stata software.

2.2.3- Econometric modeling

The values of the estimated coefficients of the Probit and Logit models are relatively close. The estimated coefficients are not directly comparable. In order for the values of the coefficients of the Probit model to approximate those of the Logit model, it is sufficient to multiply the coefficients of the explanatory variables of the Probit model by the constant $\pi\sqrt{3} \approx 1{,}81$ (Amemiya, 1981). For the econometric estimation of the data in our study, the model chosen is the logit model.

2.2.4- Presentation of the simple dichotomous model - Logit model

The formula for the logistic function called the Logit model is given by :

$\text{Ln}\left(\frac{\text{Pi}}{1-\text{Pi}}\right) = y_i^* = \alpha + \beta X_i + \varepsilon_i$

Its density is given by the formula:

$f(x) = \frac{e^{-x}}{(1+e^{-x})^2}$ avec $x \in IR$

The logistic law is defined by the following distribution function :

$F(x) = \frac{1}{1+e^{-x}}$ avec $x \in IR$

The relationship between density and distribution function is defined by :

f (t) = F(t) [(1 - F(t)]

The logistic distribution is symmetrical:

F (-t) = 1 - F(t)

It has a mean of zero and its variance is worth $\pi^2/3$.

The properties of this equation are as follows, if α > 0 :

Lim $P_i \to 1$ et Lim $P_i \to 0$

$xi \to \infty$ $xi \to -\infty$

The values of P_i are thus between 0 and 1.

$E(Y_i) = P(Y_i = 1) = \frac{e^{\alpha+\beta xi}}{1+e^{\alpha+\beta xi}}$

$P(Y_i = 0) = 1 - P(Y_i = 1) = \frac{1}{1+e^{\alpha+\beta xi}}$

Probit and Logit models commonly correspond to a log-likelihood function whose formula is given by :

$$L(Y, \beta) = \prod_{i=1}^{n} [F(xi\beta)]^{Yi} [1 - F(xi\beta)]^{(1-Yi)}$$

$\frac{Pi}{1-Pi}$ is the relative probability of the choice $y_i = 1$;

P (Y_i = 1) if the producer adopts the improved cowpea variety Korobalen;

P (Y_i = 0) if the producer does not adopt the improved cowpea variety from Korobalen;

e = exponential function;

Y_i = explained variable. It is dichotomous, that is to say it cannot take two values (0 ou 1) ;

X_i = explanatory variables that may influence the adoption of the improved cowpea variety Korobalen by the producer i ;

β = parameters of the variables to be estimated;

α = constant ;

ε_i = random term or error term.

2.2.4.1- Empirical model

The choice of the empirical model in this study concerning the logistic function is based on the diffusion and adoption of an agricultural technology. The empirical specification that justifies the choice of the logit model refers to the study of (Adéoti & al., 2002) which deals with the adoption of new cowpea technologies in West Africa.

En effet, la relation qui existe entre Y_i et Y_i^* est traduite par l'équation suivante :

$$Yi = \begin{cases} 1, & Yi* > 0 \\ 0, & Yi* \leq 0 \end{cases}$$

- Y_i = 1, If the producer adopts the improved cowpea variety Korobalen, then $Y_i^* > 0$;
- Y_i = 0, If the producer does not adopt the improved Korobalen cowpea variety, then $Y_i^* \leq 0$;

Y_i^* is a latent variable, i.e. continuous, unobservable and representative of the phenomenon studied.

The linear form of the logit model is specified by :

$Y_i^* = \beta_0 + \beta_1$ Age + β_2 Gender + β_3 Household_Size+ β_4 Education + β_5 Area + β_6 IGA+ β_7 Associated_Crops + β_8 Market_Orientation + ε_i

Où :

β (β_1, β_2, β_3, β_4, β_5, β_6, β_7 et β_8) = to the parameter vector of the variables to be estimated;

ε = at random error term.

2.2.4.2- Choice of variables of the empirical model

The variables of the empirical model are of two types : the endogenous variable (explained) and the explanatory (exogenous). The endogenous variable takes the value 1 if the producer adopts the improved Korobalen cowpea variety and 0 otherwise. Furthermore, the variable Xi is a vector of explanatory variables that determines all the factors that explain the adoption or not of the improved Korobalen cowpea variety. The variables retained for the estimation of quantitative and qualitative data are of two types : demographic/socioeconomic variables and an institutional variable. The demographic and socioeconomic variables are household size, age, gender, level of education, area cultivated, income-generating activities and associated crops. Market orientation constitutes the institutional variable, in the sense that accessibility to a market is dictated by mechanisms linked to its organization and price fixing.

