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Estimation of Water Footprint and Virtual Water for Rice in Egypt

Eman Abd Elghafour Ahmed

Department of Economics, National Research Center, Egypt

Abstract : This study aimed to Estimation of Water Footprint and Virtual Water for Rice in Egypt. This study adopted in to achieve its objectives in economic analysis represented in the economic equations used to Estimation Water Footprint, Virtual Water and coefficient of Food Security, in addition to the binomial probability distribution and standard errors at 95% confidence level.

The study results can be summarized as follows; (1) Estimate the average total Water Footprint decreased of rice crop in Egypt around 6.5 billion m^3 during the period 1995- 2014. (2) Estimate the average ratio of water import dependency of rice 15.2% and thus the average ratio self-sufficiency for water 115.2% during the study period. (3) Egypt has achieved remarkable progress in food security for rice, as the volume of strategic stocks 1.92 million tons, and in light of average domestic consumption of 5.02 million tons, coefficient of food security for rice is 0.382 during the period 1995- 2014. (4) Contribution ranged of local agriculture in achieving relative food security for rice (coefficient of food security is equal to 0.382) between a minimum of 37.1% and a maximum of 39.1% at 95% confidence level during the period 1995-2014. (5) In the light of achieving the full level of food security for wheat ranging the relative importance of Contribution of the local production between a minimum of 37.1 and a maximum of 39.1%, while ranging the relative importance of Contribution of imports between a minimum of mines value and a maximum of 1.1%, and ranging the relative importance of Contribution of foreign agricultural investment between a minimum of 40.5% and a maximum of 83.1% at 95% confidence level. (6) The total of amount virtual water Gained from Imports and Foreign Agricultural Investment to achieve the full level of food Security for rice ranging between a minimum of zero m3 valued at zero pound, and a maximum of 2.98 billion m^3 valued at 6.66 billion pounds at 95% confidence level.

This study recommends the need economic integration between local agriculture, imports and Foreign Agricultural Investment to Achieve Food Security and the introduction of the concept of virtual water when developing future strategy for the Agricultural sector to ensure the adoption of agricultural production systems used less water and focus on the import of agricultural products that needs of high water, especially in the light of escalating water.

Key Words water foot print, virtual water, inland water footprint, agricultural investment abroad, Estimate the average total Water Footprint, imported water quantity.

Introduction

Is a rice crop of goods strategic grain which occupies an important economic position in the Egyptian Agriculture, as he took the agri-food commodities that are subject to the phenomenon of self-consumption Auto of - Consumption Due to the agricultural producers detained an big part of it for the purpose of personal consumption as a kind of living safety, despite the establishment of the state select rice areas scheduled to be grown annually by about 1.1 million acres, but that there is a discrepancy between the planned and actual spaces , where overtaking reached its peak in 2008, due to the planting area of 1.8 million acres, an increase estimated at 0.7 million acres represents about 63.6% of the total planned spaces by the state.

Due to rising food prices globally, and the direction of some countries food producers to place restrictions on exports to meet the needs of its population, and global variations on water resources as a result of predicted rarity, so it became necessary to maintain strategic stocks of food commodities suffice needs of consumer for a period of six months, at least according to considerations food security and water security, and is configured for this stock through domestic production and imports of agricultural and invest abroad to cope with emergency conditions, and is considered the Egyptian agricultural investment abroad need to achieve food security strategy for goods amid an escalating water crisis with the Nile basin countries and a dam renaissance in Ethiopia, for several partly because of the relative scarcity of water resources and arable ground, as he supports and strengthens political ties, and keeps the water resources, as well as the correlation of agricultural industries, and the creation of a strategic stockpile safe food commodities, requires orientation Agricultural investment Masri in some countries that have an abundance of land and water resources and with the attractive provide the necessary investment finance investment regimes, in addition to studying agricultural investment opportunities in the countries which are selected, and the signing of bilateral agreements with them to ensure the capital, in order to maintain the Egyptian water resources, and in spite of the many countries not to grow rice crop depending on the principle of virtual water trade, but we find Egypt at the forefront of producing and exporting countries of the crop, which suggests not to rely on that vision.

