

## **ABBREVIATIONS**

**DEA:** The Data Envelopment Analysis; one of linear program model , which can be used to measure efficiency of any organization responsible for converting inputs into outputs .

**TFP:** Total Factor Productivity index approach; it is the chain, which measures a change in efficiency relative to a base year.

**MRF:** Mechanized rain fed farming; one of the three main farming systems in Sudan.

**MFC:** Mechanized Farming Corporation; responsible for all mechanized farming activities in Sudan.

**VRS:** variable return to scale.

**CRS:** Constant return to scale; one of the main DEA assumptions

**SPLM:** Sudan people liberation movement.

**DMUs:** means Decision Making Units ; it is organization responsible for converting inputs into outputs' and whose performance are to be evaluated.

**CCR:** Charnes, Cooper , and Rhodes , 1978; measure efficiency of decision making units.

**BCC:** Banker, Charnes, and Cooper, 1984; measure efficiency of decision making units.

# **CHAPTER ONE:**

## **THE STUDY FRAMEWORK:**

### **Introduction: 1-1**

The progress and success of any organizations of always measured by its performance. This is always done through careful estimation and precise evaluation to the performance achieved, Actually in these organizations. These estimation evaluations can define whether the performance of the organization is good or not. It shows, whether there are some inefficient factors in the organizations inputs and outputs. Particularly, in the large organizations which use multiple huge inputs and outputs organization which need to gain outputs from improving inputs. This process is called efficiency measurement of organization.

Recently, some organizations evaluated the performance of its activities to promote the relation between inputs and outputs basing on reducing either the amount of inputs or increasing outputs from given inputs. So, efficiency studies usually aim at discovering the weakness and strength of the organizations production system and propose the suggestion to overcome these weakness effects and enhance the strength points. For this efficiency measurement remains the most essential tool in the business organizations, public services and different entities. There are different type of efficiency measures such as profit per units, cost per unit, and ratio of outputs over inputs ...etc. Nevertheless, sophisticated measures, which use mathematics and linear programming with multi relation and variable measures like (DEA) it is not able to reach the sound evolution for the organization performance.

Nowadays, efficiency measurement is considered the most important tool in the world of business organization, public services and different entities that estimate and assess the technical and economic efficiency by using different kinds of

efficiency measures , including conventional ones, for example, profits per units , cost per units or ratio of output over inputs ...etc . Other measures use mathematics and linear program which can handle numbers of variables and relations (constraints) like ( DEA) models which provide a new approach for the use of choosing the types of “what-if” questions.

Efficiency is recently considered very important in financial institutions, banking, education...etc, to estimate and assess the performance in order to have optimum exploitation of the productive inputs to produce affirm outputs.

In Sudan where farming is the main business to the majority of the populations, agricultural schemes face some problems of reaching the optimum use of agricultural inputs while they are producing the main agriculture outputs. In the area of the Mechanized rain fed farming in Sudan, the use of efficiency measures is more crucial because the bulk of the agricultural production of the country comes from this area, which includes South Kordofan and Gedaref state.

Sesame and Sorghum are the most valuable crops in the mechanized rain fed farming, one of the three main farming systems in Sudan. In addition there are other crops such as Cotton and Guar.

Despite the increasing importance of measuring the efficiency and productivity of agriculture, the available literature indicates that, until quite recently, considerations of efficiency were rarely incorporated into the agricultural schemes. Instead authorities in the areas of study use conventional measures to evaluate the schemes performance such as profit maximization ways, cost per unit, or total productivity measurements, however, the modern efficiency measurements, for instance, linear programs models such as (DEA) method, and recent advance in computer software had made application of the method simpler than before, bringing them within the scope of agriculture.

Therefore the study of efficiency and productivity change in the mechanized rain fed schemes in Sudan, particularly Gedaref and South Kordofan areas could participate in solving the problem of the remarkable decreasing of the agriculture production.

Basing on the above mention, production is an important determinant for the future of themechanized rain fed schemes in Sudan, due to increase the needs for food crops, industrial raw material, and increase cost of production. So the developmentof themechanized rain fed schemes in Sudan is through the adoption of new technology, increasing the labor skills and the quality and quantity of agricultural machines.

