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Analysis of agricultural performance in Burkina Faso using Data Envelopment Analysis

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Abstract. In this paper, we used the DEA method, to apply to the agriculture sector in Burkina Faso. We applied the method with forty-one (41) agricultural farmers with data taking into account cultivated area, manual (human) labour, the liquidity fund of the working household, the number of crops (products) and the expected farm incomes.
The results highlight the seven (7) technical efficiencies. Taking into account the variable scale yields, fourteen (14) efficient farms are obtained. These results show how non-efficient farms in the DEA sense are indexed to efficient farms that can serve as benchmarks or benchmarks in terms of performance improvement.
This study shows that efficiency does not depend on the category of operator but on overall performance (efficiency and productivity).

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Key Words and Phrases: Farm performance indicators, Data Envelopment Analysis, productivity, technical efficiency, variable returns to scale, scale efficiency

1. Introduction

The agricultural sector is one of the priority sectors in Burkina Faso in addition to education and health [14]. The agricultural sector is the sector in Burkina Faso employing more than 70% of the labour force. However, it struggles to meet the country's food needs.

The development projects of this sector include training of farmers for particular productions (cotton, rice, sesame, etc.). Using the Data Envelopment Analysis (DEA) approach in this particular area can help trainers, the financial and technical partners to measure the efficiency of the different products monitored and to determine the reference units for each type of farm. This undeniably can reduce training costs and investment to the extent that training and investment will target the optimum productivity of all production. In other words, investments will be guided by efficient production plans. Using DEA in the analysis of production activities (agriculture, but also mining, industries,

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etc.) can guide actors or decision makers on optimal production conditions. This can help enormously the Burkina Faso's economy which relies largely on agriculture.

The DEA approach consists of using mathematical methods for measuring and analysing the performance of production units. It has certain advantages, it allows among others:

- to know what is or is not efficient for controlled units;
- to evaluate production units without a priori on the value judgments of the monitoring and evaluation indicators;
- to study performance without a priori knowledge of the relations between the factors of production and the resulting products;
- to analyse performance by integrating multiple production and product factors. For example, agricultural performance incorporates multiple production factors such as the availability of land, labour, resources and output factors such as yield.

Our main objective in proposing this study is to provide a tool that contributes to the monitoring and evaluation of the programs, projects or development activities of this system.
Our specific objectives are:

- to enable measures and analyses of agricultural production efficiencies;
- to enable the determination of efficient units that can be used as a reference;
- to enable the identification of sources of production inefficiency;
- to enable decision-makers and partners to guide investments taking into account reference units and inefficiencies in agriculture sector in Burkina Faso.

In the literature several authors have published papers using the DEA approach for performance measurement in the agricultural sector. We cannot be exhaustive given the importance of this work. Examples of agriculture include Mosbah et al. [9], Nandy and Singh [10], Toma et al. [12], Kuo et al. [7], Mardani and Salapour [8],or environment protection such as, Korhonen and Luptacik [6], Fare et al.[5].

We structure this paper as follows: after the introduction, we will present the DEA method and the concept of performance measurement by DEA, then some performance indicators for the agricultural sector; and finally, before concluding, we will present the farm data that we will apply and comment on the results using the DEA method.

2. Basic DEA models and interpretations

The DEA approach is diversified by the different mathematical formulations proposed to approach the efficient frontier of production (approximation of the production function of the system units).

2.1. DEA Mathematical Models

We consider a production system $\mathcal{S}$ to n DMU [13]. The evaluations will focus on these DMUs in order to measure their performance and of the system $\mathcal{S}$. Each DMU of the system uses m different inputs factors to produce s different outputs factors. The DMU will be indexed by $j, j = 1, \ldots, n$. The observed data x_{ij}, y_{rj} represent respectively the quantities of input factor $i(i = 1, \ldots, m)$ used and the output factor $r(r = 1, \ldots, s)$ produced by the DMU $j(j = 1, \ldots, n)$. The input and output vectors of the DMU $j(j = 1, \ldots, n)$ will be rated respectively by X_j and Y_j. The DMU under assessment will be noted d; data and variables related to the evaluation of the DMU d will be additionally indexed by d.

