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Economic performance determinants of farms in the context of health and climate change in rural district of kourthèye in Niger

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ABSTRACT: It's in a context of climate change and health that this research aims to identify the determinants of the economic performance of farms in the rural municipality of Kourthèye (Niger) on a sample of 250 producers. By adopting a parametric approach, the levels of economic efficiency were estimated and decomposed into allocative and technical efficiency from a stochastic production frontier (Cobb-Douglas-type); and the correlation test to study the link between economic performance indicators and those of health. The farm was broken down into irrigated and dry crops. Empirical results show that there's an efficiency differential between them. For irrigated crops, the average allocative efficiency indices are 0.35 and 0.26 for dry crops. With regard to the economic efficiency, it's 0.17 and 0.10 respectively, reflecting the weak economic performance of farms. The examination of the economic performance determinants shows that Household size, Off-farm income, Experience in agriculture, Access to informal credit, training of farmers, and Climate information play a positive and significant role in achieving of production frontier. However, all the health indicators taken into account have a negative and significant effect at 1% on the economic performance of these farms. Thus, a policy of the state, donors and NGOs, improving health status, other significant determinants, adoption of new modern technologies could certainly improve the overall level of economic performance of farms.

KEYWORDS: economic efficiency, determinants, stochastic production frontier, farms.

1 INTRODUCTION

Agriculture plays the most crucial role in feeding the world's population, and [1] plays a significant role in the economics of every country [2]. Unfortunately, for several decades, agricultural production, which remains dependent on climate, has not been able to meet increasingly growing demand [3]. According to the latest bulletin from the British Met Office, Europe, America, Africa, plus the northern areas, will suffers most from the increase in temperature in the coming years, and the projections, if confirmed, could seriously question the Earth's climate stability, making it ever more complicated to achieve the objectives present both in the Paris Agreement and in the 2030 Agenda. As for the next five years, the period 2020 2024, the global average temperature should fluctuate between 1.06 °C and 1.62 °C more than the average of the pre industrial period (1850 1900), with a probability slightly below 10% to temporarily exceed 1.5 °C: the limit that the IPCC scientific community in the "special report" of 2018 recommends not to exceed, in order to avoid the most serious impacts on people and ecosystems by the climate change [4]. In this context, poverty and hunger reduction are intertwined challenges and enduring issues in the world, particularly in developing countries [5]. Empirical studies suggest that most under developed and developing countries are still facing the problem of high poverty levels. Most farmers in these countries practice subsistence farming with low productivity [6]. The most important aspect of small family farms is to protect the rural environment against the socio-economic marginalization of rural territories and reducing the out-migration from the countryside as well [7].

With more than ¾ of desert territory, Niger can only be exploited for agriculture in its southern part [3] where a large section of the population depends on agriculture for its livelihood [8] (Abdul et al., 2020). Agriculture of the country areas has been characterized by low productivity due to land degradation, low technological inputs, low soil fertility, weak institution linkage, lack of appropriate and effective agricultural policies and strategies [9,10]. While several efforts have been undertaken to raise their production and productivity so as to achieve food security, such efforts have had negative implications for the environment. The vicious cycle of poverty among these farmers has led to the unimpressive performance of the agricultural sector [11]. Efficiency, along with productivity and competitiveness, is one of the key characteristics in the analysis of farms. Efficiency studies are not, despite the importance of the concept as a tool for analyzing farm performance, abundant in agriculture sector [12] of Niger. These farmers need to be abreast with the knowledge of efficiency in agricultural production especially in the area of resource allocation that will help to bring about increased agricultural productivity [13]. Therefore, there is a need for empirical studies that analyse the relationship between inputs, outputs, and farm-specific characteristics and efficiency in the irrigated and dry crop. Only focused research of this nature can be the basis of policies that promote productivity and efficiency at the household level. The goal of this study, therefore, is to determine the economic performance determinants of farms in the context of healh and climate change in rural district of kourthèye in Niger; in oder to suggest a few high priority areas for the policy intervention designed to improve the efficiency of the agricultural production, and lead to substantial and sustainable increases in the income and decreases in the rural poverty in Niger. The research questions to be addressed are: i) what is the average level of technical, allocative and economic efficiency in rural district of kourthèye's farms? ii) Are there significant differences between healh and economic performance indicators these farms?

2 Conceptual Framework Of The Study

2.1 Economic Performance

Economic performance refers to the company's ability to achieve optimum profitability in a competitive environment. [14] and [15] underlines that the words economic performance and competitiveness are often associated, competitiveness being defined "as the capacity to face competition and to face it successfully" Company competitiveness or economic performance then translates "its ability to sell products that meet the demands of demand (in terms of price, quality and quantity), while generating profits allowing it to develop". The economic performance in terms of efficiency and effectiveness at the farm level can be measured by the accumulation of plot approaches. At the plot level and as at the farm level, the results indicators can be expressed in terms of gross margin, direct margin, net margin or added value. The gross margin is a result indicator determined by the difference between the product and the operating expenses used by arable crops [16].