Mechanized rain fed agriculture schemes and hence the schemes productivity system must be evaluated and assessed in order to provide adequate supply of food and raw materials for industries and export so as to improve the economyat the regional and national level. This can be achieved by the use of modern efficiency measurements, the data envelopment analysis (DEA) as the steps to estimate the total factors of productivity growth and its components in the mechanized rain fed schemes in the study areas.

To accomplish measuring the technical efficiency and productivity growth in mechanized rain fed schemes in both two areas , first data of agriculture inputs and outputs needs to be provided and hence the schemes efficiency can be estimated through the application of a new technique (DEA) method for the main outputs data sorghum and sesame . Secondly, to identify the improvement in total factors productivity, the efficiency change and frontier shift for the study areas can be calculated.

## **1.2 Statement of the Problem:**

Although the soil and rainfall and wide land areas are suited for variety crops such as sesame and sorghum in (MRF) areas, the mechanized rain fed

schemes in south Kordofan and Gedaref areas in recent years witnessed remarkable destruction.

Mechanized rain fed schemes were very important agricultural sub-sector in the country, this agricultural sub-sector started in 1945 for large scale production of sorghum to meet the grain shortage after the Second World War. The country was mainly depending on agricultural products, but in recent years there are many problems facing the Sudanese mechanized rain fed schemes, so the evaluating and measuring the schemes performance through using (DEA) measure can help reaching the optimum levels of agricultural outputs.

On the other hand, the need for agriculture expansion horizontally and vertically has increased worldwide due to the increase in human population and subsequently the demand for more food. Moreover, the inefficiency of the mechanized rain fed schemes is considered itself a loss of agricultural exports and development opportunities for the other sectors such as food industries which depend basically on agricultural products

Accordingly, it seems that there is vital needs to measure and assess the efficiency of the mechanized farm schemes on the bases of agricultural product inputs and outputs, so as to reach the best efficiency levels in practicing agriculture in the areas of the study, South Kordofan and Gedaref in Sudan.

Consequently the research problem is to measure and define the efficiency and inefficiency factors in Sudanese mechanized rain fed agricultural schemes in both south Kordofan and Gedaref through awareness of the weakness in outputs and inputs to make the productive system more efficient, which means increasing outputs with less inputs, or producing high outputs from given inputs without affecting the quality required.

In general the research problem should raise the following questions:

- What is the level of efficiency in Sudanese mechanized rain fed schemes in south Kordofan and Gedaref state according to the data envelopment analysis (DEA) approach?

- What is the level of inefficiency in Sudanese mechanized rain fed schemes in south Kordofan and Gedaref state according to the data envelopment analysis (DEA) approach?

- What are the agricultural factors that explain the decreasing and inefficient of the south Kordofan and Gedaref mechanized rain fed schemes in Sudan?

- How can we reduce the inefficient levels in agricultural schemes in mechanized rain fed areas in the areas of the study?

- How can we provide the reference set for inefficient schemes in the area of the study, in order to enable them to reach the efficiency frontier?

### **1.3 The importance of the study:**

The agricultural sector is the most important economic sector in the Sudan. So efficiency of mechanized rain fed schemes is very important for its role in providing food and hard currency through exporting, mechanized rain fed was the main source of export until the start of oil export in 1999.

In other words, the importance of the research is:

- For a researcher engaged in efficiency measurements, the study provides new approaches and techniques which can be applied in measuring efficiency, also the study offers optimum solution for and estimating and measuring efficiency. This new technique opened the door for an integrated approach of efficiency measurements. The study explains how this approach can be used.

- For those who have the responsibility for decision making in agriculture production, the study points to the appropriate measurements for measuring agricultural schemes efficiency

In general the research importance is come from the following:

1- Most of Sudanese people depend mainly on agriculture in their life, and the agriculture activity considered as the base to the national economy

2-Measuring the efficiency of Sudanese ( MRC) agricultural schemes through applying the data envelopment analysis (DEA) approachis considered as a real contribution to the knowledge of measuring efficiency for researcher and practitioners. The use of the (DEA) method could solve the problems of efficiency measurements. This approach has many advantages in comparison with the conventional approaches..

3-Finding out the reasons behind the problem of inefficiency in the Sudanese mechanized rain fed agricultural sub- sector. More over identifyinginefficiencysources in eachinputs and outputsin the productive system.