2.2.4.2.1- Demographic and socioeconomic factors

Demographic and socio-economic factors likely to significantly influence the adoption of the improved Korobalen variety by producers are :

- household size : which is a variable taking into account the number of agricultural workers or people under the responsibility of the farm manager who can be employed as temporary or permanent labor. In sub-Saharan Africa and more particularly in rural areas, household size is an important source of labor. The larger it is, the more the farm manager has the possibility of having an abundant and sometimes unpaid workforce for their employment. It is expected that the number of agricultural workers can positively and significantly impact the adoption of the improved cowpea variety ;
- age: is expressed in number of years that the producer has. It is expected that its effect will be negative or positive regarding the adoption of the improved cowpea variety. Since in traditional societies the oldest are generally resistant to change. However, they can be open to change, that is to say to the adoption of a new agricultural technology that is well founded in terms of productivity gains, economic profitability and the preservation of their agricultural practices ;
- gender : is a binary variable that takes the value 1 if the producer is a man and 0 if not. In the study area, the society being very attached to its cultural values, it is assumed that the adoption of a new technology is facilitated by its accessibility. Which gives priority to men over women. It is expected that gender will have a positive influence on the adoption of the improved cowpea variety Korobalen ;
- education : the level of education is a binary variable that takes the value 1 if the producer is educated and 0 otherwise. It is expected that it can positively and significantly influence the adoption of the improved Korobalen cowpea variety ;
- the area cultivated : is expressed in number of hectares. It is expected that producers with large cultivable areas will prioritize the cultivation of local cowpea varieties which are less expensive in terms of seed acquisition. The expected sign of its coefficient is expected to be negative compared to the adoption of the improved variety ;
- income-generating activities (IGA) : indicate other types of activities carried out by producers independently of cowpea cultivation. The IGA variable is binary. It is equal to 1 if the producer derives most of his income from other IGAs and 0 if not. The fact that the producer exercises an IGA could reduce his interest in cowpea cultivation and more particularly in the adoption of the improved cowpea variety Korobalen. It is expected that the coefficient linked to IGAs will be negative and significant;
- associated crops: designate the association of other cereal varieties with cowpea. This is a binary variable that takes the value 1 if the producer associates cowpea cultivation with other types of cereals and 0 otherwise. Producers who simultaneously cultivate cowpea and other cereals do so for several reasons. First, the nitrogen contained in the cowpea plant is a beneficial fertilizer for the soil. This allows producers to reduce their fertilizer purchase costs and improve their economic profitability. Producers who practice intercropping strengthen their resilience to the effects of climate change. The latter result in soil degradation, unequal distribution of rainfall in time and space, and food insecurity, which increase the vulnerability of producers. It is hoped that the intercropping coefficient can positively and significantly impact the adoption of the improved Korobalen cowpea variety.

2.2.4.2.2- Institutional factor

The only factor retained as institutional is the market orientation. Even if producers have decision-making power over the flow of their production, the latter could be strongly influenced by the organization and rules of the market. The coefficient associated with the market orientation is a binary variable that takes the value 0 if the producer does not intend his production to the market and 1 if he sells more than half of his production on the market. It is hoped that the coefficient associated with the market orientation can positively influence the adoption of the improved Korobalen cowpea variety.

3. RESULTS ET DISCUSSIONS

This part deals with the descriptive statistics of qualitative and quantitative variables, the analysis and interpretation of the different results of economic profitability of the two groups of cowpea producers, namely the adopters and non-adopters of the improved cowpea variety Korobalen. The second part concerns the analysis and interpretation of the data from the econometric estimation based on the logit model.

3.1- Descriptive statistics

3.1.1- Descriptive analysis of qualitative and quantitative variables

Regarding the adoption of the improved cowpea variety Korobalen, its adoption rate is very low, less than 15%. Producers mainly cultivate local cowpea varieties. The cultivation of local varieties is widespread in the area. Women constitute nearly 5% of

producers. This confirms that they have limited access to production factors. It is noted that 65.43% of the producers surveyed have received a level of education (formal or non-formal literacy). It appears that the income of 38.27% of producers comes solely from the sale of cowpea. Those with IGA constitute 61.73% of the sample. The proportion of producers producing cowpea with other cereal varieties is 27.16%. The 66.67% of producers do not intend to market their production. Most of their production is either intended for donations (mutual aid) or for family consumption.