2.1.1 Concept Of Efficiency

Efficiency was described by [17] as the extent to which time, effort, or cost is well managed for an intended task or purpose; it also refers to the success of producing a large amount of output as possible given a set of input [18].

It is defined also as the maximum of ratios of weighted outputs to weighted inputs subject to the condition that similar ratios for every decision-making unit (DMU) are less than or equal to unity [19]. The efficiency of each DMU then is relative to the output to input ratio of the most efficient farm. In general, there are two measurement methods of efficiency analysis, the parametric and non-parametric one. Parametric approaches provide a consistent framework to analyse efficiency [20]; however, a weakness of the parametric approaches is that the stated hypothesis can never be detected directly [21]. A non-parametric deterministic mathematical programming approach was developed by [22, which attributes all the deviations away from the frontier technology to inefficiency.

The stochastic frontier model is a regression model estimated by maximum likelihood with a non-normaland non-symmetric disturbance [23]. An example of a general stochastic frontier functionalformulation is $y_i = f(x_i, b) + v_i - u_i = f(x_i, b) + e_i$, where v_i represents the random error component and u_i is the technical inefficiency component. The random error term, v_i, is assumed to be independent and identically distributed (i.i.d), with half normal distribution, as well as independent from the term u_i. Therefore, the error term, $e_i = v_i - u_i$, is not symmetric as long as $u_i \geq 0$ [24].

2.1.2 The Concept Of Technical Efficiency

Technical efficiency refers to the ability of a farm to either produce the optimum level of outputs from the given bundle of inputs, or to produce the given level of outputs from the minimum amount of inputs for the given technology. It may help in exploring the potential benefits of promoting the most efficient of existing technologies in use by vegetable farmers. [25] to study the determinants of technical efficiency used the SFA methodology developed by [26. Stochastic frontier models allow for an analysis of technical inefficiency in the framework of production functions. The SFA method is based on an econometric (i.e. parametric) specification of a production frontier. Using a generalised production function and cross-sectional data, this method can be depicted as follows: $y_i=f(x\_i_j; \beta) * \exp(\varepsilon i)$

The concept of technical efficiency model can be also illustrated graphically using a simple example of a two input (x_1, x_2) - two output (y_1, y_2) production process (Figure 1). Efficiency can be considered in terms of the optimal combination of inputs to achieve a given level of output (an input orientation), or the optimal output that could be produced given a set of inputs (an output orientation).

In Figure 1 (a), the firm is producing a given level of output (y_1*, y_2*) using an input combination defined by point **A**. The same level of output could have been produced by radially contracting the use of both inputs back to point B, which lies on the isoquant associated with the minimum level of inputs required to produce (y_1*, y_2*) (i.e. Iso (y_1*, y_2*)). The inputoriented level of technical efficiency (TEI (y, x)) is defined by **0B/0A**.

However, the least-cost combination of inputs that produces (y_1*, y_2*) is given by point C (i.e. the point where the marginal rate of technical substitution is equal to the input price ratio w_2/w_1) [27].

The production possibility frontier for a given set of inputs is illustrated in Figure 1 (b) (i.e. an output-orientation). If the inputs employed by the firm were used efficiently, the output of the firm, producing at point **A**, can be expanded radially to point **B**. Hence, the output oriented measure of technical efficiency (TEO (y, x)); can be given by **0A/0B**. This is only equivalent to the input-oriented measure of technical efficiency under conditions of constant returns to scale. While point **B** is technically efficient, in the sense that it lies on the production possibility frontier, higher revenue could be achieved by producing at point **C** (the point where the marginal rate of transformation is equal to the price ratio p_2/p_1). In this case, more of y1 should be produced and less of y_2 in order to maximize revenue. To achieve the same level of revenue as at point **C** while maintaining the same input and output combination, output of the firm would need to be expanded to point **D**. [27].

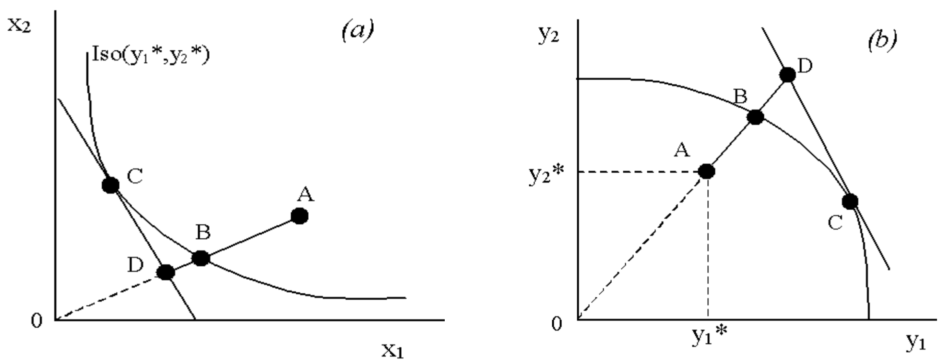


Fig. 1. Mesures d'efficacité axées sur les intrants (a) et les extrants (b)