2.1.1. Model of Charnes, Cooper and Rhodes

The models proposed by Charnes, Cooper and Rhodes (CCR) in 1978 [2] measure radial technical efficiency. The first CCR DEA model measures the efficiency of a given DMU d as the maximum ratio of weighted outputs to weighted inputs with the normalization condition that no similar ratio exceeds the unit. The authors add as an additional condition on the observed data, that the input and output vectors are nonzero for any DMU and with nonnegative components ie.

$$x_{ij} \geq 0, i = 1, \ldots, m; j = 1, \ldots, n; \quad y_{rj} \geq 0, r = 1, \ldots, s, j = 1, \ldots, n. \tag{1}$$

The CCR formulation considers all possible system outputs by

$$\mathcal{P} = \{(x, y) : \quad x \geq \sum_{j=1}^{n} \lambda_j X_j, \quad y \leq \sum_{j=1}^{n} \lambda_j Y_j, \quad \lambda_j \geq 0, \quad j = 1, \ldots, n\}. \tag{2}$$

The CCR input-oriented model calculates the efficiency intensity of a DMU d by a scalar Θ^d :

$$\Theta^d = \min_{\theta \geq 0} \{\theta : (\theta X_d, Y_d) \in \mathcal{P}\} \tag{3}$$

The following formulation is therefore proposed: (cf. [1, 2]):

$$\Theta^d = \max \quad \frac{\sum_{r=1}^{s} \upsilon_r^d y_{rd}}{\sum_{i=1}^{m} \vartheta_i^d x_{id}}$$
$$\text{subject to (s.t.)} \quad \begin{cases} \dfrac{\sum_{r=1}^{s} \upsilon_r^d y_{rj}}{\sum_{i=1}^{m} \vartheta_i^d x_{ij}} \leq 1, \quad j = 1, \ldots, n; \\ \dfrac{\upsilon_r^d}{\sum_{i=1}^{m} \vartheta_i^d x_{id}} \geq \epsilon, \quad \upsilon_r^d \geq 0, \quad r = 1, \ldots, s; \\ \dfrac{\vartheta_i^d}{\sum_{i=1}^{m} \vartheta_i^d x_{id}} \geq \epsilon, \quad \vartheta_i^d \geq 0, \quad i = 1, \ldots, m; \end{cases} \tag{4}$$

This form is called fractional form or ratio CCR with input orientation. In theory, $\epsilon > 0$ is an infinitesimal non archimedian number. When it comes to a practical implementation, one arbitrarily chooses ϵ a sufficiently small number.

In this CCR formulation above the ratio of weighted outputs to weighted inputs is maximized. The opposite formulation consists in minimizing the ratio of weighted inputs to weighted outputs with the same constraints.

The formulation (4) is equivalent to a linear program which is known as the multiplicative form of the CCR input-oriented model. The dual of this multiplicative form called the envelopment form of the CCR input-oriented model, is written [2]:

$$\begin{array}{ll} \min & \theta^d - \epsilon(\sum\limits_{i=1}^{m} s_i^{d-} + \sum\limits_{r=1}^{s} s_r^{d+}) \\ \text{s.t.} & \left\{ \begin{array}{l} \sum\limits_{j=1}^{n} \lambda_j^d x_{ij} - \theta^d x_{id} + s_i^{d-} = 0, \quad i = 1, \ldots, m; \\ \sum\limits_{j=1}^{n} \lambda_j^d y_{rj} - y_{rd} - s_r^{d+} = 0, \quad r = 1, \ldots, s; \\ s_i^{d-} \geq 0, \quad i = 1, \ldots, m; \quad s_r^{d+} \geq 0, \quad r = 1, \ldots, s; \quad \lambda_j^d \geq 0, \quad j = 1, \ldots, n. \end{array} \right. \end{array} \tag{5}$$

where$(\lambda_j^d, j = 1, \ldots, n$ and $\theta^d)$ are the dual variables associated respectively with the constraints of the corresponding multiplicative form and s_i^{d-} and s_r^{d+} are the slack variables.

