Study of the Economic Profitability of Soybean Production in the Department in Benin: An Analysis Using the *Direct Costing Method*

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Abstract

In the Collines department in Benin, soybean cultivation is an important agricultural activity that contributes significantly to economic growth. Its production engages various groups of producers and, to do this, its economic evaluation is essential to sustain its development. However, for several years, the development of departmental production has been characterized by a lackluster trend, despite the incentives and signals sent out by the market. Using data collected from a sample of 120 producers chosen at random in the said department, this study assessed, using an approach based on direct costing, the economic profitability of *soybean production*, and identified the determinants of its improvement based on a logit model. The results obtained show that the activities of the different groups of producers in the study area are economically profitable to varying degrees; and the factors identified as explaining the improvement of this profitability are: the economic situation, climatic and meteorological conditions and rural roads. To this end, as an implication of economic policies, this study suggests that the State play its part as arbiter on the market and contribute to the maintenance of rural roads. In addition, strategies must be developed to deal with climatic challenges, such as irregular rainfall.

Keywords: economic situation, economic profitability

1. Introduction

Benin's economic growth potential is partly based on the agricultural sector, which contributes 35% of GDP, provides 70% of exports and employs over 60% of the national workforce (INSTaD, 2022). These characteristic features of the sector give it a leading role in the economic development of the country; and reflect, in fact, the dissemination and ripple effects that it is likely to induce when it comes to developing a development strategy (A ɬa, 2022). In doing so, in order to better promote agricultural sectors throughout the national territory, Agricultural Development Poles (PDA) have been defined, drawing inspiration from the territorial approach to agricultural development (Theys, 2002; Lazarev, 2009). Following this approach, soybean cultivation, given its socio-economic, agronomic and environmental importance, has been identified as a potential source of growth in some PDAs, particularly the Collines department. From then on, this protein-rich legume quickly entered the consumption habits of the population, with as main by-products: oil, yogurt, cheese, germ, infant flour, etc. Indeed, while rural populations benefit from most of the added value of the sector through the production and artisanal processing of soybeans, urban incomes come mainly from the processing activities of oil mills and the marketing of by-products of soybeans soy in different forms (Baris et *al*, 2015).

Indeed, in the Collines department in Benin, soybean cultivation is an important agricultural activity that contributes significantly to economic growth (in the region). It (the cultivation of soya) therefore represents an economic opportunity for many actors, in particular producers. Its production involves various groups of producers with different areas, and its economic evaluation is essential to sustain its development. However, for several years, the development of departmental production has been characterized by a lackluster trend, despite the incentives and signals sent out by the market. It is by virtue of these considerations that the study of the economic profitability of soybean cultivation is a subject of interest for farmers, researchers and government officials. Therefore, the question that arises is how to improve the economic profitability of soybean cultivation in the Collines department in Benin for the different groups of producers, while taking into account the qualitative factors that influence it? The *direct costing* method seems to stand out as an approach that makes it possible to respond to this concern (economic profitability of soybean cultivation) by taking into account the variable and fixed costs associated with production.

This method is particularly useful for allowing, in addition to the calculation of other relevant indicators, that of the break-even point; that is, the minimum turnover that guarantees profit (A ɖa, 2022). This is what justifies the title "**Study of the economic profitability of soybean production in the Collines department in Benin: an analysis using the *direct costing method*".**

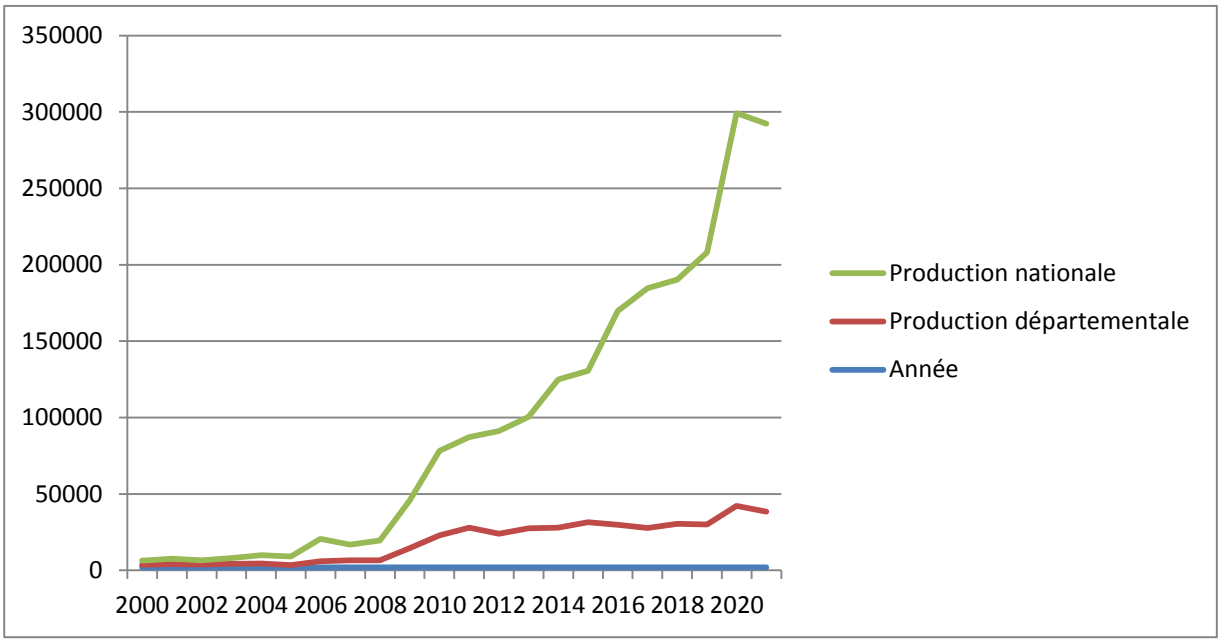
The objective of this article being to apprehend the economic profitability of soybean production both in its evaluation and in the factors which condition its improvement, it is structured in five parts. In a first part, it is made briefly a state of the production of soya in the department of Colline. Then comes, in the second part, a review of some previous work on "economic profitability". In the third part, the methodological approach was presented which made it possible to obtain, in the fourth and fifth parts, empirical results submitted for analysis and discussion.