Problem of the study:

Despite the surrounding foreign trade Agricultural investment and external movement of the risks, especially in third-party countries politically, economically and socially stable, but it includes many benefits, most notably the transfer of water resources across the border in the form of food commodities achieve the goal of food security on the one hand, and overcome the problem shortage of water resources on the other hand, in the field wondering Find food security of the rice crop in Egypt level? What is the relative importance of the contribution of local agriculture and agricultural investment outside Egypt to achieve food security from him? What is the quantity and value of virtual water lost and gained from the export and import of agricultural investment and external to achieve food security for rice in Egypt.

objectives of the study:

Targeted research estimating the amount and value of virtual water for Foreign Trade of the relative food security of rice in Egypt, through the achievement of a group of the following objectives:

1. Determination of total water footprint and various indicators of Rice.
2. Strategic reserves and food security coefficient of rice appreciated.
3. Estimate the relative importance and the probability distribution for the contribution of local agriculture and agricultural imports and external investments to achieve different levels of food security and rice.

Material and methods :

Research depended mainly on published and unpublished secondary data issued by the central authorities concerned such as administration of Agricultural Economics, which, Central Agency for Public Mobilization and Statistics. As well as on the use of references, research and studies related to by research topic

The research was Depend to achieve its objectives on each of two methods economic and statistical analysis of descriptive and quantitative commensurate with the data, and exactly the equations research depended of general time trend, as well as the equations of estimating water footprint and indicators for the rice crop, and also the equations of the strategic reserve estimate and the coefficient of food security and the relative indicators , equations for estimate the amount of virtual water value of foreign trade to achieve food security for the rice crop

First, equations estimating water footprint and indicators

1. The amount of water used in production = quantity of crop production × water needs per ton.
2. exporting virtual water quantity = the amount of crop exports × water needs per ton.
3. virtual imported water quantity = quantity of imports of the crop water needs × ton.
4. Inland Waterways footprint = the amount of water used in production - the amount of virtual water exporters.
5. External water footprint = the amount of virtual water imported from abroad - exporting virtual water quantity.
6. College = inland water footprint and water footprint + external water footprint.
7. Ratio of dependence on external water resources = (external water footprint ÷ total water footprint) × 100.
8. Self-sufficiency ratio of local water resources = (internal water footprint ÷ total water footprint) × 100.

Second: The equations of strategic reserves and the coefficient of food security and the relative appreciation indicators

1. Daily domestic consumption = total consumption ÷ number of days of the year (365 days).
2. The adequacy of production = total production ÷ domestic consumption daily.
3. The period of coverage of imports = Total imports ÷ domestic consumption daily.
4. The amount of change in the strategic reserves (surplus or deficit) = [(total length of the periods of production and the adequacy of coverage of imports - 365) × local daily consumption - the amount of exports.
5. Strategic inventory surplus = outcome - the outcome of the deficit.
6. Food security coefficient = strategic stocks ÷ average annual domestic consumption.
7. Distribution of Brnillola sometimes known probability Binominal Distribution and standard errors at a 95% confidence in the estimation of the percentage or the possibility of contributing to the achievement of relative food security, and when estimating the ratio be appreciated accompanied by standard errors are taken into account when estimating the confidence intervals as follows:-

- The standard error of the potential degree of confidence at 95% = $\sqrt{\frac{P(1-P)}{N}}$ *1.96±
- The possibility of contributing to the achievement of food security at the confidence interval 95% = $\sqrt{\frac{P(1-P)}{N}}$ * 1.96±p

whereas:

(P): represent the possibility of contributing to the achievement of food security.

1- (P): represent the possibility of not contributing.

(N): represents the length of the time series.

Third: The equations of estimating the quantity and value of virtual water gained from import Agricultural investment and external to achieve food security

1. Stock size = average annual consumption × food security levels imposed.
1. The amount of imported rice to achieve food security = relative importance of the contribution of imports × amount necessary strategic reserves to achieve food security.
2. The amount of virtual water gained from import = the amount of imported rice × average water needs per ton.
3. Virtual water value gained from import = the amount of virtual water gained from import × unit price of water resources.

