Athens Journal of Mediterranean Studies- Volume 6, Issue 3, July 2020 – Pages 215-236

The Impact of Renaissance Dam on the Agriculture Sector in Egypt and Ethiopia

By Sally Mohamed Farid Mahmoud[*]

The study aims to determine impact of the Renaissance Dam on the agriculture sector in Egypt and Ethiopia by presenting Ethiopian gains from building the dam and the regional and international investors in it. The study analyzes performance of the agricultural sector in Egypt and Ethiopia, then the impact of Renaissance Dam on it, using the econometric analysis method to measure impact of the Renaissance Dam on the agricultural sector in Egypt and Ethiopia. The results show the impact of Renaissance Dam on reduces the agricultural yield in Egypt Due to its effect on reduces the irrigated area. The study ends with risks of building the Renaissance Dam on Egypt and Ethiopia.

Keywords: *The Renaissance Dam, agriculture sector, Ethiopia, Egypt*

Introduction

The decision to build the Renaissance Dam comes within a plan to develop the Ethiopian economy by providing sustainable energy and seeking to export electricity to neighboring countries. The costs of building the dam are covered by the Ethiopian government and its people, with participation of many regional and international forces through a number of companies investing in the Renaissance Dam.

The study aims to determine impact of the Renaissance Dam on the agriculture sector in Egypt and Ethiopia by using an econometric analysis method during the period (2000-2018). The study is divided into six parts; First: Literatures Review about Impact of Dams on the Agriculture Sector, Second: the Ethiopian Gains from Building the Renaissance Dam, Third: The International and Regional Investors in the Renaissance Dam, Fourth: Analysis of the Agricultural Sector Performance in Egypt and Ethiopia, Fifth: Measuring the Impact of the Renaissance Dam on the Agricultural Sector in Egypt and Ethiopia, Sixth: The Risks of the Renaissance Dam on Egypt and Ethiopia.

Literature Review about Impact of Dams on the Agriculture Sector

The study of Cestti and Malik (2016) used an econometric model to measure the indirect economic effects resulting from the hydroelectric dams. The study determined the indirect economic effects of the Bhakra Dam in Punjab region of India using the SAM matrix at 79/1980, for effects on the project's main outputs, namely the water flow from the dam and the electrical energy generated from it, as

[*]Associate Professor of Economics, Department of Politics and Economics, Faculty of Post-Graduate African Studies, Cairo University, Egypt.

https://doi.org/10.30958/ajms.6-3-3 doi=10.30958/ajms.6-3-3

well as impact of the dam on change in irrigated areas. The results of the study revealed that the Bhakra Dam in Punjab resulted in an increase in the income of all categories of the family sector in the dam area, especially for workers in the agricultural sector by 65% (Cestti and Malik 2016).

The study used the multiplier analysis of the High Dam project in Egypt using the CGE model, which is based on the SAM matrix at 1997/1998. The Egyptian economic performance was evaluated in two cases (in case of the dam and absence of the dam) and testing the returns of main crops in the two cases, the dam divided these crops according to the agricultural season. The most important results of the analysis were that the High Dam project in Aswan had a major impact on improving the economic performance of Egypt (Cestti and Malik 2016).

The study of Robinson and Gueneau (2014) measured the potential impacts on the Pakistani economy from building the Basha Dam, using the CGE Model based on SAM matrix data for the Pakistani economy. The results showed that about 63% of the agricultural production comes from the dam project, compared to about 20% from the Sindh region, and about 17% from rest of the Pakistani regions. The results also concluded the dam not lead to horizontal agricultural expansion that it did not increase the cultivated areas, but it had an excess of the agricultural return, and the growth rates in the Pakistani economy by 3% annually (Robinson and Gueneau 2014).

The study of Benedict and Obiero (2010) examined the extent to which the rice crop responded to the amount of irrigation water used in the Mwea irrigation system, measured the economic efficiency of water use, and the main factors explaining the efficiency as the amount of water withdrawn for irrigation, the area of irrigated land, capital and labor, as well as other technical, social and economic features of irrigation. The results showed a change of capital and labor with 1% lead to a change of production with 0.51%, 0.294%. While a change of 1% in water leads to a change of the output of rice with 0.099%, so the rice production is most responsive to capital and least responsive to the amount of irrigation water under the current level of technology (Benedict and Obiero 2010).

The study of Zohaib et al. (2013) used an econometric model to measure the impact of small dams on the agricultural productivity in the Ziarat region, by determining the main crops using data for 80 families from two villages, one of which had a dam and the other village did not have a dam by taking random samples. The Cobb-Douglas yield function was used, and the model was estimated using the OLS method to determine effect of the dam on the yield of apples in both villages. The explanatory variables were land area, number of years of farm experience, farm education, plant or tree age, harvest per kg, irrigation water used. The results showed the small dams had an effect on increasing the yield, through increasing in the storage capacity of the dam to reach water to far-off agricultural lands, which helped in the sustainability of agricultural returns. In addition to the yield was better at the village that had a dam than the other village (Zohaib et al. 2013).

The Ethiopian Gains from Building the Renaissance Dam

Ethiopia is proceeding with construction of the Renaissance Dam on the Blue Nile, and passes through Sudanese territory, to meet the White Nile in Khartoum. After its completion, the lake that forms behind the dam will be submerged, with an area of 1,680 km^2 of forest in northwest of Ethiopia, and the lake will displace 30 thousand local residents. It is expected that the amount of water held inside this lake will reach about 70 billion m^3 of water, the equivalent to the annual flow of the Blue Nile River at the Sudanese border, and the dam's electricity production capacity is expected to reach 6,000 megawatts (Consulate General of Ethiopia 2016).

Ethiopia embarked on building major dams, most of which were intended to generate hydroelectric power, but it was keen to use the storage capacity of these dams to store quantities of water used for irrigation of agricultural lands, which helps to increase crop productivity and horizontal agricultural expansion, where the agricultural sector is the mainstay of the Ethiopian economy, providing employment opportunities for more than 75% of citizens.

Ethiopia is working to generate electric energy through multiple projects, whether using thermal energy or major hydroelectric dam projects, in order to fill the deficit of electrical energy, especially with the low levels of access to electrical energy in rural areas. Ethiopia depends on its domestic energy resources, the hydropower is about 45 megawatts, the wind energy is 100 megawatts, the thermal energy is 5 megawatts, and the solar energy is 5.5 kilowatt-hours (UNDP 2012).

According to World Bank estimates, nearly 70% of Ethiopians do not have access to electricity, which restricts basic services such as schools and health clinics, they use wood and charcoal for home cooking which causes a wide range of health problems (The World Bank 2015). So, the Ethiopian government seeks to develop hydroelectric energy to meet local demand and to export the surplus according to the framework of growth and transformation plan (Gebreegziabher 2017).