1-Presentation of soybean in the Collines department

Located in the center of Benin, Collines department is made up of six municipalities: Bantè, Dassa-Zoumè, Glazoué, Ouèssè, Savalou and Savè. This natural situation gives it a geostrategic privilege which makes it a hub for road traffic along the country and an essential stopover between the North, where it borders the departments of Donga and Borgou, and the South, where it is limited by the departments of Zou and Plateau. It shares its borders to the east with Nigeria and to the west with Togo, thus offering business opportunities and the flow of agricultural products between countries. Indeed, this geographical position of the territory of the Hills makes it possible to ensure the mobility of goods coming from Nigeria, Niger, Burkina-Faso and Togo and extends over an area of 13,931 km ²(13% of the national territory) with a population of 717,477 inhabitants (8% of the population of Benin), i.e. an average density of 52 inhabitants/km2 (INSAE, 2013).

It belongs entirely to the Sudano-Guinean climate zone, with two rainy seasons and two dry seasons, marked by hazards and unevenly distributed rains. The normal total number of rainy days in the year varies between 80 and 110. This results in four seasons: a major rainy season: from March to July; a small dry season: from August to September; a short rainy season: from October to November; a great dry season: from December to March. The area is fairly homogeneous, covering a peneplain modeled on a Precambrian base and dominated by hills with an average altitude of 300 m. The department of Collines has a small hydrographic network. The soils are of the tropical ferruginous type on a crystalline base with very variable characteristics. In the department, there is still an availability of land, with however a strong tendency to reduce in the localities of Dassa, Savalou and Savè because of the hills. Black and hydromorphic soils are also found in the valleys of the rivers and streams that cross the area. Slash-and-burn agriculture is the original practice, especially in the localities of Ouèssè and Savè, and is now replaced by a cropping system based on alternating fallow-crop.

About 80% of the population is agricultural, with arable land with high yields but still weakened by climatic fluctuations. 22% of the population is urban out of a national average of 39%. Despite significant agricultural potential, 47% of the population is in a situation of poverty and the area faces major challenges: high rate of malnutrition, low competitiveness of the agricultural sector, land degradation and growing land pressure (Padac, 2022). However, the local economy is still mainly driven by the agricultural sector, which is based on the production and marketing of food products from the sectors: soybeans, maize, groundnuts, cassava, cashews, peppers, yams and cowpeas. The equipment generally used, apart from the traditional ones like the daba, the hoe and the machete, are plows and tractors. The Collines department in Benin is one of the most fertile and productive regions of the country. It is considered to be one of the main centers of soybean production in Benin, as shown in the following graph, showing the evolution of national and departmental production.



Graph 1. Evolution of departmental and national soybean production

Source: Department of Agricultural Statistics (DSA) of the Ministry of Agriculture, Livestock and Fisheries (MAEP)

Indeed, the graph above is marked, during the early 2000s, by a synchronous evolution of the two curves (departmental production and national production) tending to merge from the start. This was a translation of the preponderance of departmental production in the national whole. During this period, the Collines departement, alone, concentrated on its territory, more than 75% of the national production of soybeans. However, from 2008, national production gradually demarcated itself from departmental production, to experience an exponential pace. Indeed, although progressing over time, departmental production has become timid, with a logarithmic appearance, thus reflecting the weak performance of the sector in this region, which was once exemplary. Under these conditions, the gap widened from year to year between the two variables so as to downgrade the Collines department, formerly the national leader in soybean production. The enthusiasm that this sector began to generate in the northern departments (especially Borgou and Alibori), certainly given the strong demand from neighboring Nigeria, with a very remunerative price (sometimes more than double the price of the national market), undoubtedly enabled this remarkable development. The gap observed around the 2010s has only widened over time; to the point where one is entitled to wonder if soybean cultivation is not profitable enough to continue to interest producers in the Collines department. This situation, variously appreciated, leads us to the empirical study of the economic profitability of soybean cultivation in this department, formerly a pioneer in this activity. The underlying factors of its improvement will not be obscured. But, beforehand, it seems necessary to us, in a perspective of inspiration, theoretical enrichment and extension, to make a brief synthesis of previous studies having dealt with economic profitability.

2. Literature Review

The National Institute of Statistics and Economic Studies (INSEE, 2016) defines economic profitability as one of the indicators of the profitability of a company and the growth of an economy.

Indeed, if for Jacquet and Charnoz (2003), the fight against poverty and growth are closely intertwined, for poor countries, economic growth is the key to poverty reduction. Rainelli (2007), as far as he is concerned, is more specific in his analysis, showing that the impact of agricultural growth on poverty reduction is unequivocal in developing countries. For him, improving agricultural profitability leads to lower food prices; which allows for an increase in demand. As a result, the use of inputs increases and a primary processing activity can be set up; and this movement affects the rest of the economy. In the light of this reflection, several authors have taken an interest in agricultural profitability. Their various reflections are mostly based on methodological approaches that are as diverse as they are varied.