3 RESEARCH METHODOLOGY

3.1 DATA

The study was conducted in rural municipality of Kourtheye in Niger in twelve (12) villages located in the area of the river valley.The size of the surveyed sample is 250 farmers. The following mathematical formulas were used to determine the final sample by following the following steps:

(I) Determination of the initial sample the size (TEI):

$$\mathrm{TEI} = \frac{z^2 * P\,(1-P)}{e^2} \;(1)$$

(II) Adjusting the sample size to account for the size of the farmers (TEA):

$$\mathrm{TEA} = \mathrm{TEI}\ N/\ (N+\mathrm{TEI})\ (2)$$

(III) Adjustment for the response rate, to determine the size of the final sample (TEF):

TEF=TEA/TR (3)

Where TEF = Sample size, z is the security on the representativeness of the population. A margin of error of 5% was used (z = 1.96); P is the homogeneity of the population, found from previous studies q = 1-p. A response rate (TR) of 90% has been used. This study concerned Irriguated and dry crops farmers and datas such as socio-economic characteristics of farmers (age, sex, educational level, marital status household size, income, access to informel credit, farming experience… etc), some health indicators, factors of institutional characteristics and Characteristics of farms were collected.

3.2 Theoretical And Analytical Method

In order to study the efficiency, there are two ways: a parametric or deterministic approach, which needs a specific function of production and other parametric variables, and a non-parametric model or the DEA (Data Envelopment Analysis) aimed at defining in function the distance from the frontier of an hypothetical function of production an index of technical inefficiency [28].The DEA is the most commonly applied technique in agricultural economics [26].The DEA is an excellent empirical model that compares a decision unit with an efficient frontier using the performance indicators [29]:

The most significant feature of the estimating specification in the original DEA model is that it may allow the weights of all considered variables to be allocated [30].

The overall economic efficiency score for the ith farm was computed as the ratio of the minimum cost to the observed cost and it is comparable to the economic efficiency score (Equation 3), where EE = 1 indictes economically The economic efficiency for a DMU can also be defined as the product of the technical and allocative efficiency [22].

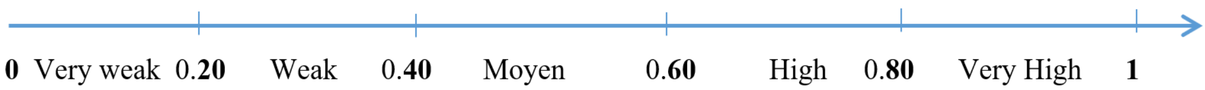
$$EE_i = \frac{W_i' X_i^*}{W_i' X_i} \quad (4)$$

The allocative efficiency index is the ability of a farm to choose its inputs in a cost minimizing way (Equation n°5).

$$AE_i = \frac{\frac{W_i' X_i^*}{W_i' X_i}}{\theta_i^{CRS}} = \frac{W_i' X_i^*}{W_i'.\theta_i^{CRS}.X_i} = \frac{X_i^*}{\theta_i^{CRS}.X_i} \quad (5)$$

where *AE* = 1 indicates that the farm is allocatively efficient, and *AE* < 1 indicates the maximum proportion of cost that the technically efficient farm could save by behaving in a cost minimizing way [20].

To assess these efficiencies the study was based on a scale from 0 to 100%. A farm with a performance score between 0 and 20 is considered economically very low, between 20 to 40 low, 40 to 60 medium, 60 to 80 high and 80 to 100% very high; as the following scale shows us:



[31] defined the technical efficiency of an individual farmer in terms of the ratio of the observed output to the corresponding frontier output given the available technology as the defined by:

$$TE = \frac{Y_i}{Y_{i^*}} = \frac{f(xi,\beta)\exp\ (Vi-Ui)}{f(xi,\beta)\exp\ (Vi)} = e^{(-Ui)} \quad (6)$$

Where: Yi is the observed output of irriguated or dry crop and Yi* is the frontier output which the farmer is expected to attain given his/her input level. The parameters of the stochastic frontier production function are estimated using the maximum likelihood method. This stochastic production frontier function is empirically defined by:

$$Log(Y) = \beta_0 + \sum_j^i \beta log.x + \ (u - v) \quad (7)$$

The variances of interest in this model are σ2 = σ2 v + σ2 u and α = σ2 u / σ2 = σ2 u / (σ2v + σ2 u). By definition the parameter α is between 0 and 1. A value of α = 1 indicates that the deviation of the frontier is entirely due to technical inefficiency, while a value α = 0 means that all the deviation of the frontier is due to random shocks. Thus, if 0 <α <1, the variation in production is characterized by the presence of both technical inefficiency and random shocks.

These formulas (EE, AE, TE) are used in this study to determine the level of the technical, allocative and economic efficiency of farms (devided into irriguated and dry crops) in the context of climate change.