Ethiopia has a number of basins within its territorial borders, as 12 basins for major rivers other than the Blue Nile, including the Omo River shared with Kenya. Ethiopia has prepared a scheme of dams on the Omo River similar to that of the dams on the Blue Nile, but with smaller capacities, given the smallness of the Omo River, compared to the Blue Nile. Ethiopia has planned to construct 5 dams on the Omo River in the name of the Jebby or Jijel dams, and already completed the construction of the first Jebby dam with a capacity of 184 MW, the second Jebby dam with a capacity of 420 MW, and the third Jebby dam at a cost of dollars 1.7 billion (Gilgel Gibe Affair 2008).

Ethiopia had justified its need to build the Renaissance Dam on several reasons, including:

1. The famine that Ethiopia suffers from, especially in areas of permanent drought and increasing poverty rates.

2. The dam project works to reduce agricultural land degradation that lead to soil erosion, in addition to reduce elimination of forest to search for fuel and coal, and find an alternative energy especially for poor families.
3. The project also includes other benefits such as reducing the losses of river water caused by evaporation (Consulate General of Ethiopia 2016).

The International and Regional Investors in the Renaissance Dam

Ethiopia had announced to fully finance cost of the dam, and had issued bonds targeting Ethiopians inside and outside Ethiopia for this purpose. However, the financing problem had become one of the most important challenges facing Ethiopia in building the dam. Despite the participation of the Ethiopian people, equivalent to 15% of the dam's total cost, the building cost had become an economic challenge for the Ethiopian government, as a result of cost rising from 4.7 billion dollars to 8 billion dollars because of the Ethiopian currency's decline against the dollar (Hathaway 2018).

Several international investors had contributed with the Ethiopian government in order to build the Renaissance Dam. These forces are represented in the following countries.

United States of America

The Renaissance Dam, which the Ethiopian government worked on secretly planning and designing with name the "Project X". Ethiopia announced the design of "Project X" only one month before laying the foundation stone, and the project name changed to "Dam Millennium" then to "Renaissance Dam" (Almal News 2019).

China

China has been a key partner in construction of the Renaissance Dam since 2013, when the Ethiopian Electric Power Corporation and the Chinese Equipment and Technology Company signed an agreement to lend Addis Ababa one billion dollars to transfer electricity for the Renaissance Dam project, in addition to expertise from China. The Industrial Bank of China introduced a loan to Ethiopia with 500 million dollars in 2010, in order to prepare studies for the dam. So china is considered as the largest country in the Renaissance Dam construction (Al3asemanews 2015).

The Ethiopian government has contracted with the Chinese group "Foyes Haydor Shanghai" to install and operate 6 turbine generators in the Renaissance Dam with 78 million dollars, and the Chinese company "Sinno Hydro" for engineering and electrical construction in order to accelerate civil works in the dam. In addition to the Chinese group "Composites Corp" that specialized in the installations and hydroelectric engines for generating electricity from the dam through the turbines, the Chinese group "Gezhouba", which works in the field of construction and contracting, and the Chinese company "Voith Hydro Shanghai" that works for Completing the Dam construction (The New Arab 2019).

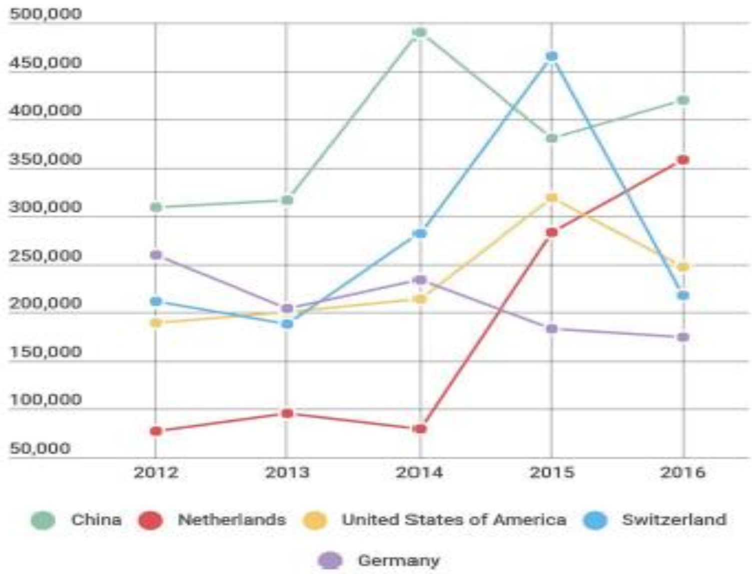
France

The French company "GE Hydro Franc" had signed an agreement with Addis Ababa to manufacture the generators and turbines of the Renaissance Dam. The agreement stipulates that the French company installs two turbines, in addition to install 5 power generating units, with a financial cost of 61.80 million dollars, in cooperation with the "Comlex" company. Also the mechanical engineering group "Voith" which had agreed upon to supply turbines to the Renaissance Dam (Farid 2020).

Italy

Italy is one of the Renaissance Dam shareholders, through the Italian company "Salini Impregilo" specialized in the dam's construction. It plays the main contractor to implement the civil engineering works of the dam, and it is one of the most prominent companies in the field of infrastructure and construction of hydroelectric stations (Salini 2019).

Figure 1. *Ethiopia Export Partners (in Thousands of USD)*



Source: UNICA 2018

Figure 1 shows that China is considered the most important partner for Ethiopia, which exports to china reach 425 million dollars in 2016, then Netherlands 360 million dollars, then United States of America 250 million dollars, Switzerland 225 million dollars, and Germany 200 million dollars.

Several regional investors had contributed with the Ethiopian government in order to build the Renaissance Dam. These forces are represented in the following countries:

Turkey

Turkey is one of the five largest countries investing in Ethiopia, with an investment value of 350 million dollars. The top five countries that invest in Ethiopia are China, India, Saudi Arabia, the United States of America, and Turkey, in terms of capital and number of projects. Turkish companies obtained licenses for 16 projects, to take advantage of the investment opportunities available in Ethiopia, and the support and facilities provided by the Ethiopian Investment Agency to foreign investors (State Information Service 2020).

Qatar

Qatar signed 3 cooperation agreements and 3 memoranda of understanding with Ethiopia. Qatar and Turkey was financing the Renaissance Dam through huge investments and agricultural projects, to grow one million two hundred thousand acres in the dam region. The two countries paid the first batch of the project, to facilitate the Renaissance Dam construction, in addition to other projects such as railway development. Turkey and Qatar provided 5 billion dollars for financing the dam, in addition to agreeing military deals that include anti-missile to protect the dam (State Information Service 2020).

Saudi Arabia Kingdom

Saudi Arabia introduced through one of investors 1.5 billion Ethiopian Birr (88 million dollars) to the Ethiopian government for building the dam, and had 3 agricultural companies in Ethiopia to grow 62 thousand hectares. The company "Horizon" had cultivated 20 thousand hectares in the Beni Shankul region where the Renaissance Dam is located. Two of cement factories in Ethiopia, which owned by Saudi Arabian investors, supplied the raw materials used in building the Renaissance Dam. In addition to sign contracts to provide logistical services for the Renaissance Dam, and one of investors denoted by 80 million dollars for the dam in 2015. The Saudi Fund for Development also provided funds and soft loans for projects directly related to the Renaissance Dam, under the name of “Stimulating Development in Rural Ethiopia” (Africa News 2019).