Indeed, based on data collected from a sample of 124 rural women chosen at random in the Commune of Gogounou

in northern Benin, Yabi (2010) assessed the economic profitability of the income-generating activities they carry out and identified the determinants. The analysis focused on the calculation of women's net annual incomes and on the econometric modeling of the factors that can determine these incomes. The results obtained show that the different types of activities carried out by rural women in the study area are economically profitable and the factors identified as explaining women's income are: the existence of at least one co-wife (negative), the women's contact with an extension agent (positive), the number of years of experience in carrying out the activities (positive), the origin of the woman (negative), access to credit (positive) and the distance that separates it from the capital of the municipality (negative).

However, limiting their study to two crops, maize and cotton, but without gender distinction, as is the case with Yabi (2010), Dossa and *al*., (2018) were interested in the comparative analysis of the economic profitability of these two crops. Indeed, corn and cotton are two very old crops produced in Benin, one for consumption the other to ensure sufficient income to meet household needs. For these two crops, the authors selected from a double-scale sampling (purposive sampling and simple random sampling) 50 producers from the locality of Kandi in northern Benin, from whom data were collected. The analysis was based on economic profitability indicators such as net margin, internal rate of return, average labor productivity and benefit-cost ratio. The results obtained show that maize and cotton crops, whether associated or not, are profitable for producers in the commune of Kandi. However, by sketching a comparison of the performance of these two crops, we come to the conclusion that it is the production of maize which is the most profitable from an economic point of view. It should, however, be pointed out that at the time, because of the many difficulties it encountered, cotton growing in Benin was increasingly neglected, although it had contributed for several years to the economic growth of the country.

This observation would have motivated Paraizo and *al.*, (2012) to analyze the profitability of cotton production in the Ouaké area in northwestern Benin. The study was based on a survey conducted among 31 cotton producers, chosen in a participatory manner with the agents of the Communal Center for Agricultural Production (CeCPA) Ouaké. Data on socio-demographic characteristics, prices and quantities of inputs and outputs used in cotton production were collected from sampled producers. The analysis of the average labor productivity and the cost benefit ratio, with an average area of 1.04 ha and an average productivity of 1085.29 kg, showed that cotton production was not economically profitable for 93.5% producers. This study had the main advantage of showing, from the notion of economic profitability, that most cotton producers do not profit from their activities.

To this end, with the aim of improving the net income of cotton producers by increasing soil productivity and reducing production costs, and also to promote cotton production that is less harmful to the health of producers and more respectful of the environment, Integrated Pest Management (IPM) and Soil Fertility Management (GIFS) have been introduced in Benin. The analysis of the economic and financial profitability of this innovation (technological package) had been the subject of a study, conducted by Dègla (2012) on a random sample of 150 producers including 75 adopters and 75 non-adopters, and using the "With and Without" approach. From the results obtained, it appears that the application of the "technological package" was economically more profitable than conventional cotton production, from the point of view of the added value per hectare, the net result per hectare, the average productivity of the family labour, the benefit-cost ratio and the internal rate of return. By way of conclusion, the author recommends that rural populations adopt this package, which would contribute to improving their financial situation.

In addition, seeking to analyze the effect of Water and Soil Conservation (CES) measures on the economic performance of paddy rice production in the communes of Malanville and Kouandé in Benin; Issiaka and *al.* (2019), relied on a sample of 100 randomly selected and surveyed rice farmers. Using a structured questionnaire, quantitative (production input and output) and qualitative (sex, commune, location of land constraint access to extension service, access to credit, etc.) data were collected and analyzed following indicators of economic profitability and then the apparently independent simultaneous regression model (SUR). At the end of the work, the results obtained show that a good application of this technique (CES) seems to be very costly from the point of view of maintenance or initial investment; which would make adoptive rice farmers less creditworthy.

All these studies on various cultures show us how rich and diversified the literature on economic profitability is. It would not seem less abundant when we look at the specific case of soybeans.

Amedodji (2018) conducted a study that assessed the economic profitability of soybean production in the Parakou area, a region neighboring Les Collines. The results showed that soybean production was profitable for growers, but production costs and marketing were the main challenges to overcome. Following him, Gomina (2019) also looked at the economic profitability of soybean production in a region neighboring the Collines, which is the Borgou department. The results highlighted the economic profitability of soybean cultivation for smallholders, but showed

that marketing was a major obstacle to profitability. In the same register, but this time, also focusing on another crop, Thiombiano (2020) studied the economic profitability of soybean and maize crops in the Collines department. The results showed that soybean production was more profitable than corn production, but production costs were higher for soybeans. This very relevant observation allows us to inquire about the challenges and opportunities that soybean producers in the Collines department may encounter in terms of economic profitability.

To this end, seeking to produce more in-depth knowledge on the issue of the economic profitability of soybean cultivation in this department, Dossou and *al*. (2019) used survey data carried out on a sample of 100 producers in the locality of Dassa-Zoumé. These data were used to assess the economic profitability of soy through four indicators: Net Margin, Benefit-Cost Ratio, Average Net Labor Productivity and Internal Rate of Return. It appears from their analyzes that soybean production is profitable in the commune of Dassa-Zoumè. However, the variation in production profitability as a function of farm size and farmers' access to credit is statistically greater than the variation within the group. The authors thus suggest the need to strengthen producer financing strategies in order to increase profitability at the small farm level, within the framework of sustainable soybean production in Benin.