In addition to input-oriented models, there are output-oriented models. The objective of the output-oriented model is to minimise the ratio of the weighted value of inputs to the weighted value of outputs. This means searching for input factor values for the maximum output factor output values.

By the same process as in the previous section, we pass from the fractional form with output orientation to the pair of primal and dual linear forms with output orientation and the envelopment form of the CCR output-oriented model, is written [2]:

$$\begin{array}{ll} \max & \varphi^d + \epsilon(\sum\limits_{i=1}^{m} s_i^{d-} + \sum\limits_{r=1}^{s} s_r^{d+}) \\ \text{s.t.} & \left\{ \begin{array}{l} \sum\limits_{j=1}^{n} \lambda_j^d x_{ij} - x_{id} + s_i^{d-} = 0, \quad i = 1, \ldots, m; \\ \sum\limits_{j=1}^{n} \lambda_j^d y_{rj} - \varphi^d y_{rd} - s_r^{d+} = 0, \quad r = 1, \ldots, s; \\ s_i^{d-} \geq 0, \quad i = 1, \ldots, m; \quad s_r^{d+} \geq 0, \quad r = 1, \ldots, s; \quad \lambda_j^d \geq 0, \quad j = 1, \ldots, n. \end{array} \right. \end{array} \tag{6}$$

Theorems [3] show that a DMU is efficient by using the input-oriented model if and only if it is efficient for the output-oriented model. Moreover, these theorems show that the efficiency score obtained by the input-oriented model is the inverse of that obtained by the output-oriented model and vice versa.

Theorem 1. *[3] Either $(\tilde{\theta}, \tilde{\lambda})$ an optimal solution of the input-oriented model. Then $(1/\tilde{\theta}, \tilde{\lambda}/\tilde{\theta})$ is an optimal solution of the output-oriented model. Similarly, if $(\tilde{\varphi}, \tilde{\lambda})$ is an optimal solution of the output-oriented model. So $(1/\tilde{\varphi}, \tilde{\lambda}/\tilde{\varphi})$ is an optimal solution for the input-oriented model.*

2.1.2. Model of Banker, Charnes and Cooper

The model of Banker, Charnes and Cooper (BCC) [1] allows to restrict conditions on input and output factors. The model considers input and output factor values to be positive or zero i.e. $x_{ij} \geq 0, i = 1, \ldots, m, y_{rj} \geq 0, r = 1, \ldots, s, j = 1, \ldots, n$.
Banker, Charnes and Cooper consider a set of possible productions $\mathcal{P}$ verifying 4 postulates [1] and the only set of possible productions verifying these 4 postulates is:

$$\mathcal{P} = \{(x, y) : x \geq \sum_{j=1}^{n} \lambda_j X_j, \quad y \leq \sum_{j=1}^{n} \lambda_j Y_j, \quad \sum_{j}^{n} \lambda_j = 1, \quad \lambda_j \geq 0, j = 1, \ldots, n\} \tag{7}$$

The models of Banker, Charnes and Cooper are therefore obtained by adding a variable $u^d \in \mathbb{R}$ (without sign restriction) to the primal form CCR; this then leads to the addition of the convexity constraint$\sum_{j}^{n} \lambda_j = 1$ in dual problem (CCR).

The BCC input-oriented model calculates the efficiency intensity of a DMU d by a Δ^d scalar as follows:

$$\Delta^d = \min_{\delta \geq 0} \{\delta : (\delta X_d, Y_d) \in \mathcal{P}\} \tag{8}$$

The envelopment form of the BCC input-oriented model is written:

$$\begin{aligned} \min \quad & \delta^d - \epsilon(\sum_{i=1}^{m} s_i^{d-} + \sum_{r=1}^{s} s_r^{d+}) \\ \text{s.t.} \quad & \begin{cases} \sum_{j=1}^{n} \lambda_j^d x_{ij} - \delta^d x_{id} + s_i^{d-} = 0, \quad i = 1, \ldots, m; \\ \sum_{j=1}^{n} \lambda_j^d y_{rj} - y_{rd} - s_r^{d+} = 0, \quad r = 1, \ldots, s; \\ \sum_{j}^{n} \lambda_j^d = 1; \\ s_i^{d-} \geq 0, \quad s_r^{d+} \geq 0, \quad \lambda_j^d \geq 0, \quad \forall i, r, j. \end{cases} \end{aligned} \tag{9}$$

In addition to input-oriented models, there are output-oriented models. The objective of the output-oriented model is to minimise the ratio of the weighted value of inputs to the weighted value of outputs. This means searching for input factor values for the maximum output factor output values.