United Arab Emirates

Emirati companies participated in construction of the Renaissance Dam, Abu Dhabi also provided 3 billion dollars in the form of aid and investments to Ethiopia, and Emirati investments amounted to about 3 billion dollars in Ethiopia (Emasc-UAE 2019).

Israel

The Israeli defense company “Ravel” had contracted with the Ethiopian government to provide it with a Spyder-MR missile defense system to secure the

Renaissance Dam and the surrounding area from any air or missile attacks. Ethiopia had also contracted with Israeli companies in the fields of databases and communications, with the aim of establishing networks for the Renaissance Dam. In addition to the Israeli company "Gigawat Global", that invested 500 million dollars in Ethiopia in the field of renewable energy and human resources development (Farid 2020).

Analysis of the Agricultural Sector Performance in Egypt and Ethiopia

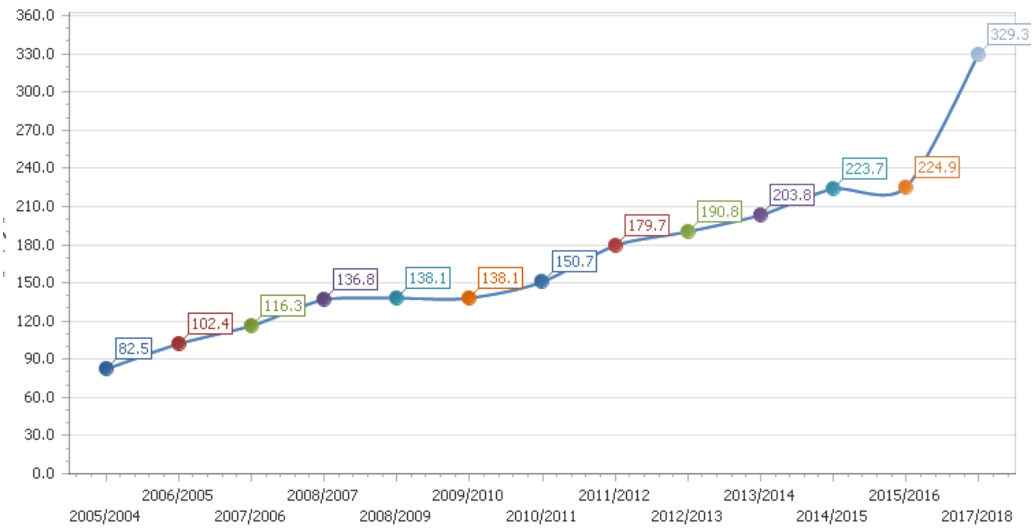
Analysis of the Agricultural Sector Performance in Egypt

The problem of the food deficit in Egypt has a great correlation with the lack of optimal utilization of the available economic and human resources, also increasing of the population and the limited natural agricultural resources are considered as factors that exacerbated the food problem in Egypt and increased the food gap.

Statistics indicate that the population of Egypt is expected to reach 116 million by 2030, this demographic explosion results from pressure on economic activity, so the food supply is unable to meet the increasing demand for food, since the volume of food production is not sufficient to its consumption, which requires resorting to import to meet the deficit, and this in turn constitutes a great danger to the Egyptian economy as it weak its assets of the foreign currencies (The World Bank Database 2020).

Figure 2. *Net Agricultural Income in Egypt*

Billion LE



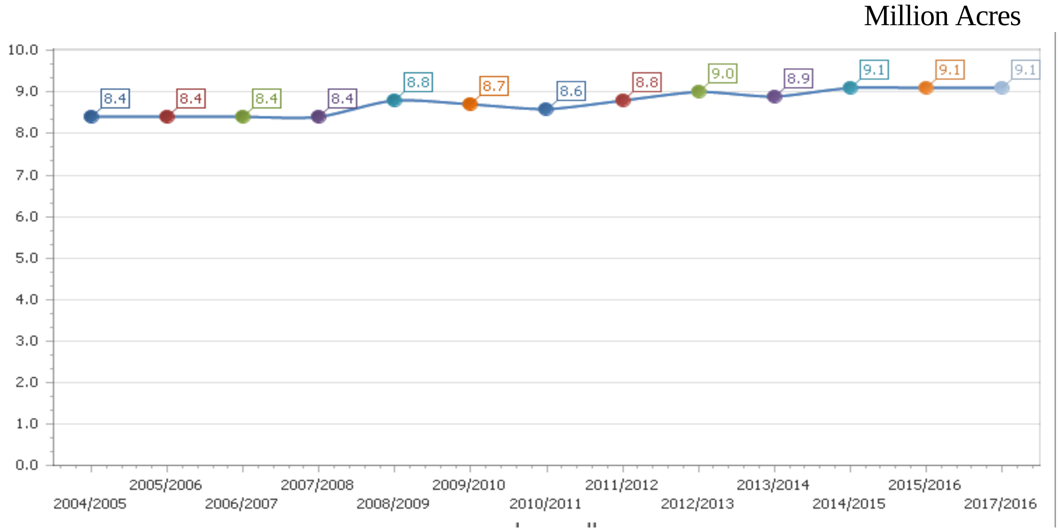
Source: CAPMAS

The area suitable for agricultural exploitation in Egypt is estimated at 8.6 million acres, constituting 3.6% of the total area of Egypt (240 million acres, one million square kilometers), and the limited and misuse of water resources makes it unable to keep pace with the growing demand to meet the population's water needs (El-Sabaa et al. 2019).

The agriculture sector is considered an important sector of the Egyptian economy and a source of the national food security; it employs about 25.6% of the total workforce in 2018. The agriculture sector has contributed about 13.4% of the real gross domestic product (CAPMAS). Figure 2 shows that net agricultural income in Egypt reached 329.3 billion LE in 2017/2018.

Figure 3 shows that the cultivated area in Egypt amounted 9.1 million acres in 2016/2017.

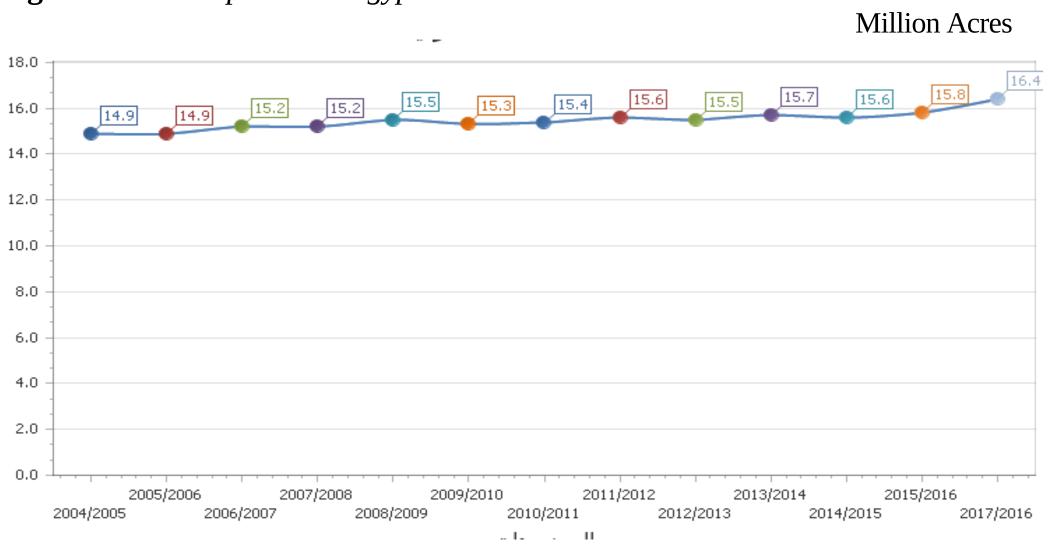
Figure 3. *The Cultivated Area in Egypt*



Source: CAPMAS

Figure 4 shows that the crop area in Egypt amounted 16.4 million acres in 2016/2017.