This study, although relevant, remains restrictive and cannot be extrapolated to the national context, nor even to the department where the inefficient evolution of production cannot be explained by the sole variable "financing", although Dassa-Zoumé is the administrative capital of the said department. It is therefore necessary to deepen this analysis by using other variables likely to explain the behavior of soybean cultivation in this department, in a global way.

Prior to these studies on the Collines department, a scientific article produced by Adimi and *al.* (2016) on the analysis of factors limiting soybean production by surveys of 123 producers in the commune of N'Dali identified the variables: lack of credit, low level of education of producers, low involvement of women, the lack of subsidies for agricultural inputs, the late onset of the rains and the lack of government support for the sector, as determining factors in explaining the low or lack of economic profitability in the production of this crop. Having scrutinized all the cultural practices in vogue in this locality, the study revealed that the characteristics of soybean-based cropping systems are essentially based on: corn-soybean rotation, soybean-cotton rotation and the very low use of mineral and organic fertilizers.

In the same perspective, but different: from the scope of experimentation which concerns in this case, three departments of Benin and indicators of profitability, summing up to agricultural income and profit, Kpenavoun Chogou and *al.* (2018) have shown that soybean production, although with a fairly low average yield, is still profitable. The originality of this study is that it categorized soybean producers into three distinct groups, based on their levels of technical efficiency.

All in all, therefore, while several studies have indicated farmers' enthusiasm for producing soybeans in their production systems, few published studies have focused on analyzing the economic profitability of soybean production by integrating all the resources invested in production as is the case with this study.

At the end of this review, it can be seen that the analysis of the economic profitability of agricultural products has been the subject of a multitude of studies, especially in Benin where it is based on methodological approaches as diverse as they are varied. To this end, even if its formalization differs according to the authors and the various economic, commercial and financial aspects discussed (Kar- Any and Zineddine, 2011), it must be recognized that its importance is of capital importance in a liberal economy (Lukuitshi-lua Nkombe, 2005) in the image of the Beninese economy. Therefore, the present research attempts to apply it to soybean cultivation, by adopting the *direct costing method*; an approach that goes beyond simple calculations of indicators, to determine the producer in his decision and his ability to act. As can be seen, through this review, this method (*direct costing*) remains a fairly rare practice in the evaluation of the profitability of agricultural activities in Benin. However, it has the advantage of being a decision-making tool, in the sense that it provides information on the minimum level of activity necessary to achieve the result objective, dear to any producer. It then allows a more refined analysis, with the calculation of intermediate financial aggregates, subject to interpretation. Very pragmatic, it can be defined as a technique for accounting for production costs which consists in determining in a relatively simple way the result of an activity by distinguishing between variable and fixed costs. The resulting margin on variable costs (i.e. the difference between the amount of the products sold or stored and the variable costs attributable to these products) must be sufficient to cover all the fixed costs and thus result in profitability of the activity. This method would provide an analytical framework that would inform us about the minimum level of activity that ensures profitability for each category of soybean producers in the Collines department.

3. Methodological Framework of the Study

3.1 Data Collection

To collect the data necessary for this study on the economic profitability of soybeans in the Collines department in Benin, we used several methods, including surveys, interviews and field observations. We started by conducting surveys with the three groups of soybean farmers we identified in the region (see more detailed explanation below). The surveys were conducted using a structured questionnaire that aimed to collect information on producers' production practices, production costs, revenues and profit margins. We used a stratified random sampling method to select 40 representative soybean farmers from each group. In addition to the surveys, we collected data at the "Direction Départementale de l'Agriculture, de l'Elevage et de la Pêche" (DDAEP) des Collines, conducted individual interviews with agricultural experts to obtain more detailed information on the costs production and farming practices. We also conducted field observations to assess production practices and to collect data on production conditions, such as soil quality, weather conditions, and cultivation techniques used by growers.

In addition, as indicated above, within the framework of this study, our field observations enabled us to identify and categorize three representative groups of producers in the Collines department. However, unlike Kpenonvoun and al. (2018) who grouped them on the basis of their levels of technical efficiency, these groups were identified according to the area sown and the degree of mechanization of the operation, thus to take into account the realities of the field and the context departmental. These groups are as follows.

- Small soy producers (PPS): these are farmers who grow soy on small plots of land, often less than 2 hectares. They generally use traditional cultivation methods and often work as a family. These producers are often family farmers who grow soybeans as a subsistence crop to feed their families and sell the surplus in local markets. They usually have little formal training in agriculture, but gain their experience of growing soybeans by doing. Their harvests are sold on local markets or to traders who buy them to process them or resell them on national or international markets.

- Medium soybean producers (MPS): these are farmers who grow soybeans on medium-sized farms, generally between 2 and 5 hectares. They often have formal agricultural training and use modern production techniques to maximize their yield and profitability. Therefore, the use of agricultural machinery, irrigation techniques and chemical fertilizers is part of their professional practice. These producers sell their crops on national or regional markets.

- Large soybean producers (GPS): these are agro-industrial companies that grow soybeans on large farms, with areas often greater than 5 hectares. These producers are often in partnership with agro-industrial companies and export their production to neighboring countries such as Togo and Nigeria. They have a high level of agricultural training and use modern technologies to maximize their production and profitability. They use modern cultivation methods and often have access to advanced technologies and external financing in order to maximize their yield. As described above, these producers sell their harvest on regional or international markets, and are often involved in the large-scale processing or marketing of soybeans as finished products.