Indeed, producers have an average age of 49 years. The youngest and oldest producers are 17 and 86 years old respectively. The average size of households made up of agricultural workers is 14 people. The latter are permanently available for agricultural work. Producers who are heads of households employ them as labor. This labor constitutes considerable human capital for farms. Their employment thus allows producers to considerably reduce their production costs which could have been allocated to the employment of salaried labor. The average area exploited allocated to pure cultivation and associated cultivation of cowpea is 1.50 ha. The largest area exploited is 5 ha compared to 0.25 ha exploited by the smallest producer.

Table 1 : Descriptive statistics of socioeconomic, institutional and demographic variables

Variables	**Characteristics**	**Mean**	**Minimum**	**Maximum**
Variables qualitatives				
Adoption	Dependent variable 1=Adoption and 0=Otherwise	0.1481	0	1
Gender	1 = Male et 0 = Feminine	0.9506	0	1
Education	1 = Educated and 0 = Uneducated	0.6543	0	1
IGA	1 = IGA income and 0 = Income from cowpea sales only	0.6173	0	1
Variables	**Characteristics**	**Mean**	**Minimum**	**Maximum**
Associated crops	1 = Associated culture and 0 = Pure culture	0.2716	0	1
Market orientation	1 = Market production and 0 = Non-market production	0.333	0	1
Variables quantitatives				
Age	Producer age - Expressed in years	49.12	17	86
Household size	Agricultural assets	14.63	3	85
Area exploited	Expressed in hectares	1.53	0.25	5

3.1.2- Economic profitability of adopters and non-adopters of the improved Korobalen cowpea variety

The estimation of the economic profitability of the two groups of producers has been done from the elements constituting their operating account.

3.1.2.1- Economic profitability of adopters

Indeed, the results in Table 1 show that producers of the improved cowpea variety IT89KD374 receive on average annual incomes of 22,857 CFA francs and 37,500 CFA francs respectively for the sale of seeds and fodder (bundles). The quantities of grains sold per producer barely reach an average of 58 kg. The minimum and maximum selling prices per kg of seed are between 0 and 400 CFA francs, for an average of 114 CFA francs per kg. The observation that emerges is that producers of the improved variety IT89KD374 make more profit from the sale of cowpea bundles. Firstly, it emerges from our investigations that most of the harvest is intended for family consumption. This leaves little room for the sale of the remaining production on the market. Secondly, producers who are unable to store the quantities needed for sale when prices are at their lowest prefer to sell off the available quantities before the lean season when selling prices are more profitable. On the other hand, most producers sell cowpea bales when they are scarce on the urban market. This results in a higher income for the sale of cowpea bales IT89KD374.

However, the average total revenue received per producer for the season is 60,357 CFA francs, for an average total production cost per producer of around 22,000 CFA francs. On average, producers have a profit margin of 38,372 CFA francs.

Table 2 : Economic profitability of adopters of improved cowpea variety - IT89KD374

Designation	**Mean**	**Minimum**	**Maximum**
Grains			
Quantity sold (Kg)	57	0	1 200
Selling price (F CFA / Kg)	114	0	400
Revenue (F CFA)	22 857	0	120 000

Designation	Mean	Minimum	Maximum
Bundle			
Quantity sold (Unit)	443	0	1 200
Selling price (F CFA / Unit)	75	0	125
Revenue (F CFA)	37 500	0	90 000
Grains and Bundles			
Total revenue (F CFA)	60 357	0	190 000
Total production cost (F CFA)	21 985	200	117 500
Profit margin	38 372	-250	181 0

3.1.2.2- Economic profitability of non-adopters

The results in Table 2 show that producers of the local variety of cowpea have average annual incomes of 35,835 CFA francs for the sale of grains and 61,797 CFA francs for that of bundles. Compared to adopters, they thus have average annual incomes of 12,978 CFA francs and 24,297 CFA francs more compared to sales of grains and bundles of cowpea. The average annual quantity sold per producer is 105 kg. The average price per kg of local variety sold is 160 CFA francs. This assumes that the local consumer is willing to pay 46 CFA francs more for the purchase of the local variety compared to that of the improved variety. Therefore, on the local market, the local variety has a higher market value than the improved variety Korobalen. In sum, for the average total revenue, as regards the sale of grains and bundles, producers of the local variety of cowpea earn 34,787 CFA francs more than those of the improved variety. The average profit margin of non-adopters exceeds that of adopters by 33,228 CFA francs.