4-Pursuing the efficiency referenceset in mechanized rain fed schemes in Sudan which can help other schemes to find optimum solutions to the problem ofoutputsshortfalls and inputexcesses

5-The research is the first attempt that measures efficiency of Sudanese agricultural sector

6-Efficiency is an essential element that measures the performance of decision makingunits and guarantees the success of these units , so improving the mechanized rain fed agricultural sector is very important becausefor its role in promoting other sectors and particularly the food industrial sector in which the agricultural products are considered the main raw material for manufacturing.

7-Recently the world is moving toward optimum use of resources for the reason of higher costs and it's rare. The study focuses on optimum use for Sudanese agricultural inputs which include labor, capital, machine, rainfall and agricultural land to give main agricultural outputs.

8-Providing statistics for different agricultural schemes in mechanized rain fed schemes.

9-Defining the efficiency can help other schemes to evaluate their performance by using the same models.

#### **1.4 The objectives of the study:**

The overall objective of this study is to measure the efficiency and productivity change of the mechanized rain fed schemes in both South Kordofan and Gedaref area and make suggestion of how to improve the efficiency he areas of the study. But the specific objectives of the study are:

-To make comparison between the mechanized and rain fed schemes in south Kordofan and Gedaref States in Sudan in terms of efficiency, so as to define the schemes with more efficiency .

-Determine the efficiency factors in the mechanized rain fed schemes that used the fewer amounts of inputs to produce certain outputs.

- Determine the inefficiency factors in the mechanized rain fed schemes in the areas of study and make suggestions to improve them to reach the required efficiency levels.

- Determine the inefficient schemes and nature of inputs that should be treated to reach the efficiency productive levels in Sudanese mechanized rain fed agricultural schemes in the areas of the study.

-Provide the reference for mechanized rain fed schemes in the areas of the study to determine future operation strategies.



- Determine the main source of total factor productivity change in (MRF) schemes, particularly, in Sudanese rain fed and mechanized schemes during the period of the study.

#### **1.4 The study questions:**

According to the study objectives, the study attempts to find answers for the following questions:

- What are the efficient agricultural schemes that had highest outputs levels from the least inputs?
- What are the inefficient agricultural schemes in the areas of the study?
- What are the agricultural input factors that could be reduced to reach outputs efficiency levels in the Sudanese mechanized rain fed schemes in the areas of study?
- What are the agriculture outputs factors that could be increased so as to reach outputs efficiency levels in the Sudanese mechanized rain fed schemes in the areas of the study?
- What is the reference set for inefficient agricultural schemes so as to improve their efficiency levels?

#### **1.5 The study area:**

The area of the study included the South Kordofan and Gedaref state in Sudan which are considered as the most agricultural productive areas in the agricultural sub-sector. Agriculture stands as a main source of livelihood and absorbs the majority of labor force in these regions. Moreover, the most financial investments are employed in this area. . The agriculture is still in its traditional nature, some farmers are still using traditional tools and machines in agricultural operations.

The unique location of the two areas encourages investors to carry out their investments, in addition, the climate (rainfall, heat, soil type...etc.) helps in the agricultural production in the areas of the study.

The study covers all localities in south Kordofan and Gedaref state in Sudan. According to the Data Envelopment Analysis (DEA), agricultural inputs and outputs data were collected built on Data Envelopment Analysis (DEA) operation research concepts and theories. The research is built on some operation research principles, which search for optimal solutions among different available solutions in order to reach the efficiency level of productive system using agricultural inputs and outputs data Sudanese mechanized rain fed and schemes in both South Kordofan and Gedaref state in Sudan.

### **1.6 Methodology of the study:**

The methodology of the research reviews the DEA method as efficiency measurement, the researcher explained different DEA models under different assumptions, constant return to scale (CRS) and variable return to scale (VRS). Also the study reviews Malmquist Productivity Index (MPI), one of very important tools that are used to measure the change in the level of economical variable, or Total Productivity Factor (TPF). The (MPI) technique is used to measure a change in efficiency that change by time, relative to a base year. This study adopts the outputs and inputs oriented Malmquist productivity change index.

