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Metatechnology Analysis of Mena and Gulf of Guinea African Countries' Agricultural Productivity

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Abstract – **The metatechnology analysis of countries' agricultural productivity was analyzed and the discussions of the study were divided into two regions of Middle East and North African (MENA), and Gulf of Guinea Africa Countries (GGA) based on their geographical location. Data Envelopment Analysis (DEA) model was used to analyse Panel data of input-output data from 10 MENA and 10 GGA regions from 1994 to 2013.The results revealed that Gabon, Benin, Nigeria, Jordan, Tunisia, Egypt are the best performing countries. The regional frontier, metafrontier, and metatechnology ratio (MTR) of the GGA region were higher than that of the MENA region. The mean technical efficiency for the pool data of both regions was 0.745, this means that the region as a whole could only produce on average 74.5% of the potential output at the given technology and suggests about 25.5% potentials for improvement in the sector. The difference in the regional and metafrontier showed that regional constraints are a subset of that of metafrontier production function. The t-test affirmed a significant difference in the regional efficiency, metafrontier, and metatechnology ratio of MENA and GGA regions. The study suggests transference of technology, as well as diffusion of technical know-how should be encouraged between GGA and MENA countries.**

Keywords –**Agricultural Productivity, Technical Efficiency, Metatechnology Ratio, MENA and Gulf of Guinea African Countries.**

I. Introduction

Agricultural efficiency is important because it enhances productivity which is the major interest of any economy. It is an essential source of overall growth in an economy, as agriculture develops, it releases resources to other sectors of the economy. Agriculture plays an important role in the economies of most of the countries in the Middle East and North Africa (MENA) region and African countries as a whole. Despite the fact that MENA most land is desert (water scarce) and dry region in the world, many countries in the region, highly depend on agriculture.

MENA and Gulf of Guinea African countries' (GGA) agriculture is quite a diverse sector whose contribution to economic development is important considering the stage of development in which the countries of the region are. Despite the fact that countries in both regions are oil wealth nations which contribute majorly to their national incomes (more than half of the GDP), majority of the population about 70% to 80% rely majorly on agriculture as source of livelihood and also depend on agriculture for employment (World Bank, 2013). The regions' agriculture contribution to GDP is relatively diverse ranging from a high of more than 20% for Syria and Morocco to a low of less than 6% for Jordan and Libya in MENA region and also its contribution to that of Gulf of Guinea African countries like Nigeria and Ghana, cannot be overlooked (Parinaz et al., 2013). This relatively limited contribution to GDP does not reflect the true importance of agriculture in employment and as source of livelihood.

It is widely agreed that increase in the productivity, arising from innovation and changes in technology is the main contributor of economic growth. This has been the base of successful industrialization in now developed economies such as the Unites States, Japan or countries in the European Union (USDA, 2015). The productivity of a production unit can be measured by the ratio of its output to its input, productivity in these regions (MENA and Gulf of Guinea African countries) still lag considerably behind that of other developed countries especially in other continents, as well as the regions' potential. On average, about 65% of the labour force in Africa is employed in agriculture, yet about 32% of GDP is accountable to agriculture, showing relatively low productivity (World Bank, 2013). Africa's rural population, therefore, has been unable to move out of poverty principally because of inability to transform their basic economic activity of agriculture to high productivity levels. It is important to take cognisance of agriculture in improving the economies through sustained improvements and development in agricultural productivity.

Efficiency can be defined as the extent to which a decision-making unit (DMU) can increase its outputs without increasing its inputs, or reduce its inputs without reducing its outputs. Technical efficiency is measured as the ratio between the observed output and the maximum output, under the assumption of fixed input, or, alternatively, as the ratio between the observed input and the minimum input under the assumption of fixed output. Therefore, for increased productivity and profitability, farmers need to improve on the management practices through trainings and transfer of knowledge and skills from less to more efficient farmers or increase on adoption of new available technologies.