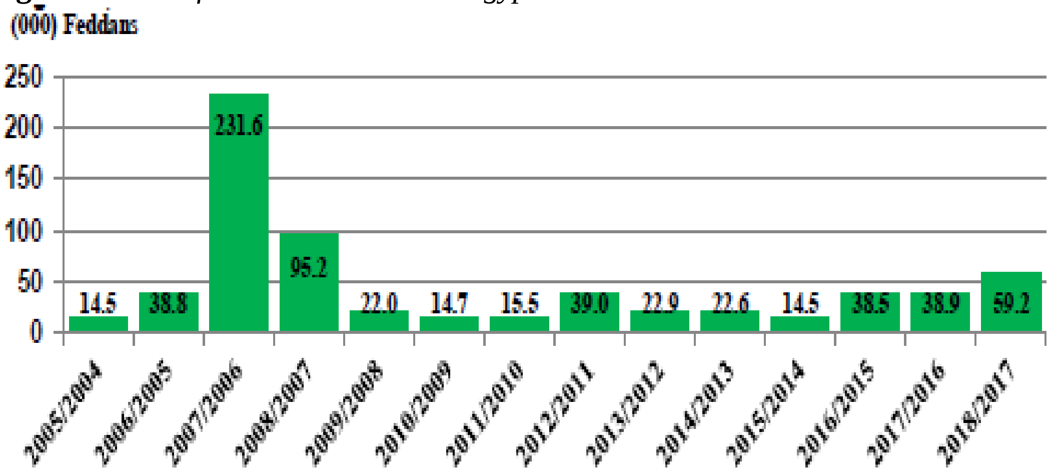
Figure 4. *The Crop Area in Egypt*



Source: CAPMAS

Figure 5 shows that area of reclaimed lands in Egypt reached 59.2 feddans in 2017/2018.

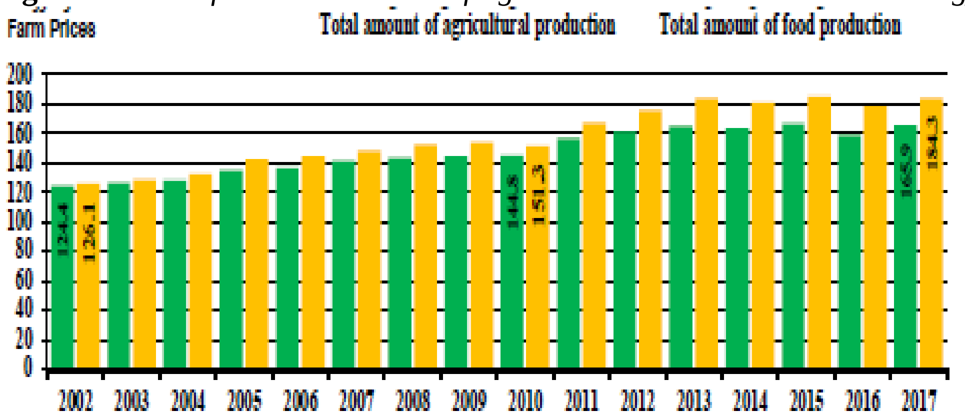
Figure 5. *Area of Reclaimed Lands in Egypt*



Source: CAPMAS

Figure 6 shows that index of the total amount of agriculture production in Egypt was estimated 156.9 and index of the total amount of food production 184.3 in 2017.

Figure 6. *Index of the Total Amount of Agriculture and Food Production in Egypt*

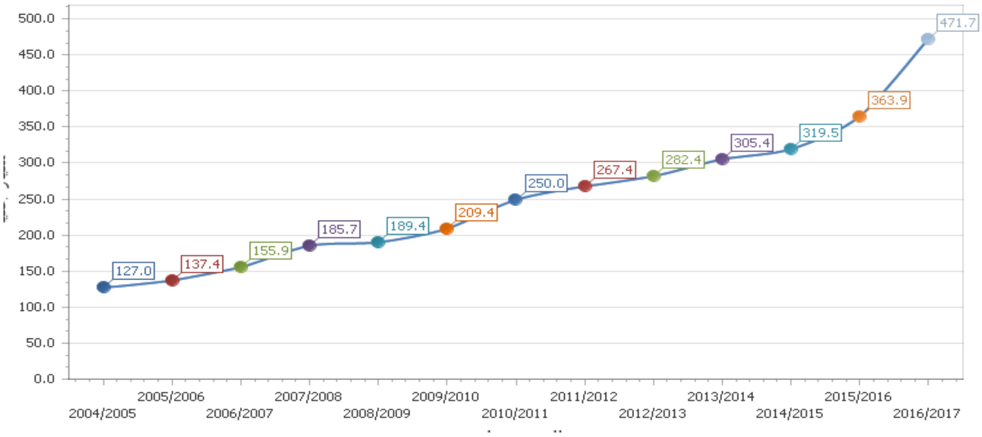


Source: CAPMAS

Figure 7 shows that value of agricultural production in Egypt reached 471.7 billion LE in 2016/2017.

Figure 7. *The Value of Agricultural Production in Egypt*

Billion LE



Source: CAPMAS

Table 1 shows total value of agriculture investment in Egypt which amounted in 17338.6 million LE in 2016/2017, and distributed into government investment 6038.6 million LE and private investment 11300 million LE. Agricultural investment presented 3.37% of total investment in Egypt in 2016/2017, government investment presented 34.8% of agricultural investment and private investment presented 65.2% of agricultural investment.

Table 1. *Total Value of Agriculture Investment in Egypt*

	Agriculture investment INV (million LE)					
Years	Government INV	Private INV	Total INV	Agr. INV % total INV	Gov. INV % agr. INV	Private INV % agr. INV
2012/2013	2950.4	5434.0	8384.4	3.47%	35.2%	64.8%
2013/2014	4146.1	7480.5	11626.6	4.39%	35.7%	64.3%
2014/2015	5213.0	8201.0	13414.0	4.02%	38.9%	61.1%
2015/2016	5039.2	11240.0	16279.2	4.15%	31.0%	69.0%
2016/2017	6038.6	11300	17338.6	3.37%	34.8%	65.2%

Source: CAPMAS

Table 2 shows the available water resources and their uses, the agricultural sector consumed about 66.75 billion m^3 in 2015, representing about 83% of the total water uses, while drinking and industry uses represented about 13% (10.5 billion m^3), and the amount of losses in evaporation from the Nile and canals was about 2.2 billion m^3 equivalent to 3%. Therefore, it is noticeable that the shortage of water resources in 2015 was about 3.8 billion m^3.