The (DEA) approach as the quantitative (linear program) models was suitable for the production inputs and outputs data. This methodology can be used to achieve the following:

- 1 identifying the inefficiency source of the inputs and outputs in the productive system.

-2 determining the reference set which could be used to improve the inefficient agricultural schemes.

According to Fare (1994) the technical efficiency change can be decomposed into pure technical efficiency change and scale efficiency change. In Total Factor Productivity (TFP) growth, improvement in productivity, as well as improvement in efficiency and technology, is indicated by values greater than one, whereas value less than one indicate regress.

The comparison between schemes can take the form of the mean of the actual measure of efficiency change, Malmquist productivity index and frontier shift from the given inputs and outputs data of the areas of the study during the period 2001 -2010.

### **1.7 The structure of the study:**

This research is organized in seven chapters. Chapter one, is the study framework, chapter two discusses and reviews the different previous studies conducted on efficiency measurement and productivity change in different fields. Also this chapter introduces analysis for these studies in order to find gap in the previous studies.

Chapter three concerned with some methodological issues that are related to the study; some concepts related to the Data Envelopment Analysis (DEA) and Total Factor of productivity (TFP) Index Approach.

In chapter four is gives background of agriculture in the Sudan, mechanized rain fed corporations in Sudan and mechanized rain fed schemes in the areas of the study, besides the geographical features of Sudan and the areas of the study.

Chapter five reviews Source of data sample of the study, the data of the study cover the period 2001-2010. Chapter six concerned analysis of the field data of the research, also this chapter reviews discussion of the research results, and finally this chapter illustrates the Empirical implications of the research.

Finally chapter seven gives lights on the main results and conclusion that researcher could be derived from discussed some of these results. Also chapter seven presents the recommendation, Suggestions for the further future Research and list of References.