In measuring economic performance indicators, the following scheme has been established and followed to take into account the economic profitability of farms.

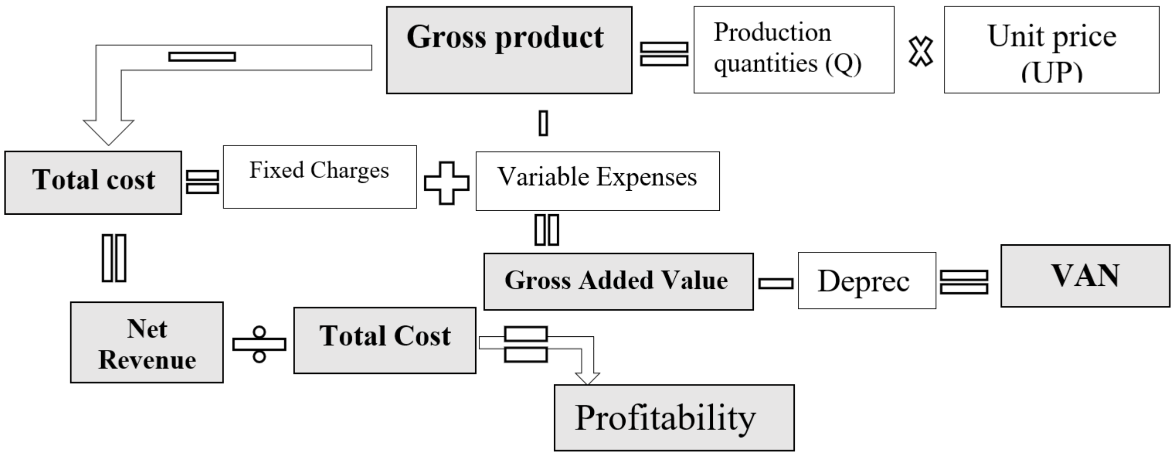


Diagram: Farm profitability calculation process

The Cobb-Douglas stochastic frontier production function was used to identify the technical and economic efficiency of farms in this study are given in the following equations:

$$\begin{aligned} Y_{TEi} = \beta_0 &+ \alpha_1\, Log_{X2} + \alpha_2\, Log_{X2} + \alpha_3\, Log_{X3} + \alpha_4\, Log_{X4} + \alpha_5\, Log_{X5} + \alpha_6\, Log_{X6} + \alpha_7\, Log_{X7} + \alpha_8\, Log_{X8} \\ &+ \alpha_9\, Log_{X9} + \alpha_{10}\, Log_{X10} + \alpha_{11} Log_{X11} + \alpha_{12}\, Log_{X12} + \alpha_{13}\, Log_{X13} + \alpha_{14}\, Log_{X14} + \alpha_{15}\, Log_{X15} \\ &+ \alpha_{16}\, Log_{X16} + \alpha_{17}\, Log_{X17} + \alpha_{18}\, Log_{X18} + \varepsilon\_T\, (u\_i + v\_j)) \end{aligned}$$

$$\begin{aligned} Y_{EEi} = \beta_0 &+ \alpha_1\, Log_{X2} + \alpha_2\, Log_{X2} + \alpha_3\, Log_{X3} + \alpha_4\, Log_{X4} + \alpha_5\, Log_{X5} + \alpha_6\, Log_{X6} + \alpha_7\, Log_{X7} + \alpha_8\, Log_{X8} \\ &+ \alpha_9\, Log_{X9} + \alpha_{10}\, Log_{X10} + \alpha_{11} Log_{X11} + \alpha_{12}\, Log_{X12} + \alpha_{13}\, Log_{X13} + \alpha_{14}\, Log_{X14} + \alpha_{15}\, Log_{X15} \\ &+ \alpha_{16}\, Log_{X16} + \alpha_{17}\, Log_{X17} + \alpha_{18}\, Log_{X18} + \varepsilon\_T\, (u\_i + v\_j)) \end{aligned}$$

With TE=Technical Efficiency, EE= Economic Efficiency X1=Household size, X2 =Age, X3=Off-farm income, X4=Membership of a Farmers' Organization, X5=Number of Years of Experience, X6=Number of people who fell ill, X7=Cost of patient care, X8=Average duration of disability, X9=Access to agricultural credit, X10=Ethatic grant, Trainig of farmers, X11=Climate information, X12=Adoption des nouvelles technologies, X13=Family Labor, X14=Number of cultivable fields, X15=Area, X16=Wage workforce, X17=agricultural equipment, X18=Intermediate consumption, X19=Animal availability and X20 =Economic result (Profitability) and i=Irriguated or Dry crop

4 RESULTS

4.1 CHARACTERISTICS OF VARIABLES INTRODUCED INTO THE MODEL

Table 1 describes the indicators for these factors. The average household size is 9±5 persons. The average age of farmers is 54.19 ± 13.36 years. The analysis of the table shows that 38.9% of farmers are affiliated to a Peasant Organization. In the context of climate variability, it was important to consider the inclusion of some health indicators in the model for analyzing the determinants of the economic performance of farm households. Also, the analysis of the table indicates that on average 6 person fall ill with an average cost of care of 9612 FCFA. In the case of agricultural activities, the result obtained on the health factor shows that on average 6 to 7 days are lost for a health problem. On the other hand, from an institutional point of view, most farmers (92.4%) have access in one way or another to information on climate variability. For farm characteristics, it should be noted that on average the cultivated area is 1,168 ± 0,87 ha for dry crops and 0,34 ± 0,16 ha for irrigated crops. The average daily wage of a workforce is estimated at 1838,02 ± 496,61 FCFA.