Weak agricultural technology has many negative impacts on the productivity. The term technology means "application of knowledge and tools accurately for achieving the envies goals and economic objectives". Thus for higher productivity it is necessary to follow this definition. In developing countries, farmers mostly use the old traditional ways of cultivation which is why their productivity is low. Which is why if the new techniques of production is not followed and keep owning to the old traditional ways of cultivation, our production process will remain slow. A relevant question for agricultural policymakers is whether to pursue a strategy directed towards technological change or a strategy towards efficiency change. That is why efficiency differences among countries, and mainly between Middle East and North African (MENA) countries and Gulf of Guinea African countries, emerged as a central issue of development economics.

A lot of studies have been conducted on agricultural productivity in many part of the world. The study on Agricultural Productivity Growth and Incidence of Poverty was carried out by (Ajao et al., 2013) using African experience and Food and Agriculture Organisation (FAO) data covering two decades (1971-2009) was used while adopting Malmquist Index Total Factor Productivity (TFP) as an indicator of agricultural productivity. Human Development Index (HDI) was also adopted as proxy for poverty. Mounir and Mohamed (2009) also used Malmquist Index Method to measure agricultural productivity growth in the Middle East and North Africa (MENA) countries during the period of 1970-2000. Belloumi and Matoussi, (2009) calculated TFP growth rate for 16 countries in Middle East and North Africa (including Iran, Iraq, Turkey and Syria) and encountered increasing agricultural productivity for the group. Tayebi (2014) used stochastic frontier production to analyse agricultural productivity in the greater Middle East. Despite all these studies, there is still a vacuum which this study filled in terms of regional distribution, scope and methodology. This will contribute immensely to knowledge and open more room for others to focus more on Gulf of Guinea African countries and MENA countries towards reducing the deficit in the ratio of population growth to rate of increase in agricultural productivity.

At this point, it must be noted that MENA and Gulf of Guinea African countries' agricultural productive performance is dependent not only on the available resources (inputs) but also and most importantly on their efficient and productive use. To further understand the impact of regional variation on the estimation of efficiency in agricultural production, it is desirable to examine how agricultural production technologies differ in MENA and Gulf of Guinea African countries to provide new evidence on production efficiency and metatechnology. Therefore, the objectives of this research are:

1. To estimate the descriptive statistics of MENA and Gulf of Guinea African countries.
2. To highlight the countries' pair counts and production efficiency of MENA and Gulf of Guinea African countries' region.
3. To determine the metafrontier of each region's result.
4. To assess the meta-technology (MTR) of all regions.

The remainder of this paper is organized as follows; we provide in section II a more detailed review of the literature and present in section III the methodology. In section IV we discuss our results. Finally, the last section is conclusion and recommendation.

II. Literature Review

According to Dethier (2011), the growth of agricultural productivity has stalled. The yields of major grains grow by about 1 percent per year, which is lower than the population growth rate. Expanding the cultivated area is not a possibility to meet future needs, in order to feed the growing population the only solution is increasing agricultural productivity. Increasing productivity that gives a major boost to economic growth and substantially reduce poverty in low-income economies such as Sub-Saharan Africa depends on a range of factors (Dethier, 2011; World Bank, 2013). Achieving productivity growth relies on the efficiency of combining resources and the support systems available particularly those that motivate the human capital. Motivating the human capital is underpinned by theories some of which are discussed in this study.

With a glance at global agricultural production, Alston et al. (2010) showed decrease in global yield growth rates for wheat, corn, soybeans and rice over period 1990-2007 for middle and high income countries.

Fuglie (2010) found decrease in global yield growth rates while his results indicate decreasing TFP growth rates in developing economies. On average, agricultural TFP growth rate has decreased from 2.30 percent over the 1990s to 1.90 percent over the 2000s.

Belloumi and Matoussi (2009) calculated TFP growth rate for 16 countries in Middle East and North Africa (including Iran, Iraq, Turkey and Syria) and encountered increasing agricultural productivity for the group.