3.2 Break-even Calculation Method

By formal definition, the equations for turnover (CA), variable cost (CV) and total cost of production are stated as follows:

$$CA = pX \tag{1}$$

$$CV = cX \tag{2}$$

$$CT = cX + CF \tag{3}$$

With, X the quantity produced and sold; p, the unit selling price; c, the unit variable cost; CF, fixed cost.

Variable expenses are expenses that vary proportionally with the level of activity, ie according to its turnover. While fixed loads are those that do not vary (at least not before crossing a certain limit) regardless of the level of activity.

On this basis, the margin on variable cost (M/CV) and result (R) equations are written:

$$M/CV = pX - cX = (-c) \tag{4}$$

$$R = M/CV - CF = (-c) - C\,F \tag{5}$$

The break-even point therefore corresponding to the turnover for which a company realizes neither a loss nor a profit (i.e. when its result is nil), it is therefore necessary that it covers the all the company's fixed and variable costs. Hence the following equation:

$$Realized\ turnover\ (break-even\ point) = Variable\ expenses + fixed\ expenses \quad (6)$$

A method for calculating the break-even point can still look like this.

$$Break\ even = \frac{Fixed\ costs\ X\ Turnover}{Margin\ on\ variable\ cost} \quad (7)$$

In addition, the notion of economic profitability thus conceptualized and formalized from quantitative variables can be improved and reinforced. It all depends on the strategies implemented by the various actors. As can be seen below, this process may result from certain factors, the combination of which contributes to strengthening and consolidating the structure of production.

3.3 Specification of a Function for Improving the Economic Profitability of Soybeans

While the use of a statistical analysis model fundamentally depends on the phenomenon studied, its application is above all based on the nature and structure of the data present. In other words, the validity of the results will depend on the compatibility of the model with the available data. In the present case, it is for us to identify the factors related to the situations in which the economic profitability of soy is improved.

The explained or dependent variable represents the "chance" that the economic profitability of soybeans will be improved, and which can only take two forms. This dependent qualitative variable thus defined is a dichotomous variable. Hence the use of logistic regression. Computer processing under SPSS will make it possible to estimate the parameters of the Logit model by the maximum likelihood method, to detect the relationships that exist between the dependent variable (the possibility that the economic profitability of soybeans will be improved) and the independent variables (qualitative characteristics production, etc.). STATA software version 9 helped us. Indeed, for the elaboration of an explanatory model of the improvement of the economic profitability of soybean production in the department of Collines in Benin, we needed to have information from internal working documents and our basic sample (120 producers, drawn at random) divided between improvable and non-improvable economic profitability.

That said, the dependent variable is the qualitative variable "the economic profitability of soybeans is improved", denoted, Y and coded as follows:

Y = 1, if the economic profitability of soy is improved

Y = 0, otherwise

In addition, it should be remembered, this function has qualitative variables as arguments. These (variables) do not establish economic profitability, but contribute to its reinforcement. They participate in its improvement and strengthening with a view to maximizing the producer's profit. Among other variables, our observations and the results of field surveys allow us to retain the following factors:

- **Producer sex (SP)**: generally, among female producers, agriculture is not the only lucrative activity that concentrates their energy. They are often shared between several jobs so that they cannot make agricultural production their main activity (Dognon, 2021). This behavior would be likely to affect their performance, improving the profitability of their soybean production;

- **Age of producer (AP):** the question we are trying to answer here is whether the improvement in economic profitability is influenced by the age of the producer. It is estimated that the more advanced the age, the more the producer acquires experience and implements good cultural practices to increase the profitability of his activity;

- **Education level (NE)**: the influence of years of education on the improvement of agricultural profitability has been mentioned in several studies (Welch, 1970; Houénínvo, 1993). Is this variable relevant in the present case? This is what justifies its inclusion in the context of this study;

- **Feeder roads (RP)**: their condition remains decisive in the increase in production and consequently in the development of its economic profitability (Millner and *al.*, 2000). The poor state of the rural roads negatively affects agricultural yields;

- **Economic situation (EC)**: this term brings together economic policies, government reforms and trade shocks that are likely to influence the evolution of the economic profitability of production. They are favorable when they have a positive impact on economic profitability, and they are unfavorable when they cause the latter to be negatively affected;

- **External financing (EF)**: the underlying idea is to see whether or not having external financing has an influence on improving the economic profitability of production, especially since in the economic literature, the importance credit as a factor of growth is variously appreciated (Bernanke, 1993 ; Gertler and Gilchrist, 1994) and that in this study area, the interest rate seems relatively prohibitive (Sossou, 2020);

- **Climatic and meteorological conditions (CM)**: having as fundamental variables time, temperature, rainfall, seasons, etc., they can be favorable (A ïfa, 2021) or unfavorable to improving the economic profitability of production;

- **Soil quality (QS)**: the Collines department is a very mountainous area. This poses the problem of land occupation. Under these conditions, one wonders if the evolution of the economic profitability of soya is not influenced by the texture of the soil. This is what leads us to include this variable in the expression of the improvement in economic profitability.

The data relating to these variables were collected by using DDAEP documents and by survey, on scales with two positions (0 = no and 1 = yes) or with five positions (from 1 = Bad to 5 = Excellent) (see Appendix). As a reminder, they are then processed and analyzed using binary logit logit regression using SPSS software.

Indeed, this regression is adopted when the dependent variable (Y) is dichotomous, as is the case in this research.

$$Y = \begin{cases} 1, if\ the\ economic\ profitability\ of\ soy\ is\ improved \\ 0, else \end{cases} \quad (8)$$

Y follows a Bernoulli law with parameter $p = \frac{e^X}{1+e^X} = \frac{e^{b_0+b_1x_1+b_2x_2+\cdots+b_jx_j}}{1+e^{b_0+b_1x_1+b_2x_2+\cdots+b_jx_j}}$ (9)

The logistic regression makes it possible to explain the probability p so that the economic profitability of soybean is improved.