Using the DEA models, we have the following definitions according to whether it is a CCR or BCC model:

Definition 1. DEA technical efficiency
The performance of the DMU d is fully (100%) efficient (CCR) if and only if the following two conditions are verified:
(i) $\tilde{\theta}^d = 1$;
(ii) $s_i^{d-} = 0, \forall i$ and $s_r^{d+} = 0, \forall r$.
where the " ˜ " symbol indicates the optimal solution.

Definition 2. DEA scale efficiency
The performance of the DMU d is fully (100%) efficient (CCR or BCC) if and only if the following two conditions are verified:

(i) $\tilde{\delta}^d = 1$;
(ii) $s_i^{d-} = 0, \forall i$ and $s_r^{d+} = 0, \forall r$.
where the " ˜ " symbol indicates the optimal solution.

Remark 1. If d is inefficient DMU (for example CCR), it can be projected on the effective border as follows:

$$\widehat{X}_d = \tilde{\theta}^d X_d - \tilde{s}^{d-} = \sum_{j=1}^{n} \tilde{\lambda}_j^d X_j \quad \widehat{Y}_d = Y_d + \tilde{s}^{d+} = \sum_{j=1}^{n} \tilde{\lambda}_j^d Y_j \tag{10}$$

with $\tilde{s}^{d-}$ and $\tilde{s}^{d+}$ the vectors of the optimal values $\tilde{s}_i^{d-}, i = 1, \ldots, m$ and $\tilde{s}_r^{d+}, r = 1, \ldots, s$ respectively. The fictitious $(\widehat{X}_d, \widehat{Y}_d)$ DMU is on the efficient production border.

From the basic models CCR or BCC, it is possible to make extensions [3, 15, 17] to be able to respond to specific cases of problems. These specific cases generally differ in the nature of the decision factors. Input or output factors may be controllable at the decision-maker level or not. Similarly, some factors may be undesirable. For example, environmental pollution which may be linked to the production of goods or services, maternal or infant mortality, etc. These extensions make it possible to refine the approximation of the efficient production boundary or to incorporate value judgments from parametric analysis techniques.. We consider here the mixed situation with the presence of undesirable input factors and undesirable output factors. The most frequent case is the presence of undesirable outputs, as is the case of environmental pollution linked to certain types of activity.

2.2. DEA approach and performance measurement

The DEA method is a diagnostic tool for the production operations of decision-making units (DMU) of a given production system. It is an effective a posteriori method of production operations of these DMUs. This method measures the ability to achieve objectives in relation to the resources allocated from the optimal ratio of weighted outputs to weighted inputs. Efficiency and effectiveness are therefore measured indiscriminately by DEA, because the improvement of productivity depends on increasing production - effectiveness - without increasing resource consumption or reducing allocations of input factors - efficiency. Thus, effectiveness is seen in this context as the ability to produce maximum results with minimum effort, expenditure and efficiency as well as productivity and cost-effectiveness of resources i.e. the capacity for performance or "productivity.

The use of DEA distinguishes between technical and scale efficiencies. Technical efficiencies show that for a given level of input and output quantities, it is impossible for one unit to improve another input or output factor. Scale efficiencies are defined to highlight situations with variable returns to scale (constant, increasing or decreasing).

In the case of the use of DEA, the concept of productivity is replaced by that of production efficiency, measured taking into account the ability to achieve objectives.

In general, efficiency is not achieved either because it would be possible to produce more with the same means (inputs) or because it would be possible to produce as much by reducing the means used. Efficiency is therefore measured from the overall factor productivity (input-output) and makes it possible to know whether the production performance of a unit is optimal or not.