Parinaz et al., (2013) used means Stochastic Frontier Analyses (SFA) to analyse agriculture efficiency in MENA, it showed that efficiency ranges between 41 percent in Egypt and 87 percent in Bahrain. The mean efficiency levels are about 0.70 for agriculture sector over the period1995-2008, which means about 30 percent of total cost can be saved if agriculture sectors were operating.

Tayebi (2014) using stochastic frontier production to analyse agricultural productivity in the greater Middle East reported that agricultural productivity is increasing in the region annually at the rate of 2.2%. Furthermore, the results indicate that secondary school enrolment, political rights and civil liberties, years since independence, openness and major conflicts played an important role in the differential performance of the countries in this region.

Ajetomobi (2008) in an attempt to estimate Total Factor Productivity (TFP) of Agricultural Commodities in Economic Community of West African States (ECOWAS): 1961 – 2005 considered rice, cotton and millet. Astronomical growth was evidenced in the TFP of all the selected crops with rice showing impressive result after an outstanding performance of rice considering the TFP in ECOWAS and pre-ECOWAS sub-period, rice and millet hard more impressive TFP in ECOWAS period (1979-2005) but larger TFP for cotton in pre-ECOWAS period. In both periods, there is the sustenance of productivity growth of rice and cotton through technological progress while the efficient use of inputs sustained the productivity growth in millet Ajao et al., (2013) while carrying a study on Agricultural Productivity Growth and Incidence of Poverty: An Experience from Africa reported that the result of Malmquist TFP index analysis showed that there was an 0.2 percent growth per annum of average TFP and a large variation in growth rate over the period under review across the sampled countries. Twenty-two countries representing about 52% of the total sample experienced productivity growth, Congo and Somalia experienced decline in growth. From the overall result, there were 3.6, 3.3 and 2.6 increases in agricultural productivity in the North, East and South Africa, while Western and Southern Africa regions experienced decline in agricultural productivity due to weakening efficiency level. The continent as a whole witnessed 2.1% surge in production frontier which shows technological improvement and a 1.8% reduction in efficiency level.

Ikala (2010) has described that agriculture is the profession of majority of humans. The United Nations Organization (2010) estimated that the world as a whole, over 50% of the world population is engaged in agriculture or dependent of it for a living, this is a general description of the sector. On the other hand, it includes farming, fishing, animal husbandry and forestry.

Agriculture has been defined as the production of food and livestock and the purposeful tendering of plants and animals, (Olajide et al., *2013*). He additionally described agriculture is the stronghold of several economies and it is essential to the socio-economic improvement of a nation since it is a key component and feature in general development. Essentially, the agriculture sector play an important role in the development of an economy in four critical ways - factor contribution, product contribution, foreign exchange contribution and market contribution according to World Bank (2007).

The agricultural sector faces growing global and regional demand for agricultural products for food, feed, industry and fuel. Continued population and income growth, combined with urbanization, particularly in developing countries and, as we have seen, including those in SSA, is placing pressure on current food supplies at the same time that global productivity increases are levelling off. At the same time, geo political and environmental concerns are placing increased emphasis on the replacement of petroleum with renewable sources, such as crops, for production of fuels, lubricants and fibres.

The rural economy of Sub-Saharan Africa countries continues to be majorly rooted in agriculture compared to other regions. Sixty-two percent of the population of Sub-Saharan Africa (excluding South Africa) are employed in agriculture and they contributed 27% of the Gross Domestic Product in 2005 as reported by Staatz et al., (2007). Smallholder farms dominate these agricultural production systems. Smallholder farms, are characterize by having two hectares or less, representing eighty percent of all farms in Sub-Saharan Africa, and contribute up to 90% of the production in some Sub-Saharan Africa countries as at 2009 (Wiggins, 2009).

Nin et al., (2009) estimated the Malmquist index for 59 countries for the period 1967 - 2003. The aim of their paper is to measure and compare agricultural TFP growth in China and India. They found that TFP growth was high in China, with an average annual growth of 2.11%. In India the TFP growth is slow and lower than in China but it was positive.