Table 1. Descriptive analysis of farm performance variables

Models Variables	Descriptive analysis		
	Modalities	**Mean or frequency**	**S.R**
Socio-economic characteristics of farmers			
Household size	Continue	9,9	3,9
Age	Continue	58	14,7
Off-farm income	Yes	31,4%	
	No	68,6%	
Number of years of experience	Continue	37,93	14,21
Membership of a Farmers' Organization	Yes	38,9%	
	No	61,1%	
Climate-health factors			
Mean number of people who fell ill	Continue	4	1,13
Mean cost of patient care	Continue	9612,	6177,56
Average duration of disability	Continue	18,8	14,4
Factors of institutional characteristics			
Access to agricultural credit	Yes (1)	16,7%	
	No (0)	83,3%	
Ethatic grant	Yes (1)	30,1%	
	No (0)	69,9%	
Trainig of farmers	Yes (1)	51,3%	
	No (0)	48,7%	
Climate information	Yes (1)	92,4%	
	No (0)	7,6%	
Characteristics of farms			
Family labor (mean number)	Continue	4,80	3,24
Number of cultivable fields (mean number)	Continue	2,47	1,22
Area (ha)	Dry crops farms (DCF)	1,168	0,87
	Irrigued crop farms (ICF)	0,34	0,16
Wage workforce per day (Fcfa)	Continue	1838,02	496,61
Animal availability	Yes (1)	80,3%	
	No (0)	19,7%	

4.2 Level Of Economic Performance Of Agricultural Holdings

The results shown in Table 2 show the average levels of technical, allocative and economic efficiency of irrigated and dry crops; and their distribution by classes of performance index. It was found that, in terms of technical efficiency, most irrigated farms have a performance index between 0.40 and 0.60. This shows a relatively average level of efficiency of the irrigated farms and suggests a great disparity between the farms that determine the border. Moreover, for dry crops, the majority (37.8%) have an index below 0.20: hence the low efficiency of these types of holdings. In terms of economic efficiency, most farms (75.6% for irrigated crops and 91.1% for dry crops) have a performance index below 0.20. For the case of the average allocatives efficiencies, they are respectively 0.35 and 0.26 for these same holdings. The minimum level of technical efficiency is 0,11 for irrigated farms and 0,05 for dry farms, while the maximum level is 1 for farms considered to be operating at optimum size and constant yields of scale.

Table 2. Distribution of Farm Economic Performance Indices

Economic Performance Index Class	Appreciation	Technical efficiency		Allocative efficiency		Economic efficiency	
		ICF	DCF	ICF	DCF	ICF	DCF
[0 - 0.20 [	Very weak	5,0%	37,8%	26,1%	62,8%	75,6%	91,1%
[0.20 – 0.40 [	Weak	36,1%	25,0%	35,6%	18,9%	19,4%	7,2%
[0.40 – 0.60 [	Medium	52,2%	30,6%	27,2%	15,6%	2,8%	1,1%
[0.60 - 0.80 [	High	5,6%	2,2%	7,8%	2,2%	1,1%	0,0%
[0.80 – 1.00]	Very high	1,1%	4,4%	3,3%	0,6%	1,1%	,6%
Minimum		0,11	0,05	0,01	0,13	0,00	0,01
Mean		0,41	0,33	0,35	0,26	0,17	0,10
Maximum		1,00	1,00	1,00	1,00	0,71	1,00

4.3 Determinants Of The Technical And Economic Efficiency Of Farms

4.3.1 Case Of Irrigated Crop Farms (ICF)

The gamma (γ), assessment, significantly different from zero, indicates the existence of 57% productive inefficiencies and deviation from the border. This result means that the gap between observed and potential output of the sectors studied is partly due to their inefficiency. Thus, 43% of the differences between observed and potential output of sectors are related to random effects including measurement errors, which may be due to the nature of the data, which are sector-wide averages.