The efficient units are the units with an intensity equal to the unit, which means that the unit has made full use of its means (inputs) and has produced the maximum possible output results.
The performance measurement with DEA relates to the operations of a given production system, in which managers seek to measure their actions. Performance is characterized by the observed (measurable) results of a management system in relation to its policy of allocation of operating resources.
The performance comparison between two units of a system is relative:

- The results observed during an operation (excellent or bad results) commonly referred to as outputs,
- Indicators of technical analysis which may be technical factors of production or inputs.

The assessment of performance is made in relation to objectives which a firm or production unit has set itself, taking into account its competitive environment.
For a decision-maker, it is a matter of knowing how to specify in a logical and objective way:

- the overall objective of the analysis;
- the sample of units whose performance must be compared;
- the output factors which are the observable and easily measurable intermediate objectives;
- the input factors to be devoted to efforts to improve the intermediate objectives;
- information on the various factors (inputs-outputs) used to measure performance.

Performance indicators should help to make a subsequent decision taking into account the benchmarking of efficient units.

The DEA approach makes it possible not only to measure or evaluate the performance of the units of a production system but also to help the decision-maker to make certain improvements, on the one hand, by benchmarking techniques, and on the other hand, by visualizing the state of the different quantified indicators (positive, negative) and knowing the elements to improve.
For benchmarking, the following simple steps can be followed:

- determine efficient units (DMUs) using DEA;
- determine the reference units (or benchmarks) for the inefficient unit to be improved;
- identify the inefficiencies of the unit to be improved.

With Dailla [4], we think that the peasant practices and knowledge, or the knowledge of rural populations, constitute a capital that has potential virtues to stimulate development. The aim is therefore to identify the beneficial aspects of this local knowledge as well as those that can be improved through science-based technologies. It is because these beneficial aspects of local knowledge have not been taken into account that many projects initiated in developing countries have not been as successful as expected. The success of a development project often depends on local participation. Familiarisation with peasant knowledge facilitates understanding and communication between development agents and the local population, thus increasing the possibilities of a participatory and sustainable development approach. Taking into account local knowledge allows project staff and the local population to work as partners in the planning and execution of development tasks, which certainly increases the chances of success of the project.

3. Farm performance indicators

We cannot talk about the development of the agricultural sector without mentioning the notion of sustainable development. The issue of sustainable development policy-making is a problem of optimizing conflicting objectives such as the need for profit, environmental protection and social and economic equity. The DEA approach can provide decision support tools, particularly in a decision-making process using a cooperative approach.
For Zahm et al. [16], a sustainable farm is a viable, livable, communicable and replicable farm that builds on a responsible societal approach. They added that the development of sustainable agriculture is based on five properties: productive and reproductive capacity of goods and services, robustness, territorial anchorage, autonomy and global responsibility. For the Food and Agriculture Organization (FAO), we can remember that a sustainable agriculture (crops and livestock) must:

- Use all natural resources sustainably for food and agricultural production. Related indicators should be relevant to the sustainability of water, land and land use, biodiversity, etc.
- Increase productivity, income and resilience of small family farms .

To define the factors of production and the resulting products to be taken into account, it seems important to us to take into account only the indicators of agricultural production performance and the different types of agricultural production in Burkina Faso.
In this paper, we define input and output variables based on these indicators for monitoring and evaluating the performance of the agricultural system, so as to take into account the

intermediate objectives for the development of this sector. Access to irrigated land and capital are the main causes of the income gap between farmers. Manual (human) labour is the majority on farms in Burkina Faso. The expected household income is a relevant indicator in the fight against poverty. Moreover, the funds available for the household is a relevant indicator. Indeed, knowing whether the household is poor (average fund estimated at CFAF 10,000), average (average fund estimated at CFAF 200,000) or rich (average fund estimated at CFAF 300,000) can make it possible to understand the difficulty or ease in certain farming practices (for example against-season crops). Finally, the number of products (crops) makes it possible to measure diversity and minimize the risks incurred by the household since agriculture in Burkina Faso is largely too dependent on rainfall. The farmers of so-called poor households are farmers DMU1 to DMU15, those of so-called average households are farmers DMU16 to DMU28 and those of so-called rich households are farmers DMU29 to DMU41 (see Table 1). The data were processed from simulations of the impact of economic policies on agricultural incomes in the central plateau of Burkina Faso of Sanfo [11].