III. Research Methodology Data Analysis

This study employed non-parametric methods to measure technical efficiency of agricultural productivity in MENA and GGA countries. The DEA, using the mathematical programming approach to the evaluation of efficiency, goes under certain assumptions that the structure of production technology envelops the data as tightly as possible. The DEA has some advantages over the parametric approaches. Firstly, since it uses linear programming and constructed series of equation there is no need for assumptions set for a DEA production function. The method also gives an allowance for comparing different production frontiers in terms of a performance index. Also, efficiency estimate is not affected significantly when using small sample size. Finally, the DEA gives the freedom of determining efficiencies of the sub-vectors, for example specifying a target resource use, unlike the stochastic production frontier (Speelman et al., 2007).

DEA is a linear programming methodology that uses data on output and inputs of countries, to construct a piece-wise linear surface over the data point. This frontier surface is constructed by the solution of a sequence of linear programming problem. The procedure is easily introduced via the ratio. For each country we would like to obtain a measure of the ratio of all outputs over all inputs, such as u’yi/v’xi, where ‘u’ is an m x 1 vector of output weights and ‘v’ is a k x 1 vector of input weights. Under constant return to scale assumption, the optimal weights are obtained by solving the mathematical programming problem:

$$Max_{u,v}(u'y_i/v'x_i), \quad (1)$$

Subject to

$$u,'y_j/v'x_j \le 1, \qquad j = 1, 2 \dots \dots, N$$

$$u, v \ge 0 \quad (2)$$

This involves finding values for u and v such that the efficiency measure of the i-th farmer is maximized, subject to the constraint that efficiency measures must be less than or equal to one. To avoid having an infinite number of solutions, one imposes the constraint v'x = 1, which provides,

$$Max\ \mu, v\ (\mu' y_i), \quad (3)$$

Subject to

$$v'x_i = 1$$

$$\mu' y_j - v' x_j \le 0, \quad j = 1, 2, \ldots \ldots, N$$

$$u, v \ge 0 \quad (4)$$

Where the notation changes from 'u' and 'v' to 'μ' and 'v' reflect the transformation. This form is known as the multiplier form of the linear programming problem (Coelli, 1996). Using the duality in linear programming, one can derive an equivalent envelopment form of this problem:

$$Max_{\theta,\lambda}\theta, \quad (5)$$

Subject to

$$-y_i + Y\lambda \ge 0$$

$$\theta x_i - X\lambda \ge 0$$

$$\lambda \ge 0 \quad (6)$$

Where θ is a scalar and λ is a Nx1 vector of constants. θ measures the ratio of the observed vector of outputs to the maximum vector that could be achieved, given the input vector. The value of θ obtained will be the efficiency scores for the ith country. The constant returns to scale (CRS) assumption are appropriate when all firms are operating at an optimal scale. The use of the variable returns to scale (VRS) specification will permit the calculation of efficiency scores devoid of scale efficiency effects. According to Coelli (1996), the VRS specification has been the most commonly used specification in the 1990's. We also opted for the VRS specification. The linear programming problem under CRS in the equation above can be easily modified to account for VRS by adding the convexity constraint: N1'λ=1 to equation (3) to give:

$$Max_{\theta,\lambda}\theta, \quad (7)$$

Subject to

$$-y_i + Y\lambda \ge 0$$

$$\theta x_i - X\lambda \ge 0$$

$$N1'\lambda = 1$$

$$\lambda \ge 0 \quad (8)$$

Where N1 is an Nx1 vector of one. If we have data on Lk countries, the above linear program is solved Lk times for each year. The metafrontier is constructed using a DEA model based on the pooled data for all the countries in all the regions. Since we have a total of L= ΣkLk countries, we re-run the above linear program model with the inputs and output matrices with data for all countries. Data Envelopment Analysis Computer program (DEAP 2.1) and a multi-stage DEA procedure was employed to run the models.