Therefore, producers of the local variety of cowpea have a higher economic profitability than producers of the improved variety of cowpea Korobalen. However, it emerges from the results and data collected that non-adopters of the improved variety of cowpea sell larger quantities than adopters. Of the two average selling prices (local variety and improved variety), those received by non-adopters of the improved variety of cowpea are more profitable. The price and quantity sold factors are positively correlated with the increase in economic profitability. With regard to the average total revenue received by non-adopters, the expenses they make in terms of average total cost approximate those of adopters. Compared to the areas exploited, non-adopters and adopters cultivate on average 1.49 ha and 1.88 ha respectively. All other things being equal, which are correlated with the variation in the total cost of production. Obviously, and in view of these aforementioned factors, non-adopters appear rational, due to the high production cost of the improved Korobalen cowpea variety.

Table 3 : Economic profitability of non-adopters of improved cowpea variety - IT89KD374

Designation	Mean	Minimum	Maximum
Grains			
Quantity sold (Kg)	105	0	600
Selling price (F CFA / Kg)	160	0	700
Revenue (F CFA)	35 835	0	420 000
Bundles			
Quantity sold (Unit)	577	0	1 500
Selling price (F CFA / Unit)	98	0	250
Revenue (F CFA)	61 797	0	250 000
Grains and Bundles			
Total revenue (F CFA)	95 144	0	300 000
Total production cost (F CFA)	23 544	0	148 200
Profit margin	71 600	-105 900	248 300

3.2. Econometric estimation result of the adoption model

This section, which concerns the econometric estimation of the model, highlights the results obtained through the logit model. Then follows the analysis and interpretation of the coefficients of the variables on the basis of their impacts, the probability of adoption and their significance.

For the estimation of the adoption model of the improved Korobalen variety, eight (8) variables were retained to determine their impacts on the probability of adoption. For all the variables, three have significant coefficients. These are the coefficients associated with the size of the household, the area cultivated and the associated crops.

Compared to household size, the result obtained was contrary to the expected effect. The coefficient associated with household size is therefore negative and significant at the 5% threshold. The household size variable is negatively correlated with the adoption

of the improved cowpea variety Korobalen. It negatively impacts the adoption of the improved cowpea variety. The marginal effects indicate that any increase in household size by one unit of agricultural assets reduces the probability of adopting the improved cowpea variety by 0.009 points. The more agricultural assets the household has, the more it is encouraged to adopt local cowpea varieties to the detriment of the improved variety. This can be explained by the fact that larger households have a preference for adopting the local variety because of their consumption pattern linked to cultural aspects. Larger households tend to be more conservative and more attached to the production of local cowpea varieties. This result contrasts with that obtained by (Adeoti & al., opt.cit), for whom large households in Cameroon, Nigeria and Mali tend to use improved cowpea varieties. Furthermore, the same relationship is observed between household size and the adoption of improved cowpea varieties by (Agwu, 2004) among producers in Bauchi and Gombe states in Nigeria.

Indeed, against all expectations, the sign associated with the coefficient of the area under cultivation is positive and significant at the 10% threshold. The area under cultivation variable positively influences the probability of adopting the improved cowpea variety Korobalen. The area under cultivation promotes the adoption of the improved cowpea variety. Producers cultivating large areas prefer to adopt the improved cowpea variety. Thus, those cultivating large areas have sufficient resources (human capital, material capital and financial capital) to adopt the improved cowpea variety. The production costs incurred by the adoption of the improved variety have no impact on the reduction of cultivable areas. On the contrary, the area under cultivation is positively correlated with the adoption of the improved variety. The expansion of the areas under cultivation should not constitute an obstacle to the adoption of the improved cowpea variety Korobalen. The larger the areas under cultivation the producers have, the greater the probability of adopting the improved cowpea variety Korobalen. On average, the area exploited by adopters is greater than that of non-adopters by 0.39 ha. When the size of the area exploited increases by one unit, all other things being equal, the probability of adopting the improved cowpea variety increases by 0.088 points. This result corroborates with that obtained by (Sidibé, 2004) in Burkina Faso.