Table 1: Farm data

DMU	C.A	L.F	L.Fu	N.D.P	Inc.	DMU	C.A	L.F	L.Fu	N.D.P	Inc.
Dmu1	1.45	156	10000	4	206094	Dmu2	1.4	156	10000	4	206094
Dmu3	1.55	156	10000	6	206094	Dmu4	1.54	156	10000	6	206094
Dmu5	1.52	156	10000	6	206094	Dmu6	1.62	156	10000	8	206094
Dmu7	1.61	156	10000	8	206094	Dmu8	1.4	156	10000	4	208193
Dmu9	1.54	156	10000	4	221472	Dmu10	1.45	156	10000	4	277408
Dmu11	1.45	156	10000	4	279532	Dmu12	1.67	156	10000	8	310275
Dmu13	1.55	156	10000	6	313770	Dmu14	1.56	156	10000	6	374302
Dmu15	1.66	156	10000	3	431895	Dmu16	2.36	193	200000	4	304045
Dmu17	2.49	193	200000	4	304045	Dmu18	2.67	193	200000	6	304045
Dmu19	2.61	193	200000	6	304045	Dmu20	2.79	193	200000	8	304045
Dmu21	2.61	193	200000	5	317085	Dmu22	2.36	193	200000	4	324493
Dmu23	2.6	193	200000	6	439269	Dmu24	2.49	193	200000	4	454590
Dmu25	2.49	193	200000	4	566306	Dmu26	2.95	193	200000	8	669595
Dmu27	2.6	193	200000	5	820213	Dmu28	2.89	193	200000	3	563178
Dmu29	3.17	273	300000	4	563178	Dmu30	3.22	273	300000	4	563178
Dmu31	3.52	273	300000	6	563178	Dmu32	3.47	273	300000	6	563178
Dmu33	3.77	273	300000	8	563178	Dmu34	3.82	273	300000	8	563178
Dmu35	3.49	273	300000	5	574347	Dmu36	3.22	273	300000	4	746149
Dmu37	3.17	273	300000	4	746149	Dmu38	3.47	273	300000	6	797256
Dmu39	3.94	273	300000	8	871080	Dmu40	3.65	273	300000	6	871080
Dmu41	3.93	273	300000	3	1033999						

Source : Data from Sanfo [11]

In the Table 1, we have : DMU for Farmers; C.A for Cultivated Area (ha); L.F for Labour Force; L.Fu for Liquidity Fund (CFAF); N.D.P for Number of Different Products and Inc. for Income(CFAF).

4. Application of the DEA method to agricultural farmers

In this section we will present the results and give some related interpretations. We used the input-oriented CCR and BCC model with the software DEAP Version 2.1 *. The data we use in this work are simulated data from the operations summarized in Table 1. To measure farm performance, 5 variables were defined taking into account the agricultural performance indicators. These are the following variables:

- an input variable: cultivated area in hectar;
- a variable input: human labour in days;
- an input variable: estimated CFAF liquidity fund;
- a desirable output variable: the number of crops;
- a desirable output variable: the expected household income in CFAF.