IV. Source of Data and Sampling Method for Data

The study was based on data exclusively drawn from the FAOSTAT system of statistics (AGROSTAT) used for dissemination of statistics compiled by Food and Agriculture Organization (FAO). A panel data on 10 countries in MENA region and 10 countries in Gulf of Guinea region of African countries from 1994 to 2013 was used

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Table I: Countries grouped according to regions

Region	List of Countries	Characteristics
Region 1- MENA	Iran, Iraq, Jordan, Turkey, Algeria, Egypt, Libya, Morocco, Sudan, Tunisia	World most water scarce and dry land, with high dependency on climate sensitive agriculture.
Region 200 – Gulf of Guinea region of African countries	Cote Devoir, Ghana, Togo, Benin, Nigeria, Cameroon, Gabon, Congo Republic, Democratic Republic of Congo, Guinea	Great variation in climate, including precipitation. Varied scope for irrigation.

V. Measurement of Variables

Output

The output aggregates that will be used here refer to the final output (agricultural output) in different countries exclusively. These aggregates will be constructed using international average prices (expressed in US dollars). The output series are adjusted for price differences across countries, expressed in billions of US dollars. The 2004-2006 base years (in million dollars) is used to cover the study period, 1994-2013, using the FAO production index number series.

Input

Labour: The economically active population in agriculture includes all persons engaged in economic activities in agriculture, forestry, hunting or fishing. Since we are to examine the agricultural sector productivity for a country, as a whole, it is quite appropriate that the economically active population is used as an aggregate measure of the labour input into the sector.

Land: This variable will includes the arable land, land under permanent crops as well as the area under permanent pasture, expressed in millions of hectares.

Livestock: The livestock input variable that will be used in the study is the sheep-equivalent of five categories of animals. The categories of animals to be considered are buffaloes, cattle, pigs, sheep and goats. Data on numbers of these animals will be converted into sheep equivalents using the following conversion factors: 8.0 for buffalo and cattle; and 1.0 for sheep, goats and pigs.

Fertilizer: This input is quite difficult to measure. The FAO Fertilizer Yearbook provides details of fertilizer production and use in different countries, and the data available involve a large number of fertilizers. It is impossible to consider fertilizer data in such detail. Thus, following other studies (Rao *et.al., 2005;* Nkamleu *et.al., 2006*) on inter-country comparisons of agricultural productivity, the sum of the nitrogen (N), potassium (P_2O_2) and phosphate (K_2O) contained in the commercial fertilizers that were applied as the measure of fertilizer input in this paper. This variable is expressed in thousands of tons.

VI. Result Discussion Descriptive Statistics

The results of the descriptive and DEA analysis brought about some interesting outputs. The mean, standard deviation, minimum and maximum were computed for MENA and GGA countries region as presented in table II.

Table II. Descriptive statistics

Region	Variable	Obs	Mean	Std. Dev.	Min	Max
MENA	Net output (‘000 2004-2006 dollars)	200	4343631	5414147	1262.35	2.19e+07
	Land (‘000 ha)	200	33947.06	37861.85	963.3	141235.2
	Livestock (‘000 2004-2006 dollar)	200	801650.3	695462.1	93310	2995427
	Labour (‘000 persons)	200	15183.56	12260.04	925	46752
	Fertilizer (metric tons)	200	58424.66	63726.72	2000	360846.6
GGAC	Net output (‘000 2004-2006 dollars)	200	5068745	8161369	194588.3	3.64e+07
	Land (‘000 ha)	200	17693.03	18990.97	2400	73700
	Livestock (‘000 2004-2006 dollar)	200	531178.3	830770.4	37660	3711840
	Labour (‘000 persons)	200	4990.36	7968.119	189	93589
	Fertilizer (metric tons)	200	28872.76	57073.2	787	370868.3
POOL	Net output (‘000 2004-2006 dollars)	400	4656188	6928989	1262.35	3.64e+07
	Land (‘000 ha)	400	25820.04	31000.87	963.3	141235.2
	Livestock (‘000 2004-2006 dollar)	400	666414.3	777037.4	37660	3711840
	Labour (‘000 persons)	400	10086.96	11518.34	189	93589
	Fertilizer (metric tons)	400	43648.71	62200.7	787	370868.3

Source: Field Survey, 2017

Peer Counts

The DEA analysis identifies peers (best performing countries). In table III, each country that makes up the whole region were treated as a different observation in different years and it is in line with the study of Rao et al, (2005).