Table 2. *The Uses of Water Resources and Percentage of the Deficit in Egypt*

Billion m^3

	2005	2010	2015	2020	2025
Agriculture	58.5	62.7	66.75	70.88	75.58
Drinking &industry	9.2	9.8	10.55	11.10	11.96
Total water required	67.7	72.5	77.3	81.98	87.54
available resources	67.2	71.4	73.5	74.8	75.8
shortage	5.0	1.1	3.8	7.18	11.74

Source: El-Sabaa et al. 2019

Table 3 shows that the cultivated area amounted 9.5 million acres in 2019, and the per capita share of the cultivated area about 2.3 carats / inhabitants in 2019, and Egypt suffered from a deep food gap that exceeded 55% of its food needs in 2019, it is expected to increase its gap to reach 75% due to the filling of the Renaissance Dam. Egypt reached the level of water shortage (less than 640m^3 per capita per year); the per capita water became 606 m^3 in 2019.

Table 3. *Indicators of Cultivated Area and Per Capita Water in Egypt*

Years	Population (million)	The cultivated area (million acres)	Per capita cultivated area		Per capita water
			Acres / inhabitants	Carats / inhabitants	
2005	70.65	8.38	0.119	2.9	849
2006	72.01	8.41	0.117	2.8	833
2007	74.46	8.42	0.113	2.7	806
2008	75.84	8.43	0.111	2.7	791
2009	77.19	8.78	0.114	2.7	777
2010	78.5	8.8	0.112	2.7	764
2011	80.5	8.62	0.107	2.6	745
2012	82.6	8.8	0.107	2.6	726
2013	84.5	8.95	0.106	2.5	710
2014	86.4	9.10	0.105	2.5	694
2015	89.6	9.12	0.102	2.5	673
2016	93.5	9.13	0.097	2.4	640
2017	96.3	9.14	0.096	2.32	623
2018	97.3	9.35	0.095	2.31	617
2019	100	9.5	0.095	2.3	606

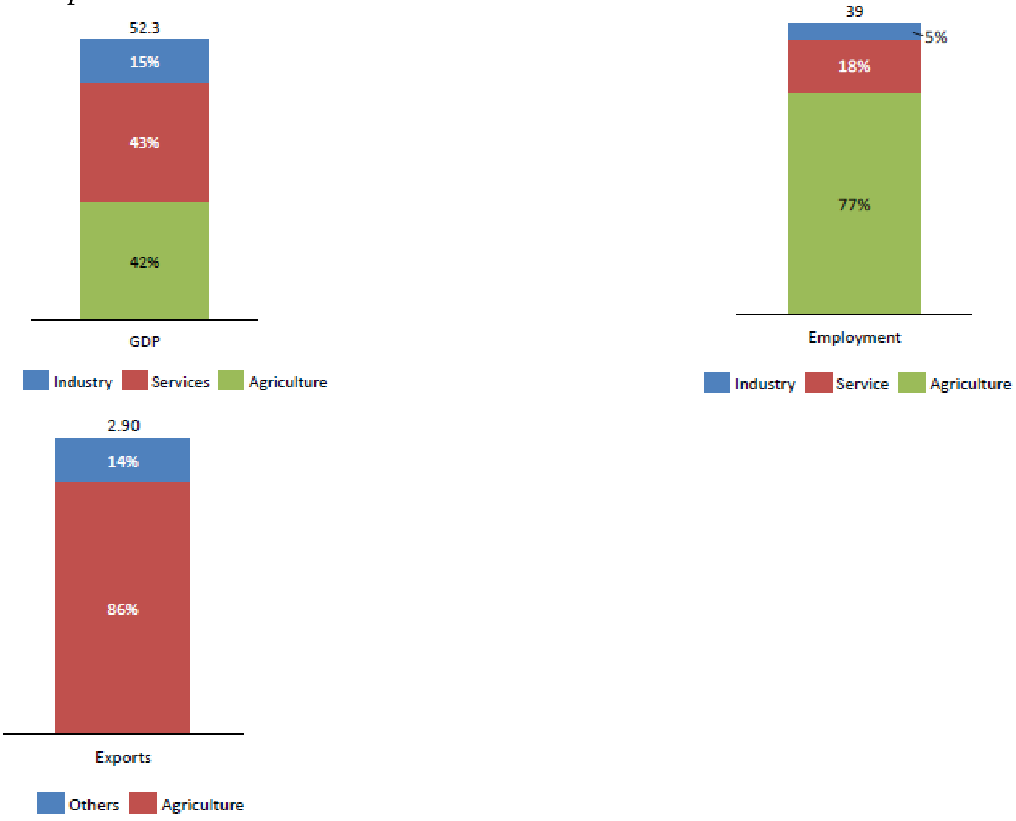
Source: El-Sabaa et al. 2019

Analysis of the Agricultural Sector Performance in Ethiopia

Ethiopia was classified by the World Bank as a low-income economy; and was considered the fifth-fastest growing economy among member nations in the International Monetary Fund, with a GDP growth rate of 9.6 percent in 2019 (Agricultural Transformation Agency 2019).

Figure 8 shows that Agriculture was the backbone of Ethiopia's economy because the agricultural sector employed 77% of the work force, industry employed 5%, and services employed 18%. The agriculture generated 42% of the GDP, while services and industry generated 43% and 15% respectively. In addition the agriculture contributed 86% of exports of Ethiopia in 2019.

Figure 8. *Contribution of Agriculture in GDP, Employment and Exports in Ethiopia in 2019*

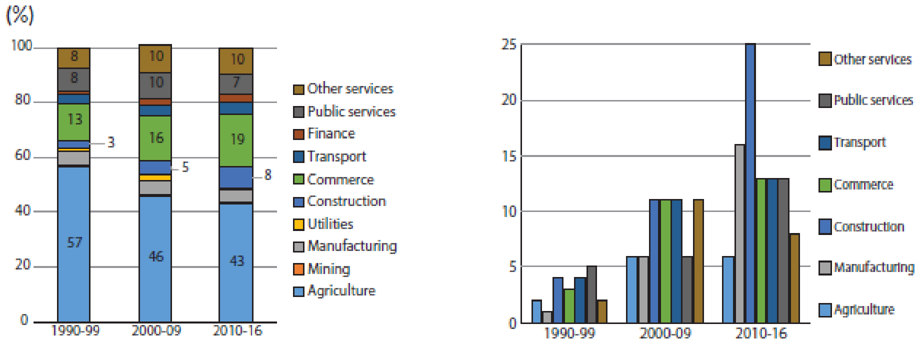


Source: Agricultural Transformation Agency 2019

Ethiopia had steady and broad-based growth over the past 10 years due to agriculture and services sectors expansion, with manufacturing experiencing had moderate growth (UNICA 2018).