The coefficient associated with the variable associated crops is positive and significant at the 5% threshold. It positively influences the probability of adopting the improved variety of cowpea. Producers who associate the cultivation of cowpea with other types of cereals are more likely to adopt the improved variety of cowpea. The practice of associated cultivation promotes the adoption of the improved variety of cowpea. When producers associate the cultivation of cereals with cowpea, the probability of adopting the improved variety of cowpea increases by 0.297 points. The practice of associated cultivation also allows producers to optimize their yield. Several studies have demonstrated the impact of growing cowpea in association with other types of cereals on improving cereal yield. Growing cowpea in association with cereals helps to combat the enemies of the latter. This is particularly the case of striga hermonthica, which parasitizes cereals such as millet and sorghum. Intercropping remains an effective alternative to combat striga. This method of controlling plant parasites is less expensive compared to the costs incurred by purchasing fertilizers and herbicides (Lawane & al., 2009). Hence the interest for producers in growing cowpeas in association with cereals. The association of cowpea cultivation with other types of cereals thus plays a determining role in the adoption of the improved Korobalen cowpea variety. Producers in the area who adopt the improved cowpea variety do so on the basis of an association of crops in order to significantly increase their yield.

Table 4 : Result of the estimation of the adoption of the improved cowpea variety - IT89KD374 by the Logit model

Adoption	Coefficients	Standard deviation	Marginal effects
Age	0.008985^{NS}	0.0311442	0.0000911
Gender	-0.8429561^{NS}	1.518316	-0.085466
Household Size	-0.0904775^{**}	0.0459348	-0.0091734
Education	1.335105^{NS}	1.163258	0.1353642
Area Exploited	0.8738187^{*}	0.4911909	0.0885951
IGR	0.3896185^{NS}	1.122591	0.0395028
Associated Crops	2.930965^{**}	1.051342	0.2971659
Market Orientation	0.0081576^{NS}	1.044863	0.0008271
Constant	-3.409875^{NS}	2.89272	-
Logistic Regression	Number Of observations = 81 Pseudo R^2 = 0.3119		

NS : Not Significant, ****** : Significant at the threshold of 5% et ***** : Significant at the threshold of 10%

CONCLUSION

The cultivation of the improved cowpea variety IT89KD-374, called Korobalen, is suitable for Sahelian countries such as Mali. The cowpea IT89KD-374 is early maturing and drought tolerant. It is more resistant to plant parasites called striga. Its introduction in Mali aimed to reduce food insecurity and, moreover, to mitigate household vulnerability during the lean season. However, the popularization of the improved cowpea variety Korobalen was not accompanied by incentive measures to promote its large-scale adoption. At the national level, the various policies implemented for the mass dissemination of the improved cowpea variety have taken more into account the characteristics related to its productivity and its adaptation to different agro-ecological zones. To promote the wide dissemination of the improved cowpea variety, it is therefore necessary to take into account certain factors that can facilitate its adoption. Hence the objective established by this study, by linking economic profitability and the adoption of the improved variety of cowpea.

However, the study revealed that the adoption rate of the improved cowpea variety Korobalen is 14.81%. On the other hand, non-adopters have a higher economic profitability than adopters. The adoption rate and economic profitability indicate that producers benefit more by adopting local cowpea varieties. The factors that positively and significantly affect the decision on the probability of adopting the improved cowpea variety are the area under cultivation and the practice of associated cultivation. These two factors favor the adoption of the improved cowpea variety Korobalen. On the other hand, household size negatively and significantly influences the probability of adopting the improved cowpea variety Korobalen.

To promote wide dissemination and accessibility of the improved cowpea variety Korobalen, it is necessary to :

- reduce the purchase prices of seeds and agricultural inputs such as fertilizers and herbicides. This would allow producers to allocate large areas of arable land to the production of the improved cowpea variety ;
- to restructure the average size of farms according to producers' production objectives;to make its market price more attractive to producers. This could encourage an increase in supply ;
- to raise awareness and inform producers about good cultivation practice measures ;
- to promote the promotion of associated crops to better optimize the yield of the various associated crops.

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