The logit of p is: $logit(p) = ln\left(\frac{p}{1-p}\right) = b_0 + b_1x_1 + b_2x_2 + \cdots + b_jx_j$ (10)

$$= b_0 + b_1SP + b_2AP + b_3NE + b_4PR + b_5CE + b_6FE + b_7CM + b_8QS \quad (11)$$

As a reminder, above are the exogenous variables, likely determinants of the situation of the improvement of the economic profitability or not of soybean production. Each of these variables includes appropriate modalities (see appendix), which will in turn be translated by the items of the questions presented.

4. Empirical Framework of the Study

4.1 Analyzing and Summarizing the Information Collected

On the basis of documentary research and the survey carried out in the field, we obtained information which we summarize as follows.

- The yield per hectare of soybeans in the department varying between 1500 kg and 2000 kg, we retained an average of 1750 kg per hectare.
- The seeds are 30 kg on average per hectare and cost 300 F per kg. Depending on the length of the cycle, it is necessary to sow between June 15 and July 30 at the latest.
- Simple herbicides account for an average of 3 liters per hectare, at 4,000 F per litre, while post-selective herbicides account for 2 liters, at 6,500 F per litre. .
- The fertilizers used are NPK, for 3 bags (of 50 kg) per hectare, at 14,000 F per bag, and urea, for 1 bag (of 50 kg) per hectare, at 14,000 F per bag.
- The cost of transporting soybeans from the farm to the self-generated markets is estimated at 5000F per ton produced, or 5F per kg of soybeans.
- As with cotton (A ïfa, 2022), the cost of supplying labor (MO) is 500 F (breakfast: porridge accompanied by donuts for 100 F; lunch: main course such as dough corn, at 300 F; water to drink, at 50 F and snack: gari, for 50 F) per man-day.
- The selling price of soybeans or the purchase price to the producer is estimated at an average of 275 F.

4.2 Break-even Point Calculation

4.2.1 Inventory of Production Costs

The total cost of production (CT) is broken down into variable cost (CV) and fixed cost (CF). The variable cost is made up of the cost of inputs, the cost of farming operations and the cost of transport and food costs; while the fixed cost (CF) mainly concerns the depreciation and maintenance costs of materials and equipment acquired for production.

- **Purchase costs of soybean inputs**

Inputs that go into the production of soybeans include seeds, herbicides and fertilizers.

The data collected at the DDAEP Collines, cross-checked with those obtained in the field, are recorded in the following table.

Table 1. Evaluation of the purchase cost of inputs (F)

Wording	**Quantity**	**Unit cost**	**Amount**
Seeds	30	300	9,000
single herbicide	3	3,500	10,500
Post-selective herbicide	2	6,500	13,000
NPK fertilizer	3	14,000	42,000
urea fertilizer	1	14,000	14,000
Subtotal			**88,500**

Source: Field survey, 2023

- **Cost of cultural operations**

Costs relating to cultural operations in soybean production cannot be omitted from the calculation of production costs: these include, among other things, costs of clearing, ploughing, sowing, thinning, weeding, spreading, harvesting, etc. For the first group of producers, let us remember that the cultivation operations are purely manual. The plowing is done by the dabe, and the weeding, the hoe.

With regard to the remuneration of the workforce, the field survey data revealed to us that over the past five years, a man-day has been paid on average at 1,500 F. This information is in good agreement with the work of Dossa and *al.* (2018), who report that the amount of labor needed to produce one hectare is 42.73 man-days.

To summarize, labor is involved in the activities of: clearing, ploughing, sowing, thinning, weeding, weeding, spreading, harvesting, etc.; occupies an average of 42.73 man-days per hectare and valued at 1,500 F per man-day. Which is equivalent to: 64,095 F per hectare.

With regard to plowing, the process differs between groups, given the type of equipment used. Indeed, as a reminder, the PPS uses manual tools, the MPS practices animal traction and the GPS uses the tractor.

- **Transport loads and food loads**

These charges include the various workers' food costs and the cost of transportation. They are summarized in the following table, taking into account the assumptions made above.

Table 2. Evaluation of transport loads and food loads (F)

Wording	Quantity	Unit cost	Amount
Feed	42.73	500	21,365
Transportation	1,750	5	8,750

Source: Field survey, 2023

- **Fixed production costs**

As a reminder, the fixed costs of soybean production are charges that do not vary according to the volume of activity or the area sown. Indeed, the production of soybeans requires the use of essential tools including the hoe, the daba, the cutter, the processing device, animal traction, motorized equipment... The fixed costs here are the costs depreciation and maintenance of these materials and production equipment. Depreciation costs relate to capital expenditure and are determined by applying a linear depreciation rate to the total acquisition value of the equipment.

4.2.2 Calculation of Break-even Points

In accordance with the *direct costing method*, this part of the work is essentially quantified and comes under a numerical application of reality. This means that the results to be analyzed are obtained from calculations. These calculations are based on facts observed on the ground.