Most countries relate with the later years of 2000 to 2013, which was assumed to be an improvement in agricultural productivity over a particular period of time, then the frontier shows peers from later years. Congo Republic dictated the way in the early year (1994) majorly because of the agriculture in forestry but which could not continue with the pace of agriculture because of the petroleum extraction which has supplanted forestry as the mainstay of the economy. Also Nigeria (2000, 2004, 2005, 2006, 2010, 2012, 2013) appeared as peers, Nigeria appeared as peers for most countries. Gabon appeared as peers in (2007, 2010, 2013) leading the way for many other countries through various years (123) in 2013. This may be due to the development in agricultural sector as one of the key part of Emerging Gabon Strategy Plan (Plan Strategique Gabon Emergent PSGE) like a government policy agricultural Development Investment Programme (Projet de Developpement et d’investissement Agricole au Gabon, PRODIAG) across all provinces which boosted the development of arable land and increased productivity.

Jordan, Tunisia, and Egypt were also best performing countries in MENA countries. Tunisia lead the way in the year 1995 with (88), this might be as a result of diverse economy Tunisia is involved which agriculture is part of the major sector along line with industry and services. The country is rated the most competitive economy in Africa and 45th in the world by the World Economy Forum in 2009, there is increase in the training of farmers in the techniques needed through an integrated approach to improve agricultural practices and they are becoming increasingly able to participate and cope with unpredictable weather patterns and little arable land affecting them in the past years.

Jordan was peered in (1994, 1996, 2004 and 2013). While Egypt peers in (2002) for (21) and (2008) for (17) decision making units (DMUs).

Table III. Peer Counts

Region	Peer Count	Country	Year
Gulf of Guinea	25	Congo Republic	1994
	16	Democratic Republic of Congo	1994
	21	Togo	1994
	25	Togo	1995
	13	Togo	1996
	15	Democratic Republic of Congo	1999
	32	Cote divoire	2000
	19	Nigeria	2000
	32	Benin	2003
	26	Nigeria	2004
	34	Benin	2005
	20	Nigeria	2005
	13	Benin	2006
	85	Nigeria	2006
	20	Gabon	2007
	84	Benin	2008
	12	Gabon	2010
	25	Nigeria	2010
	16	Benin	2012
	29	Nigeria	2012
	91	Benin	2013
	25	Cote divoire	2013
	35	Democratic Republic of Congo	2013
	123	Gabon	2013
	25	Ghana	2013
	31	Nigeria	2013
MENA	64	Jordan	1994
	57	Jordan	1996
	88	Tunisia	1996
	21	Egypt	2002
	22	Jordan	2004
	17	Egypt	2008
	19	Jordan	2013
	15	Tunisia	2013

Source: Field survey, 2017

Technical Efficiency and Meta-Technology Ratio (Mtr)

Ten (10) countries from MENA and ten (10) countries from GGA were considered for the study. The average regional efficiency for twenty (20) years period was presented in table IV. The technical efficiency score for the regions were fairly stable over the twenty (20) years. The technical efficiency of MENA for the group period of (1994-1998, 1999-2003, 2004-2008, 2009-2013) were 0.803, 0.761, 0.781, and 0.810 respectively while the score for GGA were 0.988, 0.990, 0.976 and 1.000 respectively. The technical efficiency for the region of MENA declined from 1994-1998 through 1999-2003 and 2004-2008 from 0.803 to 0.781 while it increased in the period of 2009-2013 to 0.810. The highest technical efficiency score was recorded in the period 2009-2013 with score of 81%. The mean technical efficiency score the period in MENA was 0.803 throughout the period in reference which means the region MENA produced 80% of the potential output using the regional technology available. Also, in GGA region, the mean technical efficiency score for the whole period was 0.988 which indicates that GGA region could only produce 98% of the potential output using the regional technology available. The lower technical efficiency score in MENA region may be due to the scarce and limited arable land and also the conflict and war in some part of the region.