The result of Table 3 shows that variables such as age and agricultural experience are positively related to technical and economic efficiency in a significant way ($p<0.001$). Indeed, older farmers are technically efficient because of their high level of knowledge of the situations experienced in relation to the less elderly, allowing them to develop different strategies to deal with climate shocks on the farm. Training has played a very significant role in the positive improvement of the level of technical efficiency to a threshold of 1% and 5% for economic efficiency. Farmers who receive training may be more efficient than those who do not. The plausible reasons for a positive correlation could be explained by the acquisition of certain skills, access to information and good planning of agricultural activities according to the climate context. Consideration of key health indicators has been of paramount importance in the context of climate variability. The results of the table indicate that all the health indicators considered showed a significant negative effect on both technical and economic efficiencies: the number of people who fell ill (-.070), cost of patient care (-.136) and average duration of disability (-.046) at the 5% threshold for technical efficiencies and (-0.061), (-0.190) and (-0.034) for economic efficiencies at the 1% threshold, respectively. The greater impact on economic efficiency can be explained by the high cost of care. At the level of Factors of institutional characteristics, the results showed that trainig of farmers and climate information positively improves technical efficiency in reaching the production boundary. Variables such as access to informal agricultural credit, ethatic grant are negatively correlated with economic efficiency. For economic efficiencies, only variables such as climate information and ethatic grant are significant. This could be explained by the fact that for these crops some intermediate consumption is subsidized and managed by the state. As regards the characteristics of irrigated farms, it is noted that the variables wage workforce, agricultural equipment, intermediate consumption, family labor and economic result (profitability) have a positive and significant effect with both efficiencies at a threshold of 1%. this may be due to the fact that irrigated crops, in this case rice farming is more practiced (twice a year) and marketed. They also contribute to improving the living conditions of farmers by increasing their income. There is also a negative link between the size of the area exploited and the efficiencies.

Table 3. Determinants of the technical and economic efficiency of ICF

Independantes variables	Technical efficiency			Economic efficiency		
	Coef.	Std. Err.	P>t	Coef.	Std. Err.	P>t
Socio-economic characteristics of farmers						
Household size	.024**	.118	.050	.022**	.005	.040
Age	.014***	.492	.000	.010***	.021	.000
Off-farm income	.197**	.187	.049	.004***	.008	.000
Membership of a Farmers' Organization	.064	.246	.220	.028	.011	.325
Number of Years of Experience	.142***	.764	.000	.012***	.033	.000
Climate-health factors						
Number of people who fell ill	-.070**	.254	.051	-.061***	.001	.000
Cost of patient care	-.136**	.030	.030	-.190***	.004	.000
Average duration of disability	-.046**	.119	.039	-.034***	.009	.000
Factors of institutional characteristics						
Access to informal agricultural credit	-.048***	1.759	.001	.138	.017	.452
Ethatic grant	-.076***	.473	.000	.036***	.005	.001
Trainig of farmers	.126***	.393	.000	.027	.004	.120
Climate information	.066***	.889	.000	.064**	.009	.023
Characteristics of farms						
Family Labor	.025***	.063	.000	.048***	.007	.002
Number of cultivable fields	-.063	.168	,344	.150	.021	.290
Area	-.062*	.018	,070	-.077*	.008	.080
Wage workforce	.661***	.619	.000	-.120***	.005	.000
agricultural equipment	.076***	.076	.000	.097***	.021	.000
Intermediate consumption	.058***	.050	.000	-.037***	.008	.000
Animal availability	.041**	.090	,030	.069**	.034	.041
Economic result (Profitability)	.064***	.017	,000	.030***	.041	.001
Sigma2 σ2	0.36	0,83	-	0. 23	0.80	-
gammaγ	0.57	0.15	0.000	0.50	0.12	0.00
Log likelihood function	163.275 (0.000), N=250					

**** = significatif à 1%, ** = significatif à 5%, * = significatif à 10%.*

4.3.2 CASE OF DRY CROP FARMS (DCF)

The parameters of the model of the indicators of the economic performance determinants of DCF meet the basic conditions required. Gamma = 0.69 provides information on the presence of inefficiency and allows to say that 69% of variations in input costs are due to the economic inefficiency of producers and that 31% of this variability is due to random factors as well as measurement errors. The analysis of the determinants of technical and economic efficiency in a climate change context shows that variables such as Household size have a significant and positive effect on the economic efficiency of DCF and not a significant effect on technical efficiency. In fact, with climate change, as a result of soil poverty, most of the labor force is moving out of the country and financing part of the agricultural activities. The Number of Years of Experience and age positively improve both efficiencies at the 1% threshold. This could be explained by the fact that these two variables are part of the determinants of perception and adaptation to the effects of climate change. As a result, the older the farmer becomes, the more experience he accumulates and the number of years of farming experience increases the efficiency of family farms. Off-farm income and Membership of a Farmers' Organization are significant at the 5% threshold in terms of technical efficiency. The results of this table show that there is a negative link between levels of techno-economic efficiency and health indicators. The Number of people who fell ill, Cost of patient care and Average duration of disability are significant at the 5% threshold with technical efficiency and 1% with economic efficiency. In terms of institutional factors, the results show a positive and significant sign of access to informal credit, trainings of farmers, climate information and Ethatic grant in terms of technical efficiency at a 5% threshold and then negative and not significant in terms of economic efficiency for the informal credit and government subsidies variables. There is also a negative link in terms of government subsidies and economic efficiency. This could be explained by the fact that, in most cases, additional state aid is scarce or late for farmers; This delays cultivation activities at times in this climate change context, where rains are irregular and poorly distributed in space but also in time. Climate information has a positive and significant impact (1%) on economic efficiency. The results suggest that, family labor, number of cultivable fields, area, and wage workforce have a positive and significant effect on economic efficiency levels at the 1% threshold. The results show that the agricultural equipment coefficient plays a positive and significant role in economic efficiency at 5%. Economic result (Profitability), although improving the level of technical and economic efficiency of farms, is not statistically significant as this type of crop is more used to support households' food needs.