Table 3. Evaluation of the purchase cost of inputs (F)

Wording	Quantity	Unit cost	Amount
seeds	30	300	9,000
single herbicide	3	3,500	10,500
Post-selective herbicide	2	6,500	13,000
NPK fertilizer	3	14,000	42,000
urea fertilizer	1	14,000	14,000
Workforce	42.73	1,500	64,095
Feed	42.73	500	21,365
Transportation	1,750	5	8,750
Subtotal			**182,710**

Source: Field survey, 2023

In total, therefore, the variable costs are evaluated at 182,710 F for one hectare or 1,750 kg of soybeans. Consequently, for 1 kg of soy produced, the unit variable cost is estimated at 104.406 F

Referring to the work of Gibigaye (2013) on the calculation of profitability according to the degree of mechanization and considering that the acquisition price of material goods is often not influenced by the economic situation, the fixed cost table is presented as follows.

Table 4. Fixed cost according to the degree of mechanization (F)

Labels	**Manual cultivation (PPS)**	**Animal traction (MPS)**	**Motorized cultivation (GPS)**
Depreciations	15,000	327,880	1,978,378
Interview	5,000	100,000	549 576
Total fixed cost	**20,000**	**427,880**	**2,536,954**

Source: Gibigaye (2013)

The total cost equations of the groups are then stated as follows:

$$\text{PPS: } Y_p = 104.406\,X + 20{,}000 \quad (12)$$

$$\text{GME: } Y_m = 104.406\,X + 427{,}880 \quad (13)$$

$$\text{GGE: } Yg = {}_{104.406X} + 2{,}536{,}954 \quad (14)$$

Considering the sale price per kg of soybeans set at 270 F, the break-even points are established as follows.

Table 5. Calculation of break-even points

Wording	PPP	MPS	GPS
Turnover	270X	270X	270X
Variable cost	104.406X	104.406X	104.406X
Margin on variable cost	165.594X	165.594X	165.594X
Fixed price	20,000	427,880	2,536,954
Result	165.594X – 20,000	165.594X – 427,880	165.594X – 2,536,954
Value break-even point (F)	(20,000 * 270X)/165.594X= 32,609.877	(427,880 * 270X)/165.594X= 697,655.712	(2,536,954 * 270X)/165.594X = 4,136,487.912
Volume break-even point (kg)	120,777	2583.910	15,320.325
Break-even point in area (ha or m²)	0.0690 ha = 690 m²	1.4765 ha = 14,765 m²	8.7544 ha = 87,544 m²

Source: our calculations

4.3 Explanatory Factors for the Improvement in the Economic Profitability of Soybeans

Logit explanatory model of the improvement in the economic profitability of soybean production in the Collines department in Benin are as follows in the table below,

Table 6. Equation of the improvement in the economic profitability of soybeans (logit estimate)

Dependent variable	Logit : Improving the economic profitability of soybeans (ARES)				
independent variables	B-parameters	ES	Wald	Sig F [1]	observation
SP (Producer gender)	-0.311	0.076	2009	0.210	Not significant
AP (Age of producer)	1,836	1,002	3,148	0.160	Not significant
NE (Level of studies)	2009	1,123	2,209	0.631	Not significant
PR (state of rural roads)	1,826	1,431	0.704	**0.013**	**Significant**
EC (Economic situation)	5,023	2,411	5,372	**0.020**	**Significant**
EF (External financing)	-1.032	1,722	2,998	0.265	Not significant
CM (Climate and weather conditions)	2,103	1,199	2,698	**0.095**	**Significant**
QS (Soil Quality)	-3.031	1.006	2,902	0.502	Not significant
Constant	-3.002	4,001	0.549	0.510	
"-2Log likelihood"				**22,217**	
KHI [2] / Sig KHI [2]				**98.821/ 0.000**	
Cases correctly classified/ N				**90.20/100**	

1 Probability that the coefficient is equal to zero; wald statistics with Logit.

The equation for improving the economic profitability of soybeans (RES) is written:

$$LogARES = -3{,}002 - 0{,}311SP + 1{,}836AP + 2{,}009NE + 1{,}826PR$$
$$+5{,}023CE - 1{,}032FE + 2{,}103CM - 3{,}031QS \quad (15)$$

5. Discussions and Interpretation of Results

5.1 Soybean Profitability Analysis

The calculations from Table 5 show us that for each group, a break-even point is identified from which the producer can expect a profit. Indeed, for the PPS group, the break-even point (in area) is 0.069 ha.; for the MPS group it is 1.4765 ha while for the GPS its value is 8.7544 ha. It follows that any producer belonging to each of these groups must cultivate an area beyond the corresponding threshold before hoping to make his activity profitable.

In addition, when we look at the margin on variable cost relating to this soybean production activity in the Collines department, we see that it is positive and takes a value corresponding to 165.594 X (X being the quantity of soybeans produced). This proves to us that beyond the fixed costs, the production of soybeans in the Collines department generates value for all categories of production. We therefore retain that beyond structural costs, soybean production is a profitable activity regardless of the area sown. We deduce that the difference in results observed by group of producers is due to the format or structure given to the production. Inspired by a decision of objective, this structure which becomes a constraint, is a choice made by the producer to maximize his profit. Thus, for a return to scale, it is suggested to each producer to maximize, as much as possible, his production up to the upper limit of his group to

which he belongs. This will allow him to cover in an optimal and rational way the fixed charges whose amounts remain constant whatever the level of production so to generate a substantial profit.