Metafrontier estimates the technical efficiency of all the groups, which allows computing base on the distance between a region potential output level and the technology leader's potential output level for a given input mix. The technical efficiency related to metafrontier for the period of (1994-1998, 1999-2003, 2004-2008,2009-2013) were 0.752, 0.732, 0.754, and 0.796 respectively for MENA region while GGA region were 0.959, 0.965, 0.941, and 0.948 respectively. MENA had a mean technical efficiency score of 0.716 throughout the period while GGA region also had mean technical efficiency of 0.888, this implies that MENA and GGA regions would be producing respectively 71.6% and 88.8% of the potential output should it be using the meta-technology (technology at the metafrontier). It could be found that there was clear differences in the technical efficiency related to metafrontier and technical efficiency related to the group frontier, this as a result of the constraints in the regional linear programming problem are subsets of the constraints in the metafrontier linear programming problem. The difference in the technical efficiency score related to group frontier and metafrontier was 0.087 for MENA and 0.1 for GGA region, these depict the bias of the technical efficiency obtained by using regional frontiers relative to the technology available for that of the whole region of both MENA and GGA regions. The GGA region has the highest technical efficiency related to both regional frontier and metafrontier production technology compare to that of MENA region, this suggests the need GGA countries to acquire new technology in order to improve their productivity from the current level. It could also be found that the mean technical efficiency for the pool data of both region of MENA and GGA was 0.745 throughout the period of reference, this means that the region as a whole could only produce on average 74.5% of the potential output at the given technology and suggests about 25.5% potentials for improvement in the sector. This is related by findings by Blaise Nkemleu and Joachim in 2006 which reported that the average technical efficiency of Africa countries was about 0.74 when they carried out metafrontier analysis of regions in Africa (Northern Africa, Western Africa, Central Africa, East Africa, and Southern Africa). But differ and more than 0.68 found by Rao et al., 2003 in their study where they carried out metafrontier analysis on Africa agricultural sector and compared it with the world agricultural sector using 1986-1990 panel date.

Meta-technology (MTR) ratio can be interpreted as the technological gap faced by agricultural sector in these regions when their performances are compared with the continental level. Estimates of meta-technology(MTR) presented in table 9, MENA had the lowest productivity potential ratio of 0.892 and this can be interpreted that if MENA region was to be 100% efficient, the technology in the region would only allow it to produce 89.2% of what it would do with meta-technology (technology at the metafrontier), it also suggest that even if all the countries in MENA region achieved the best practice with respect to the technology observed in the region, they would still be lagging behind with a technology gap of 0.892. GGA region meta-technology ratio (MTR) was 0.899 which could be interpreted that if GGA region was 100% efficient with respect to its regional technology, its regional technology would only allow the region to produce 89.9% of what it would produce with meta-technology (technology at the metafrontier). it could be also noted that the meta-technology ratio (MTR) of MENA and GGA were higher than that of the pool data of both MENA and GGA region together which was 0.858, this indicates that if whole region of MENA and GGA region technology is improved, both regions would be better for it.

From a point of view, the difference in region shows the type of intervention needed to be put in place in MENA region and GGA region to enhance the productivity of both regions as a whole. We had lower efficiency score of MENA lower than that of GGA region in regional frontier and metafrontier but both had almost the same Meta-technology ratio, this might be as a result of scarce land for arable, lack of technical know-how or the technology were only available to few who could afford it. Also the productivity potentials for GGA region implies they need to seek for new technology, they have almost exhausted the ones available and the efficiency score of the region corroborate the fact that because of its high values of almost 100% across the period (this could be verified in the regional frontier in the period of 2009-2013). Another critical area to observe is the decline in the meta-technology ration of GGA region over the period of 20 years, this is disquieting with the millennium development goal of an annual growth rate above 7% a year required to achieve economic convergence with other developing countries and to maintain similar quality.