Figure 9 shows that Agriculture dominated the economy, but manufacturing grew quickly. Agriculture was the leading economic sector, with 25% annual growth over the period 2010-2016, and the manufacturing with 17%.

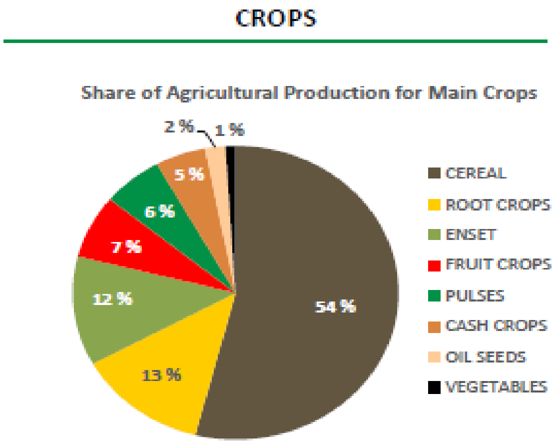
Figure 9. *Composition of Gross Value Added and Sectorial Growth in Ethiopia %*



Source: UNICA 2018

Figure 10 shows that the Diversity of agro-ecologies and climates for cultivation of wide range of crops in Ethiopia which, cereal 54%, root crops 13%, enset 12%, fruit crops 7%, pulses 6%, cash crops 5%, oil seeds 2%, and vegetables 1% of crops production.

Figure 10. *Share of Agriculture Production for Main Crops in Ethiopia in 2019*



Source: Agricultural Transformation Agency 2019

There are many activities that depend on agriculture in Ethiopia, including marketing, processing, and export of agricultural products. The Major crops include coffee, beans, oilseeds, grains, potatoes, sugar cane and vegetables. Ethiopia was the second largest producer of corn in Africa. The total irrigated area in Ethiopia was 200 thousand hectares in 2017 (Agricultural Transformation Agency 2019).

Measuring the Impact of the Renaissance Dam on the Agricultural Sector in Egypt and Ethiopia

The study of Benedict and Obiero (2010) determined the impact of irrigation water on the agricultural productivity, and indicated extent of the crop's yield to the amount of irrigation water by using the Cob Douglas function.

According to the linear regression of the Cob Douglas function that used by the study of Benedict and Obiero (2010), the logarithmic form can be used as follows (Benedict and Obiero):

$$\text{In } Y = \text{In } A + B_1 \text{ In } X_1 + B_2 \text{ In } X_2 + B_3 \text{ In } X_3 + B_4 \text{ In } X_4 + B_5 \text{ In } X_5 + E$$

Whereas: Y: Total yield from seasonal and sustainable crops
X1: irrigation water X2: labor X3: capital X4: irrigated area
X5: rain area

For measuring impact of the Renaissance Dam on the agricultural sector in Egypt and Ethiopia, the study runs two models one for the agriculture sector in Ethiopia and the other for Egypt. The two models use the dependent variable as the total return from the seasonal and sustainable agricultural crops during the period (2000-2018), and the independent variables are represented in the labor component; expressed by the number of workers in the agricultural sector, the land component; expressed by The cultivated crop area has been divided into the irrigated area that depends on irrigation water and the rain area that depends on rain water, the capital component; expressed by the total capital used in the agricultural process by agricultural tools as, tractors, fertilizers and other capital inputs, and finally irrigation water; expressed by the water as one of the elements of the production process for the agricultural crops.

Measuring the Impact of the Renaissance Dam on the Agricultural Sector in Egypt

The study relies on reports issued by the Central Agency for Public Mobilization and Statistics in Egypt, which provides data on the total and sectorial employment, including the agricultural sector, as well as the rain and irrigated area of the total cultivated area in Egypt. Databases of the FAO have also been used to obtain data on irrigation water and capital used in the agricultural production process during the period of study.

Unit Root Test was performed through the Augmented Dicky Fuller ADF test to examine the stability of time series. The null hypothesis is: the time series has a unit root problem (the time series is not static), the Alternative Hypothesis: The time series does not have a root unit problem (the time series is static).

Table 4 shows results of the unit root test, after comparing the calculated value with the tabular value, the calculated value is greater than the tabular value at the level for irrigated area, so this time series is not static, and by taking first Difference, the calculated value be less than the tabular value, so the time series of the first differences are static with a confidence degree of 99%, and the test results show that the time series of (irrigated water, labor, capital, rain area and yield productivity), are static at the level with a confidence degree of 99%.

Table 4. *The Unit Root Test Results of the Model in Egypt*

Variables	Calculated value		Tabular value		
	Level	First Difference	1%	5%	10%
Irrigated water	-5.13		- 4.421	- 3.260	- 2.771
Labor	-7.08		- 4.297	- 3.213	- 2.748
Capital	-6.01		- 4.297	- 3.213	- 2.748
Irrigated area	-3.04		- 4.421	- 3.260	- 2.771
Irrigated area		-18.32	- 5.835	- 4.247	- 3.590
Rain area	-7.76		- 4.421	- 3.260	- 2.771
Yield Productivity	-5.84		- 4.421	- 3.260	- 2.771

Source: Author using Eviews 8

After estimating the parameters, the estimated equation is as follow:

LnY = 9.59 + 16.34 LnX1 + 11.97 LnX2 + 8.25 LnX3 + 46.43 LnX4+ 4.79 LnX5 + U

Table 5 displays the estimated results.

Table 5. *Results of the Model in Egypt*

Variables	Coefficient	Std. Error	t-Statistic	Prob.
Constant	9.59	1.480	4,95	0,002
Irrigated water	16.34	0,3303	6,63	0,000
Labor	11.97	0,0644	3,07	0,001
Capital	8.25	0,5389	6.23	0.004
Irrigated area	46.43	0.210	2.47	0.000
Rain area	4.79	1,190	8.15	0.006
R-squared	0.956	F-statistic	84.3	DW 2.51

Source: Author using Eviews 8.

- The explanatory level of the model: R-squared is equal to 0.956 which mean that the independent variables are able to explain about 95.6% of the changes in the Yield Productivity variable, and the rest is due to other factors, including random errors.
- The overall significance of the model: the results show that the value of (F-statistic) equal to 84.3 and it is statistically significant, which means rejecting the null hypothesis that the estimated regression model is not significant, and accepting the alternative hypothesis so the estimated model is significant, this indicates the independent variables have a significant effect on the Yield Productivity in Egypt.
- The partial significance of model: It is noted from the results that the parameters are statistically significant, which indicates that these parameters differ substantially from zero, which reflects the importance of these independent variables.

- Standard parameters of the model: the value of Durbin Watson coefficient in this model is 2.51 and by examining the corresponding tabular value, the Durbin Watson indicates that there is no false slope, and the estimated model is free of the problem of linear correlation between the independent variables.
- Economic interpretations of the estimated parameters: the estimated results are consistent with the economic theory.