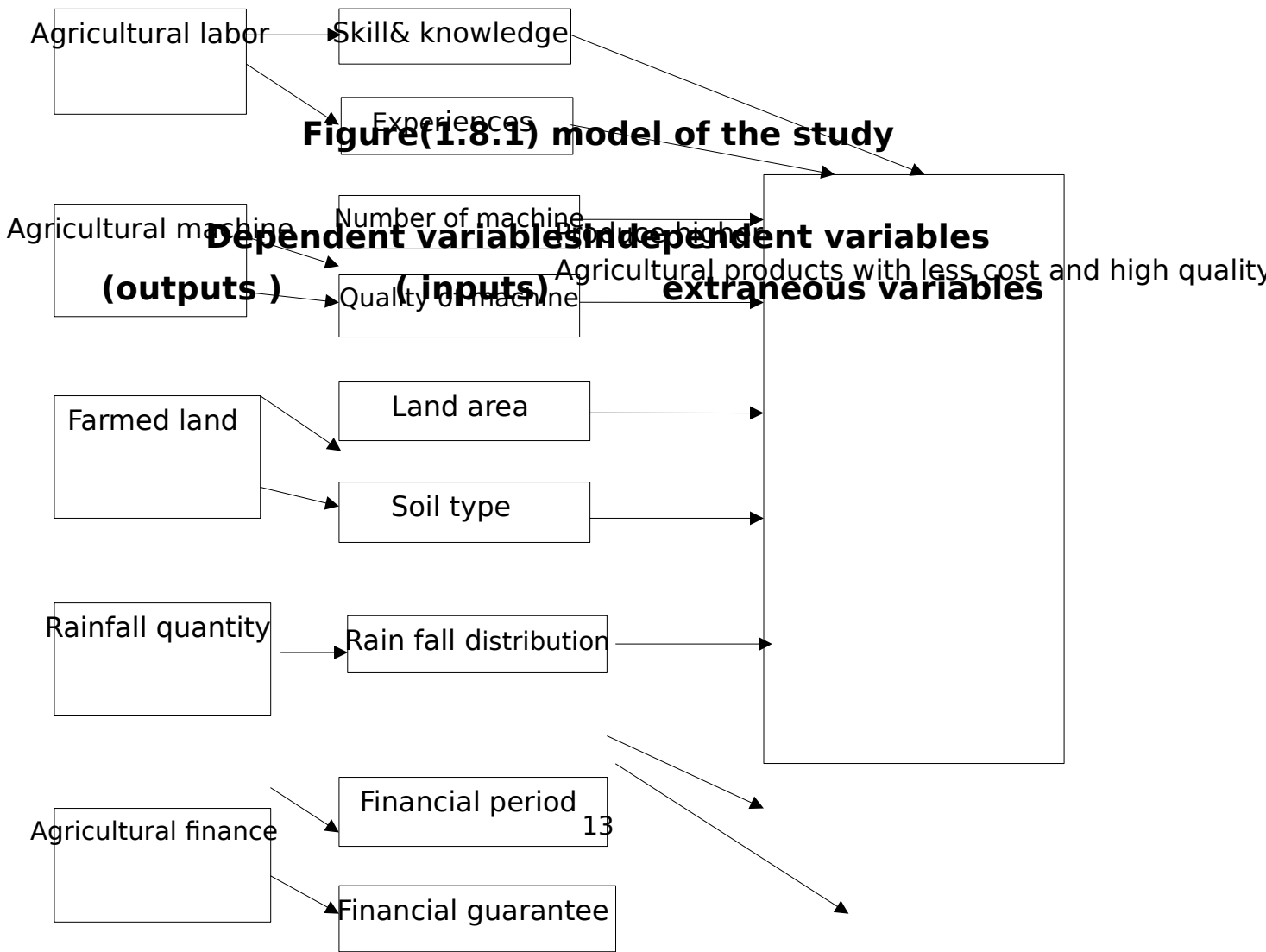
### **1.8 The Model of the study:**

The model of this study is used to identify the key variables which include group of independent, dependent variables, an independent variable is the (inputs data) of the mechanized rain fed agricultural sub-sector schemes in the two areas such as (labor, finance, machine, farmed land and annual rainfall quantity). The dependent variable is the (outputs data) . the outputs data represent the agricultural products , which include Sesame and Sorghum in products in the mechanized rain fed agricultural schemes in Sudan during the period of the study 2001-2010.

The study specified two outputs as dependent variable included the main agricultural products in the mechanized rain fed agricultural schemes which included two main crops sorghum and sesame in the areas of study during the period 2001 to 2010.

The coming figure (1.8.1) explains the model of the study.

**Figure(1.8.1) model of the study**



The previous figure shows two main variables of the methodology independent and dependence, these variables are an important step to use the data envelopment analysis (DEA) model to measure the technical efficiency for any decision making units. The study assumed that there is a sample of  $n$  units where each unit utilizes  $j$  inputs to produce  $r$  different outputs. Because, the DEA models cannot reflect the change in efficiency over period of study so that, Malmquist (total productivity) index can measure changes in efficiency for DMUs which were under evaluation and could be used to distinguish the type of unit efficiency.

### **1.9 Specification the Data:**

The data envelopment analysis can be applied to inputs and outputs data, these data cover the period (2001 - 2010). The process of measuring the . Where labor, finance and machines can be used as inputs variables. While sorghum and sesame products as outputs variables in the mechanized rain fed agricultural

sub-sector. The data collected from the two major schemes; south Kordofan and Gedaref mechanized rain fed agricultural schemes, so these inputs and outputs data are important variable according to data envelopment analysis (DEA) technique to measure the Malmquist productivity index (MPI) in any decision making units.

The study uses both constant return to scale (CCR) and the variable return to scale (BCC) model of (DEA) to measure the Malmquist productivity index (MPI) and its components, as a very important steps to measure efficiency of this agricultural sub-sector sector; the Mechanize rain fed schemes " in both south Kordofan and Gedaref State during 2001- 2010. In addition to the above the models were based on two different ways; the output orientation and input orientation.

The data of study were taken from the Sudanese agricultural records and reports, "the mechanized rain fed agricultural corporation" and Sudanese agricultural bank. Also some data were taken from the head quarter of ministry of agricultural - department of and agricultural economics.

In the coming chapter, the study will throw lights on some topics in Sudanese agriculture that is related to the study. In addition, the chapter is describing the study areas. Also the chapter gives lights on some factors that have direct effect on agriculture activities and efficiency such as geographical and soil factors.

In the next chapter, the study reviews and discusses the available related literatures, and relevant periodicals concerning technical efficiency and productivity change measurements.