Table IV: Technical Efficiency and Meta-Technology Ratio

Region	Year	TE(Region)	TE(MF)	MTR
MENA	1994-1998	0.803	0.752	0.936
	1999-2003	0.761	0.732	0.962
	2004-2008	0.781	0.754	0.965
	2009-2013	0.810	0.796	0.983
	1994-2013	0.803	0.716	**0.892**
GGAC	1994-1998	0.988	0.959	0.971
	1999-2003	0.990	0.965	0.975
	2004-2008	0.976	0.941	0.964
	2009-2013	1.000	0.948	0.948
	1994-2013	0.988	0.888	**0.899**
POOL	1994-1998	0.868	0.813	0.937
	1999-2003	0.845	0.810	0.959
	2004-2008	0.854	0.823	0.964
	2009-2013	0.880	0.809	0.919
	1994-2013	0.868	0.745	**0.858**

Source: Field survey, 2017

VII. Conclusion and Recommendation

This study adopted the recently developed metafrontier functions techniques to investigate meta-technology analysis of MENA and Gulf of Guinea African countries' agricultural productivity using the panel data for a period of twenty (20) years (1994-2013). Since the state of knowledge pertaining to the transformation of agricultural inputs into outputs is technology, the study conceptualized the existence of an enveloping/overall technology referred to as the Meta-technology otherwise known as the technology at the metafrontier which is represented by the metafrontier production function. Also, the regional frontier which reveals partially the state of knowledge within the region. The decomposition (ratio) of the metafrontier and the regional frontier avail us the opportunity to determine and estimate the meta-technology ratio (MTR).

The study adopted the use of Data Envelopment Analysis (DEA) to estimate the regional frontier and metafrontier for Middle and North African region (MENA) and Gulf of Guinea Africa region (GGA), the study also estimated the descriptive statistics of the regions, the mean technical efficiency and meta-technology ratio (MTR) of the regions. The regional frontier was higher than that of the metafrontier because the regional constraints of linear programming were subsets of that of the metafrontier. The mean efficiency of regional frontier and metafrontier of Gulf of Guinea African region were higher than that of MENA region. DEA assumes al noise to be inefficiency and may be prone to outliers but it can be used in studying multi-output and multi-input technologies which can be delved into in future studies.

From a policy standpoint, the results of this study helped us to distinguish two regions where urgency should be on policy to help shift the technology and where the movement towards the best practice frontier is most desirable.

However, there is need to pay more attention to improving the technical efficiency of agricultural productivity because with the existing technology and available resources, there is more room to increase and improve the technical efficiency of the countries and the region as a whole.

The MENA region should maximize the opportunity they have by optimizing the use of the available technologies and availing genuine farmers the opportunity to these technologies so that their level of efficiency would improve. Also Gulf of Guinea African countries should seek for new technology so as to improve the production potentials towards the global technology.

There should be quick and sustainable conflict/war resolution in some part of MENA countries to improve infrastructures that will help or aid productivity.

Transfer of technology and diffusion of technical know-how should be encourage between MENA and Gulf of Guinea African countries to boost agricultural productions in the regions.

There should be more orientation and enlightenment to encourage investment in agricultural venture as well as labour saving technology to allow surplus labour to earn more off farm income to support farming.

There should be more private and government intervention in agricultural sector in the regions with more orientation and enlightment programmes, more subsidies for agricultural technology to encourage investment in agricultural sector.

In addition, agricultural research and innovation centres should be strengthened to develop and offer affordable and quality seeds and other agricultural inputs to generate growth in agricultural productivity.

These recommendations will go a long way in providing more resources for other sectors; reduce importation of food thereby improving the competitive position of countries in these regions and boost economic growth by contributing to the national GDP. Also, it will provide more food with lower prices, improve consumers' welfare, ensure food security, rural development will be facilitated in the process and therefore alleviate poverty.

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