The results indicate that there is a positive relationship between labor and capital with productivity of the crop, as a change in the volume of labor and capital by one unit leads to increase productivity by 11.97 and 8.25 units, respectively. The irrigation water affects positively yield of the crop in Egypt, a change in irrigation water by one unit leads to increase productivity by 16.34 units.

The cultivated area is divided into rain area and irrigated area, the effect of rain area on productivity of the crop is limited, but the irrigated area positively and significantly affects yield of the crop, so increase rain area by one unit leads to increase productivity by 4.79 units, but increase irrigated area by one unit leads to increase productivity by 46.43 units. This may reflect the importance of the irrigated area in Egypt and the use of irrigation water is more than the use of rain water.

This indicates extent of the agricultural yield in Egypt related to irrigation water, and impact of the Renaissance Dam on reduce the agricultural yield in Egypt Due to its effect on reduce the irrigated area.

Measuring the Impact of the Renaissance Dam on the Agricultural Sector in Ethiopia

The study relies on reports issued by the Ethiopian Central Statistical Authority, which provides data on the total and sectorial employment, including the agricultural sector, as well as the rain and irrigated area of the total cultivated area in Ethiopia. Databases of the FAO have also been used to obtain data on irrigation water and capital used in the agricultural production process during the period of study.

Unit Root Test was performed through the Augmented Dicky Fuller ADF test to examine the stability of time series. The null hypothesis is: the time series has a unit root problem (the time series is not static), the Alternative Hypothesis: The time series does not have a root unit problem (the time series is static).

Table 6 shows results of the unit root test, after comparing the calculated value with the tabular value, the calculated value is greater than the tabular value at the level for four variables (labor, capital, rain area, irrigated area), so these time series are not static, and by taking Differences of the first degree, the calculated value be less than the tabular value, so the time series of the first differences are static with a confidence degree of 99%, and the test results show that the time series of two variables (irrigation water and yield productivity) are static at the level with a confidence degree of 99%.

Table 6. *The Unit Root Test Results of the Model in Ethiopia*

Variables	Calculated value		Tabular value		
	Level	First Difference	%1	%5	%10
Labor	3.670		- 4.297	- 3.213	- 2.748
Labor		-5.030	- 5.835	- 4.247	- 3.590
Capital	7.133		- 4.297	- 3.213	- 2.748
Capital		-7.129	- 5.835	- 4.247	- 3.590
Irrigated area	- 1.575		- 4.421	- 3.260	- 2.771
Irrigated area		-11.288	- 5.835	- 4.247	- 3.590
Rain area	- 0.435		- 4.421	- 3.260	- 2.771
Rain area		- 6.104	- 5.835	- 4.247	- 3.590
Irrigated water	-9.743		- 4.421	- 3.260	- 2.771
Yield Productivity	-7.581		- 4.421	- 3.260	- 2.771

Source: Author using Eviews 8

After estimating the parameters the estimated equation is as follow:

$$LnY = -5.8 + 0.233\,LnX1 + 2.776\,LnX2 + 6.144\,LnX3 + 0.016\,LnX4 + 8.32\,LnX5 + U$$

Table 7 displays the estimated results.

Table 7. *Results of the Model in Ethiopia*

Variables	Coefficient	Std. Error	t-Statistic	Prob.	
Constant	-5.8	2.500	-8.94	0.000	
Irrigated water	0.233	0.067	2.49	0.013	
Labor	2.776	0.875	7.50	0.005	
Capital	6.144	0.483	12.71	0.000	
Irrigated area	0.016	0.300	1.29	0.000	
Rain area	8.32	2.674	10.59	0.0002	
R-squared	0.996	F-statistic	76.9	DW	2.52

Source: Author using Eviews 8

- The explanatory level of the model: R-squared is equal to 0.996 which mean that the independent variables are able to explain about 99.6% of the changes in the Yield Productivity variable, and the rest is due to other factors, including random errors.
- The overall significance of the model: the results show that the value of (F-statistic) equal to 76.9 and it is statistically significant, which means rejecting the null hypothesis so the estimated regression model is not significant, and accepting the alternative hypothesis so the estimated model is significant, this indicates the independent variables have a significant effect on the Yield Productivity in Ethiopia.

- The partial significance of model: It is noted from the results that the parameters are statistically significant, which indicates that these parameters differ substantially from zero, which reflects the importance of these independent variables.
- Standard parameters of the model: the value of Durbin Watson coefficient in this model is 2.52 and by examining the corresponding tabular value, the Durbin Watson indicates that there is no false slope, and the estimated model is free of the problem of linear correlation between the independent variables.
- Economic interpretations of the estimated parameters: the estimated results are consistent with the economic theory.

The results indicate that there is a positive relationship between labor and capital with productivity of the crop, as a change in the volume of labor and capital by one unit leads to increase productivity by 2.7 and 6.1 units, respectively. The irrigation water affects positively yield of the crop in Ethiopia, but it is a limited effect, so a change in irrigation water by one unit leads to increase productivity by 0.233 units.

The cultivated area is divided into rain area and irrigated area, the effect of irrigated area on productivity of the crop is very limited, but the rain area positively and significantly affects yield of the crop, so increase rain area by one unit leads to increase productivity by 8.3 units, but increase irrigated area by one unit leads to increase productivity by 0.016 units. This may reflect the increase in the rain area in Ethiopia compared to the irrigated area and the use of rain water is more than the use of irrigation water. So why is Ethiopia building this number of dams, given the limited impact of the dams on the agricultural sector?

It is clear from results of the model that the agricultural yield is highly dependent on rain water in Ethiopia and not irrigation water, as it records the highest rate of rainfall compared to countries in the Nile Basin, so the purpose of building the renaissance dam is not for increasing irrigation water and creating irrigated agricultural areas.

The Risks of the Renaissance Dam on Egypt and Ethiopia

There is various risks result of building the renaissance dam, which Egypt and Ethiopia could suffer from them.