4. The quantity of rice from outer agricultural investment to achieve food security = relative importance of the contribution of investments × amount necessary strategic reserves to achieve food security

The concepts used in the study

1. Self-sufficiency

It means the state's ability to achieve full accreditation of economic resources and possibilities of self in the production of all its food needs locally. Given the limited agricultural resources and in the light of globalization and the liberalization of world trade, the standard is the choice of comparative advantage and competitiveness without discrimination between domestic production and imported.

2. Food Security

Can distinguish between the two levels of food security Food Security: (a) the absolute food security, food security and self-intended food production within a single country in excess of domestic demand, and this type of food security is difficult to achieve due to the scarcity of water resources. (B) food security and relative meant the state's ability to provide the quantity of goods needed to form a strategic stockpile and food of sufficient domestic consumption for a period of not less than six months, and the measured level of food security by a factor of food security and the value ranges between zero and correct one. When the difficulty of achieving food security, the value of food security coefficient equal to zero, this means that the outcome of the surplus and the deficit in domestic consumption equal to zero, but in the light of achieving the full food security, the value of food security coefficient equal to the correct one, and that means the possibility of achieving a surplus of food for consumption local enough for one year. With the availability of strategic reserves the possibility for individuals at all times to enough food for the life of vitality and healthy realized.

3. Strategic stock

It means the amounts held by the state and the private sector to meet the domestic expected demand or export, and is estimated by the outcome of both directed to the development of strategic reserves in some years the surplus and the amount of the deficit that is being pulled out of this stockpile during the other years in which the deficit in domestic consumption appears. And it is affected by the management and organization of strategic stocks a range of factors, the most important periods of the adequacy of the production and cover the imports for local consumption, and consumer differences and temporal and spatial conditions of the world market for the commodity

4. Foreign Agricultural Investment

The external agricultural investment in several models, including:

A) any future procurement contracts to buy high-water requirements of food from overseas markets specific amounts in future periods at an agreed price, it provided that such price is not subject to change. (B) the acquisition of a leader and international companies. (C) to control the group agricultural companies through the purchase of preferred securities. (D) the direct agricultural investment and external owning or renting agricultural land going into the production process.

5. Virtual water

Tony Allan is considered the first of the early nineties to clarify the concept of virtual water, which are identified as so much of the water needed to produce a good or service (7). This concept is based on the premise that the export or import of agricultural products from countries that suffer the poorest in water resources is tantamount to export or import water resources (water virtual trade), and can be referred to the possibility of importing virtual water by importing products or goods have been used, which is expressed in these external water situation, where they are considered external water for the importing country, in addition to the possibility of exporting virtual water through the export of the products of these waters were used in their production, it expressed in those waters in this case water virtual interior, where they come from internal water sources ie for the State-owned exporters. It is the amount of water consumed for the production of various agricultural products. Can thus states that suffer from scarcity of water resources in the province on the water resources by importing virtual water, any import of food and commodities with high water needs, and thus overcome the scarcity and scarcity of local water resources problems.

6. Water Footprint

It is defined as the total volume of fresh water used in the production of goods and services consumed by the individual or the community, and through the concept of water footprint can determine the actual consumption of water in each of the agricultural, industrial and domestic purposes. The water footprint consists of two parts: (a) internal water footprint Internal Water Footprint estimates calculates the default amount of water used for agricultural purposes, less the amount of virtual water exported through agricultural products to other countries. (B) the external water footprint External Water Footprint and calculates the estimated amount of virtual water imported from abroad minus the amount of virtual water, which was re-exported from imported products.

-The relationship between the virtual water and water footprint

Can clarify the relationship between the virtual water and water footprint through the form of (1) It is clear from the figure that the total virtual water exporters (VWE) consisting of virtual water re-exported from foreign regions (VWR), and virtual water exported from the local areas (VWD.(

VWE = VWR + VWD

Virtual water imported (VWI) consisting of virtual water re-exported from foreign regions (VWR), external water footprint (EWF).