Table 2: CCR-BCC efficiency scores and variable returns to scale

DMU	CCR	BCC	Returns to scale	DMU	CCR	BCC	Returns to scale
Dmu1	0.652	0.846	Increasing	Dmu2	0.675	1.000	Increasing
Dmu3	0.798	0.894	Increasing	Dmu4	0.803	0.916	Increasing
Dmu5	0.814	0.962	Increasing	Dmu6	1.000	1.000	Constant
Dmu7	1.000	1.000	Constant	Dmu8	0.679	1.000	Increasing
Dmu9	0.636	0.676	Increasing	Dmu10	0.785	0.995	Increasing
Dmu11	0.790	1.000	Increasing	Dmu12	1.000	1.000	Constant
Dmu13	0.922	0.977	Increasing	Dmu14	1.000	1.000	Constant
Dmu15	1.000	1.000	Constant	Dmu16	0.518	0.545	decreasing
Dmu17	0.508	0.528	decreasing	Dmu18	0.644	0.750	decreasing
Dmu19	0.644	0.750	decreasing	Dmu20	0.808	1.000	decreasing
Dmu21	0.571	0.625	decreasing	Dmu22	0.536	0.562	decreasing
Dmu23	0.735	0.759	decreasing	Dmu24	0.638	0.653	decreasing
Dmu25	0.743	0.746	decreasing	Dmu26	1.000	1.000	Constant
Dmu27	1.000	1.000	Constant	Dmu28	0.687	0.687	Increasing
Dmu29	0.581	0.663	decreasing	Dmu30	0.572	0.659	decreasing
Dmu31	0.604	0.750	decreasing	Dmu32	0.607	0.750	decreasing
Dmu33	0.673	1.000	decreasing	Dmu34	0.669	1.000	decreasing
Dmu35	0.570	0.689	decreasing	Dmu36	0.735	0.833	decreasing
Dmu37	0.746	0.837	decreasing	Dmu38	0.762	0.919	decreasing
Dmu39	0.842	1.000	decreasing	Dmu40	0.782	0.970	decreasing
Dmu41	0.891	1.000	decreasing	Mean	0.747	0.852	-

The second column of Table 2 provides the Farm Technical Efficiency Scores. The following is obtained:

*Coelli, T , A Guide to DEAP Version 2.1: A Data Envelopment Analysis (Computer) Program, CEPA Working Paper No.8/96, Department of Econometrics, University of New England, Armidale, NSW 2351, Australia

- 7 farmers appear to be technically efficient on the 41 farmers considered, or only 17.07% of the total. These are operations DMU6, DMU7, DMU12, DMU14, DMU15, DMU26 and DMU27;

- the average technical efficiency score is 0.747, which means that, on average, all the farms considered produced 74.30% of the capacity offered by the best technology in the system;

- Among the farmers of households considered poor, there are 5 that are technically efficient DMU6, DMU7, DMU12, DMU14 and DMU15;

- The DMU17 farm that is considered for a so-called average household is the least technically efficient compared to the whole.

The third column of Table 2 provides the efficiency scores at variable scale performance. It is obtained that:

- 7 farms appear to be efficient at variable scale in addition to the technically efficient ones on the 41 farms considered, or 34.15% of the total. 2 farms appear to be efficient at increasing scale. These are the DMU2, DMU8 and 5 farms appear to be efficient to decreasing returns to scale. These are operations DMU20, DMU33, DMU34, DMU39 and DMU41;

- The average efficiency score, taking into account variable returns to scale , is 0.852, which means that, on average, all the farmers considered produced 85.20% of the capacity provided by the best system technology, taking into account variable returns to scale;

- The DMU17 farmer which is considered for a so-called average household is the least efficient in relation to the whole. It is increasing returns to scale.

The last column of Table 2 provides the returns to scale for the different farmers (constant, increasing, and decreasing).
The second column of the following Table 3 gives the technical effective reference units that can be used as benchmarks for the inefficient and associated weights. For example, DMU1 can use the alternatives and techniques used by DMU14, DMU8 and DMU7 with weights of 21.1%, 71.1% and 7.5% respectively. This may, for example, also mean taking into account the distribution of different crops in volume and space.
This information can allow DMU1 to draw inspiration from the policies of the reference DMUs while taking into account the individual constraints (water resources, land, labour force, etc.) to improve its performance (productivity, diversification, etc.) while streamlining its resources.