Table 4. Determinants of the technical and economic efficiency of DCF

Independantes variables	**Technical efficiency**			**Economic efficiency**		
	Coef.	**Std. Err.**	**P>t**	**Coef.**	**Std. Err.**	**P>t**
Socio-economic characteristics of farmers						
Household size	.114	.059	.541	.030***	.005	,000
Age	.043***	.046	.000	.056***	.021	,004
Off-farm income	.293**	.398	.032	.085***	.008	,000
Membership of a Farmers' Organization	.012**	1.231	.020	.060	.011	,320
Number of Years of Experience	.031***	.822	.000	.179***	.033	.001
Climate-health factors						
Number of people who fell ill	-.084**	-.122	.045	-.183***	,180	.000
Cost of patient care	-.017**	.471	.035	-.186***	,134	.000
Average duration of disability	-.156**	.090	.026	-.061***	,109	.000
Factors of institutional characteristics						
Access to informal agricultural credit	.028**	.988	.015	-1.490	,017	,612
Ethatic grant	.021**	.535	.050	-.010	,005	,116
Trainig of farmers	.050**	.445	.026	.003	,004	,112
Climate information	.014**	.005	.035	.078	,009	,000
Characteristics of farms						
Family Labor	.114**	.837	.020	.150***	.007	.000
Number of cultivable fields	.007	.009	.429	-.238***	.005	.000
Area	.011**	.027	.050	-.264***	.015	.000
Wage workforce	.054***	.591	.000	.102***	.040	.000
Agricultural equipment	.026***	2.460	.000	.077**	.021	.050
Intermediate consumption	.011**	.004	.030	.005**	.008	.025
Animal availability	.077	.041	,554	-.077	.021	.655
Economic result (**Profitability**)	.077	.021	0,170	.077	.021	.199
Sigma2	0.562	0.431		0.310	0.235	
Gammaγ	0.71	0.321	000	0.69	0.28	000
Log likelihood function	30.686 (0.000), N=250					

**** = significatif à 1%, ** = significatif à 5%, * = significatif à 10%.*

4.4 Relationship Between Economic Performance Indicators And Health Indicators

Analysis of the correlation reveals a negative link between health indicators and those of the economic performance of farms regardless of the type of crop considered. In fact, the increase in the number of people who fell ill, the cost of patient care and average duration of disability, significantly (1%) reduces the economic efficiency of farms with respective coefficients of -.138, -.382 and -.113. Moreover, the analysis of the correlation table shows that health indicators such as number of people who fell ill and average duration of disability also negatively impacts the economic profitability of both cultures.

Table 5. Correlation test between health indicators and economic performance

Measuring indicators	EE of Irriguated Crop	EE of Dry Crop	Number of Actif people who fell ill	Cost of patient care	Average duration of disability	Profitability
EE of Irriguated Crop	1					
EE of Dry Crop	0,123***					
Number of people who fell ill	-0,138***	-0,221***	1			
Cost of patient care	-0,382**	-0,037***	0,541***	1		
Average duration of disability	-0,113***	-0,151***	0,0117***	0,035*	1	
Profitability	0,481	0,311	-0,101**	0,065**	-0,113***	1