The Negative Effects of Renaissance Dam on Egypt

The most important negative effects of the Renaissance Dam on Egypt are as follows:

1. The main concern is that the huge lake behind the dam will need five to seven years to fill with water, which reduces the amount of water that reaches Egypt by 12-25% during this period. Experts indicates that the

percentage of lake water loss due to evaporation may reach three billion m^3 of water per year, which is estimated to be three times the amount of annual rain in Egypt, so Egypt's annual share is reduced by about 12 billion m^3 to reach 43 billion m^3, which may represent a disaster for Egypt, because the per capita share will become less than 606 m^3 annually (El-Sabaa et al. 2019).
2. Egypt's water deficit due to fill the dam will reach 94 billion m^3 in 2050; it will deprive Egypt of Nile water for two years, because Egypt's share of river water reaching 55 billion m^3 annually, so it is expected that Egypt will lose 200,000 acres of agricultural land.
3. The dam will also affect the electricity supply in Egypt at a rate ranging from 25% to 40%, as the capacity of the Aswan High Dam to produce hydroelectric power decreases to reach the loss value of 100 megawatts (Kenawy 2017).
4. Reducing the area of export crops in Egypt, such as vegetables and fruits, and thus the loss of traditional export markets in the global market, which means the loss of foreign exchange resources for the agricultural sector and the negative impact on the trade balance and the balance of payments in Egypt. On the other hand, increase the gap between the production and consumption of some import crops, as wheat, corn, rice, sugar and oils, which suffer from a gap of 32% in 2019 (El-Sabaa et al. 2019).
5. Reducing the areas of crops that contribute in agricultural manufacturing industries such as rice, oil, corn, reeds, cotton, textiles, dyeing, tanning, animal and fish production, these lead to decrease the added value in the national economy and the loss of more resources in Egypt.
6. Increasing economic burdens on the Egyptian economy, as High food prices and high inflation in addition to the costs of desalinating sea water to cover the deficit in water, and reprocessing of wastewater to benefit from it in irrigation of agricultural lands (Kenawy 2017).

The Negative Effects of Renaissance Dam on Ethiopia

1. The high cost of building the dam, it is estimated at 4.8 billion dollars, and is expected to reach 8 billion dollars.
2. The flooding of about half a million acres of forest land, and irrigable agricultural lands, which are rare in the Blue Nile Basin, for formatting the dam lake.
3. The dumping of some mining areas for many important minerals, such as gold, platinum, iron and copper, and some quarry areas. In addition to the displacement of about 30 thousand citizens from the Lake District (Jameel 2018).
4. The short life of the dam, which ranges between 25 to 50 years, as a result of severe silting (420 thousand m^3 annually), that will affect the turbines to generate electricity and decrease efficiency of the dam gradually (Kenawy 2017).

5. The dam is subjected to collapse as a result of geological factors and the surge speed of the Blue Nile water, which in some periods reaches more than half a billion m^3 per day. Increasing the chance of an earthquake in the reservoir area due to the weight of water in this area of a fractured rocky environment (Jameel 2018).

Conclusion

The results show importance of the irrigated area in Egypt and the use of irrigation water is more than the use of rain water. This indicates extent of the agricultural yield in Egypt related to irrigation water, and impact of the Renaissance Dam on reduce the agricultural yield in Egypt Due to its effect on reduce the irrigated area. The results show that the agricultural yield is highly dependent on rain water in Ethiopia and not irrigation water, so the purpose of building the Renaissance dam is not for increasing irrigated agricultural areas. The study indicates various risks result of building the renaissance dam, which Egypt and Ethiopia could suffer from them.

Egypt is not only facing Ethiopia, but also is facing an alliance, whether at the regional or international level, in view of what Ethiopia receives supporting from a number of countries such as Qatar, Turkey and China. United States of America and Israel are interested in continuing water to be Egypt's weak point. The Egyptian agriculture strategy 2030 could be reassessed according to the current water resources and the possibilities of decreasing them as a result of building the Renaissance Dam, through a realistic strategy in which agricultural investments are distributed in the public budget according to what can be developed from the resources in order to preserve the agricultural sector and expand agricultural reclamation in view of threatening the Renaissance Dam.

References

Africa News (2020) *Investors in Ethiopia grand renaissance dam*. Retrieved from: https://bit.ly/3bqbsO8.

Agricultural Transformation Agency (2019) Ethiopian agriculture and strategies for growth. Presented at the *Ethiopia – Norway Agribusiness Seminar, November*.

Almal News (2019) *Firms working in Renaissance Dam*. Retrieved from: https://bit.ly/2yL6M8s.

Al3asemanews (2015) *Funds of the Renaissance Dam*. Retrieved from: https://bit.ly/3cHxXPS.

Benedict OPO (2010) *Analysis of economic efficiency of irrigation water-use INMWEA irrigation scheme, Kirinyaga District, Kenya.* Master Thesis. Kenya: Kenyatta University.

Central Agency for Public Mobilization and Statistics - CAPMAS (2019) *Agriculture Statistics in Egypt*. Retrieved from: https://bit.ly/2yMZnFE.

Cestti R, Malik RPS (2016) *Indirect economic impacts of dams case studies from India, Egypt and Brazil*. Washington, DC: World Bank, Academic Foundation.

Consulate General of Ethiopia (2016) *Grand Ethiopia Renaissance Dam*. Los Angeles: Consulate General of Ethiopia.

El-Sabaa A, Rihan M, Mohsen ASA (2019) *An Economic study of the impact of the Ethiopian Renaissance Dam on the Egyptian agricultural sector*. *Egyptian Journal for Agricultural Economics* 29(2).

Emasc-UAE (2019) *Emirates supports the Renaissance Dam.* Retrieved from: http://www.emasc-uae.com/news/view/16312.

Farid S (2020) *Water effects of the dam.* Retrieved from: https://bit.ly/3dLEt8m.

Gebreegziabher Z (2017) Sustainable financing of Ethiopia's energy infrastructure: an economic analysis. Presented at the *9th International Conference on the Ethiopian Economy, School of Economics Addis Ababa University, July*.

Gilgel Gibe Affair (2008) *An analysis of the Gilbel Gibe hydroelectric projects in Ethiopia*. UK: CEE Bank Watch Network.

Hathaway T (2018) *What cost Ethiopia's Dam boom?* Berkeley: International River.

Jameel AL (2018) *The grand Ethiopian Renaissance Dam: an opportunity for collaboration and shared benefits in the Eastern Nile Basin*. Massachusetts, USA: The Massachusetts Institute of Technology.

Kenawy E (2017) Potential economic impacts of Ethiopian Renaissance Dam on Egypt. *International Journal of Economics, Commerce and Research (IJECR)* 3(3).

Robinson S, Gueneau A (2014) Economic evaluation of the Diamer –Basha Dam. The World Bank. Retrieved from: https://bit.ly/2SWviu1.

Salini (2019) *Ethiopia – Grand Ethiopian Renaissance Dam 6000MW.* Retrieved from: https://bit.ly/2WMQeEI.

State Information Service (2020) *Ethiopia dam.* Retrieved from: https://bit.ly/35Z0jTo.

The New Arab (2019) *China in Renaissance Dam*. Retrieved from: https://www.alaraby.co.uk/economy/a7f5deee-d6c7-4c0a-b77b-1b4b04ee1d8e.

The World Bank (2015) *The little data book 2013*. Washington: The World Bank.

The World Bank Database (2020) *Agriculture indicators in Egypt.* Retrieved from: https://data.worldbank.org/indicator.

UNDP (2012) *Assessment and gap analysis on sustainable energy for all.* Ethiopia: Ministry of Water and Energy Rapid.

United Nation Economic Commission for Africa - UNICA (2018) *Structural transformation, employment, production, and society in Ethiopia.* UNICA.

Zohaib S, Usman M, Hafsa H, Shazia S (2013) *Agricultural production impact of mini-dam: case study of Ziarat, Baluchistan*. *Pakistan Development Review* 4(51): 277–287.