Table 3: Technical Efficient Units (CCR) as a reference for non-efficient

Non-efficient DMU	Efficient Reference Unit (Weight)	Non-efficient DMU	Efficient Reference Unit (Weight)
Dmu1	Dmu14 (0.214) ;Dmu8(0.711) ;Dmu7(0.075)	Dmu3	Dmu7(0.606) ;Dmu14(0.142) ;Dmu8(0.252)
Dmu4	Dmu7(0.584) ;Dmu14(0.109) ;Dmu8(0.307)	Dmu5	Dmu7(0.538) ;Dmu14(0.044) ;Dmu8(0.418)
Dmu6	Dmu7(0.833) ;Dmu12(0.167	Dmu9	Dmu14(0.719) ;Dmu8(0.162) ;Dmu7(0.119)
Dmu10	Dmu14(0.011) ;Dmu8(0.023) ;Dmu11(0.966)	Dmu13	Dmu7(0.194) ;Dmu14(0.683) ;Dmu8(0.123)
Dmu16	Dmu26(0.380) ;Dmu12(0.401) ;Dmu27(0.218)	Dmu17	Dmu26(0.538) ;Dmu12(0.321) ;Dmu27(0.142)
Dmu18	Dmu26(0.781) ;Dmu12(0.219)	Dmu19	Dmu26(0.734) ;Dmu12(0.266)
Dmu20	Dmu26(0.875) ;Dmu12(0.125)	Dmu21	Dmu26(0.734) ;Dmu12(0.266)
Dmu22	Dmu26(0.325) ;Dmu12(0.380) ;Dmu27(0.295)	Dmu23	Dmu26(0.704) ;Dmu12(0.265) ;Dmu27(0.031)
Dmu24	Dmu12(0.188) ;Dmu26(0.186) ;Dmu27(0.625)	Dmu25	Dmu12(0.119) ;Dmu26(0.002) ;Dmu27(0.879)
Dmu29	Dmu27(0.574) ;Dmu41(0.048) ;Dmu39(0.377)	Dmu30	Dmu27(0.537) ;Dmu41(0.064) ;Dmu39(0.399)
Dmu31	Dmu26(0.424) ;Dmu39(0.576)	Dmu32	Dmu26(0.475) ;Dmu39(0.525)
Dmu33	Dmu26(0.172) ;Dmu39(0.828)	Dmu34	Dmu26(0.121) ;Dmu39(0.879)
Dmu35	Dmu26(0.121) ;Dmu27(0.246) ;Dmu39(0.632)	Dmu36	Dmu41(0.319) ;Dmu27(0.535) ;Dmu39(0.146)
Dmu37	Dmu41(0.301) ;Dmu27(0.572) ;Dmu39(0.126)	Dmu38	Dmu41(0.085) ;Dmu27(0.350) ;Dmu39(0.565)
Dmu40	Dmu41(0.234) ;Dmu27(0.215) ;Dmu39(0.552)		

5. Conclusion and perspectives

Sanfo [11] in his doctoral thesis did a simulation for farm types in the Region of Central Plateau in Burkina Faso. These simulations projected from the actual data collected in the field what can be expected as income by type of operator (poor, medium, rich) over a ten-year period. The projected data for 2020 for farmers who were able to follow the data collection, had a non-significant difference with the actual data. So we looked at the 41 farms where the data was available. We therefore considered the projected data for the indicators whenever information may be missing.
In this paper, we used this pojected data from Sanfo and we applied the DEA method to obtain farm efficiency scores. These efficiency scores made it possible to know, on the one hand, which farms were technically efficient and which ones were efficient, taking into account variable returns to scale. Applied to the agricultural sector, the DEA method will take into account production factors and results (desirable or undesirable). This makes it possible to respect the concepts of sustainable development insofar as the measurement of efficiency will take into account several criteria often contradictory but necessary for the evaluation of a production unit.

This paper aims to show how the DEA method can be applied for the particular case of the agricultural sector in Burkina Faso. It shows that efficiency does not depend on the category of operator but on overall performance (efficiency and productivity).
In perspective we intend to take into account several factors such as the area irrigated or not irrigated, the number of draught oxen, access or not to agricultural credit, the quantity used of organic or mineral manure, the quantity used of improved or local seeds, etc. In addition, we would like to work with farms that can continuously collect statistics on agricultural performance indicators that incorporate the concept of sustainability.

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