**** = significatif à 1%, ** = significatif à 5%, * = significatif à 10%. EE= Economic efficiency*

5 DISCUSSION

In the study area, agriculture is the main economic activity of the population, whose production is carried out in rain for some speculations and in irrigation for others [32]. In terms of farming, the average household is the majority [33]. Unfortunately, this activity also faces the poverty of farmers, the effects of climate change coupled with the health context, thus contributing to making these farms technically and economically inefficient. In this context, knowledge of the determinants of economic performance is of paramount importance to any farm. Several factors were considered in this study. These are the socio-economic characteristics of farmers, Factors of institutional characteristics, Characteristics of farms and health factors. In order to be economically efficient, you have to understand or invest rationally in these factors. It is remarkable that in addition to the factors of production, the health aspect has a negative impact on the economic performance of farms. In fact, the increase in the various costs of taking care of the diseases recorded in households (the degree of complication, treatment, prevention and other expenses linked to the indirect treatment process), but also by the total number of sick persons, significantly affects other agricultural expenditure. This same result was found by [33]. Most farms (75.6% for irrigated crops and 91.1% for dry crops) have an economic performance index of less than 20%. The average technical efficiency in the variable scale yield is 0.41 and 0.33 for irrigated and dry crops respectively; This means that, on average, respondents were able to obtain about 41% of the potential output of a given combination of inputs. This also implies that about 59% (1-TE) and 67% (1-TE) of production are discontinued due to technical inefficiency for irrigated and dry farms respectively. These results are lower than the results found by [34] (0.558 of overall economic efficiency) in the economic analysis of maize production and [35] in his study of the technical efficiency of family farms in Mauritius. In the area, farmers place more importance on irrigated crops, in this case rice farming than on dry crops. This could be the reason why irrigated farms are economically more efficient than dry farms. Thus, the effects of climate change are more noticeable on farms with dry crops than irrigated, especially with soil degradation, low soil fertility, health problems at household level, irregular and poorly distributed rain and the total dependence of these farms on the rainy season (which lasts no more than 3 months). However, this type of agricultural production system is increasingly characterized by an overexploitation of natural resources, which is the basis of its functioning, following the rapid growth of the rural population [36]. In the short and medium term, this overexploitation leads to soil degradation which leads to a reduction in productivity, compromising the sustainability of agricultural production systems [37], thus promoting the technical and economic inefficiency of farms. Reduced rainfall and climate variability reduce plant productivity [38]. It is also important to clarify the finding of a new pest (earthworm) as a result of climatic variability in irrigated farms. Despite the different strategies adopted by farmers, ineffectiveness in terms of control has been noted. The study, like that of [39], showed that the deterioration in health status leads to a resolution of the population situation. An episode of malaria in an agricultural asset would cause a very significant reduction in the yield of irrigated crops. The number of working days missed on the holding is an indicator influencing the economic result [40, 33]. The strong mobilization of the family labor force, as confirmed by [41], may be explained by the fact that the requirements in the dry crop operation are not as important in terms of labor compared to those in irrigated crops for which the labor requirement is very high. [33], and that the slightest delay in Crop operations would negatively affect the yield [41] of dry crops.

6 CONCLUSION AND RECOMMENDATIONS

This study uses the Cobb-Douglas-type production boundary to identify the determinants of technical and economic efficiencies in dry and irrigated farms. Based on the estimated levels of these economic efficiencies, the average level of economic efficiency is low for dry and medium-sized farms for irrigated crops. The effects of climate change are becoming more and more worrying in the area and are coupled with the degrading health situation of the peasants especially during the rainy season. The results show that the farms studied perform poorly economically when referring to the average indices of these farms. However, it is noted that irrigated farms are economically more efficient (0.17) than dry farms (0.10). For the determinants of the technical efficiency of irrigated farms, variables such as age, number of years of experience, household size, factors of institutional characteristics, family labor, wage workforce, agricultural equipment, intermediate consumption, economic result (profitability) were statistically more significant. Furthermore, it should be noted that age, off -farm income, number of years of experience, climate information, family labor, wage workforce, agricultural equipment, intermediate consumption and economic result (profitability) positively improve economic efficiency and negatively by variables such as number of people who fell ill, cost of patient care, average duration of disability, ethatic grant, wage workforce and intermediate consumption. The analysis of the determinants of the technical efficiency of dry crop farms shows that variables such as Age, Number of Years of Experience, Wage workforce, agricultural equipment, Access to agricultural credit, train of farmers, Climate information, Family Labor improve the level of technical efficiency of farms. For the determinants of the technical efficiency of irrigated farms, variables such as age, number of years of experience, household size, factors of institutional characteristics, family labor, wage workforce, agricultural equipment, intermediate consumption, economic result (profitability) were statistically more significant. Furthermore, it should be noted that age, off-farm income, number of years of experience, climate information, family labor, wage workforce, agricultural equipment, intermediate consumption and economic result (profitability) positively improve economic efficiency and negatively by variables such as number of people who fell ill, cost of patient care, average duration of disability, ethatic grant, wage workforce and intermediate consumption. The analysis of the determinants of the technical efficiency of dry crop farms shows that variables such as Age, Number of Years of Experience, Wage workforce, agricultural equipment, Access to agricultural credit, train of farmers, Climate information, Family Labor improve the level of technical efficiency of farms.

Based on these research findings, the study makes recommendations at three levels: at the government level, to agricultural households, Funders, researchers and academics:

- The government should put more emphasis on improving the health of farmers, modern production technologies, more appropriate means of combating the effects of climate change, in order to significantly reduce the technical and economic inefficiencies of farmers.
- Households should ensure hygiene and avoid stagnating water at the level of dwellings. This reduces the proliferation of mosquitoes, the source of malaria, and ultimately reduces the number of days of disability and the cost of treatment.
- Funders, researchers and academics should encourage new scientific research to combat new predators found on irrigated farms, whose impact will significantly reduce economic performance.

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