5.2 Analysis of the Explanatory Factors for the Improvement in Soybean Profitability

From the observation of table 6, we see that only three (03) variables out of the eight (08) identified are significant. These are, in order of explanatory magnitude of the variables: economic situation (EC), climatic and meteorological conditions (CM) and condition of rural roads (PR). We can therefore conclude, based on these results (generated in Table 6) that the economic profitability of soybeans in the Collines department in Benin is a positive function of:

- the economic situation which is likely to shape and condition the reaction of producers on the market. Indeed, the economic situation is affected by economic policies, reforms, shocks (positive or negative), constraints, major trends, bottlenecks ... which emit signals through which the reactions of the various market players change. These, in turn, influence the expected improvement in economic profitability per producer. If the economic situation is favorable, the producer comes out with good profitability. Otherwise, it is negatively affected and has an impact on production. It is undoubtedly these sorts of distortions which have caused or marked the poor performance of soybean production in this department, which was a pioneer at the start;
- climatic and meteorological conditions that are not the rest. Soy is a crop that needs both water and sun for good yield and therefore good economic profitability for the producer. Climate and meteorology therefore influence the economic profitability of soybeans. Therefore, the cultivation of soy has specificities that should be known to obtain good yields. Indeed, the minimum temperature for soybeans to grow is 10 ℃ and the maximum temperature is 22 ℃, with a maximum of around 40 ℃. The germs give well when the temperature varies between 15 and 40 ℃, with an optimum temperature around 30 ℃ (Nieuwenhuis and Nieuwelink , 2005);
- rural roads, the existence and maintenance of which promote the behavior of producers in the face of agricultural supply. Indeed, if we start from the principle that farmers have free access to the market, inequalities in road density to the detriment of certain areas with appreciable potential would favor a process of adverse selection (Cabral, 1997). As Akerlof (1970) pointed out, the increase in transaction costs (transport, information, etc.) has the effect of eliminating small producers from the market, so as to create the disappearance of certain products. Large farmers able to bear higher transaction costs represent only a tiny part of producers, the resulting situation is the weak response of supply and arbitration in the allocation of cultivated areas. This is undoubtedly the case of soybean cultivation in the Collines department where rural tracks seem to play a decisive role in the economic profitability of producers.

The variables: sex (SP), age (AP) and level (NP) linked to the person of the producer are not significant. Neither are the factors: external financing (EF) and soil quality (QS). Indeed, these variables have no influence on the improvement of the economic profitability of soybean production in the Collines department. With regard specifically to the quality of the soil, this reaction of non-significance is perfectly justified given the more or less homogeneous character of the land in this department.

As an implication of economic policies, it is advisable, so that the profitability of soybean production is more improved and more growing, that the public authorities restrict themselves to their partition of "police State", able to allow the market to fully play its regulatory role, with a view to a satisfactory allocation of the resources due to various actors. They must also, by virtue of their sovereign attribution, contribute to the maintenance of rural roads, vectors of the connection of agricultural farms to the market. In addition, to deal with climatic and meteorological conditions, strategies must be developed.

6. Conclusion

Agriculture is a key sector for Benin's economy. In the Collines department (in Benin), soy is grown by a large number of producers and, as such, contributes significantly to the economic growth of the region. Indeed, soybean cultivation is an important agricultural activity that encompasses three groups of producers with different areas, and its economic evaluation is essential to determine the producers. The economic profitability of soybean cultivation is therefore a topic of interest to farmers, researchers and government officials. To this end, in order to assess this economic profitability, the *direct costing* method was adopted within the framework of this study. This is an approach that calculates the economic profitability of growing soybeans taking into account the variable and fixed costs associated with production. This method, which made it possible to analyze the economic profitability of soybean production in the Collines department, tells us that, relative to each of the producer groups, this activity is

profitable to varying degrees or thresholds. Therefore we asked ourselves: "how to improve the economic profitability of soybean cultivation in the Collines department in Benin in consideration of the qualitative factors that seem to influence it?". This led us to specify an economic profitability function on the basis of a logit model. This allowed us to observe that the factors: economic situation, climatic and meteorological conditions and rural roads favor this economic profitability. To this end, the State should remain in its arbitration role to regulate the market without intervening. Furthermore, strategies must also be developed to deal with climatic challenges, such as the irregularity of rainfall. This study contrasts with that of Yabi (2010) and Adimi and *al*., (2016) who show that gender, age and access to credit promote economic profitability. On the other hand, from the point of view of the issue of "economic profitability", the results of this study are in line with those of: Amedodji (2018), Kpenouvoun and *al*. (2018), Gomina (2019) and Dossou and *al*. (2019) who found that soybean cultivation is profitable in Benin. As such, it is desirable that future work on soybeans focus on the themes of comparing its economic profitability with other crops, as Thiombiano has already begun (2020). This could better determine the producers in their choices and decisions.

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APPENDICES

Appendix 1. Explanatory Variables, Types, Modalities and Expected Signs

Variable	Nature	Terms	Expected signs
Educational level	Qualitative	1 = Not educated 2 = Primary course 3 = Cycle 1 secondary course 4 = Cycle 2 secondary course 5 = At least Bac level	+
Sex	Qualitative	0 = Female 1 = Male	+
Age	Qualitative	1 = Less than 20 years old 2 = Between 20 and 25 years old 3 = Between 25 and 30 years old 4 = Between 30 and 35 years old 5 = Over 35	+
Climatic and weather conditions	Qualitative	1 = Bad 2 = Fair 3 = Good 4 = Very good 5 = Excellent	+
External funding	Qualitative	1 = yes 0 = no	+/-
Economic conditions	Qualitative	1 = Bad 2 = Fair 3 = Good 4 = Very good 5 = Excellent	+
Condition of rural tracks	Qualitative	1 = Bad 2 = Fair 3 = Good 4 = Very good 5 = Excellent	+
Soil quality	Qualitative	1 = Bad 2 = Fair 3 = Good 4 = Very good 5 = Excellent	+

Appendix 2. Administrative Map of the Collines Department in Benin