VWI = VWR + EWF

As can be seen that the total virtual water imported (VWI), and local water resources used (WU) equal to the total virtual water exporters (VWE), in addition to the total water footprint (TWF), to Aattiya so-called virtual water balance (VWB).

VWB = VWI + WU = VWE + TWF

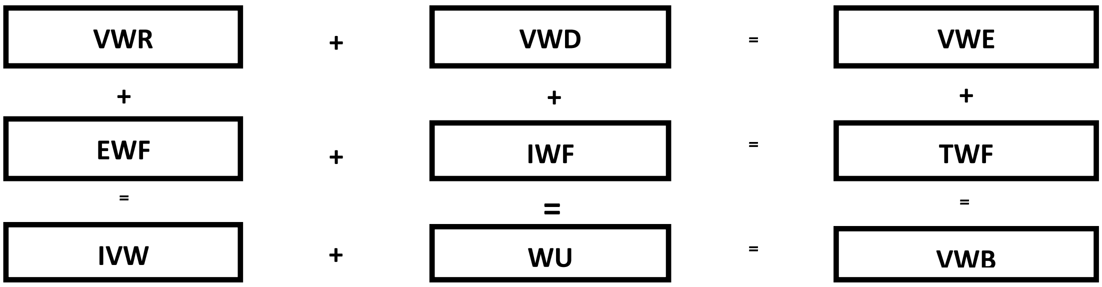

Figure 1: Shows the relationship between the virtual water and water footprint

whereas:

VWR: virtual water re-exported from foreign regions. VWD: virtual water exported from the local areas.
VWE: virtual water exporters. EWF: Water footprint of Foreign Affairs.
IWF: inland water footprint. TWF: total water footprint
IVW: virtual water imported. WU: local water resources used.
VWB: virtual water balance.

7-Source: reference

Results and discussion:

First, productivity and economic indicators

Describes the data and the results of the agendas (1.2) productivity and economic indicators for the rice crop, in terms of them turned out to be rice area ranged within a minimum and amounts to about 1.1 million acres in 2010, and a high of about 1.8 million acres in 2008, an average of about 1.5 million acres during the the period of the study, while showing lack of moral function.

Alfdanah productivity within a minimum and also ranged at around 3.42 tons / acre in 1995, and a high of about 4.07 tons / acre in 2013, an average of about 3.9 tons / acre during the study period, increased by an annual increase of about 0.04 tons / acre.

While total production within a minimum range and amounts to about 4.3 million tons in 2010, and a high of about 7.3 million tons in 2008, an average of about 5.7 million tons, increased by an annual increase of about 36.5 thousand tons during the study period.

As national consumption ranged within a minimum and amounts to about 4.2 million tons in 1995, and a high of about 5.7 million tons in 2012, increased by an annual increase amounted to 89.7 thousand tons

While imports of the crop ranged between double edged minimum about 0.3 thousand tons in 1996, and a maximum about 172 thousand tons in 2007, while showing not a significant function.

As it ranged from exports of the crop magnitude within a minimum about 137 thousand tons in 2011, and a max. of about 1.8 million tons in 2007, increased by an annual increase of about 8.2 thousand tons during the study period.

While the largest deficit in yield was around 1.2 million tons in 2010, and was the largest surplus of about 1.9 million tons in 2008.

Second, indicators of water

Describes the data and the results of the agendas (3.4) Water indicators for the rice crop, which shows that watery rated acre ranged within a minimum and is about 4.4 thousand m3/acre in 2011, and a maximum of about 7.97 thousand m3 / acre in 1998, and calculates the direction equation General of the evolution of the water of the crop rated in different forms show not a significant function.

Table 1:Evolution of productivity and economic indicators for the rice crop in Egypt during the period (1995-2014).

The gap Thousand tons	Exports Thousand tons	Imports thousand tons	%Self-sufficiency	per capita yer/kg	Consumption Thousand tons	Production Thousand tons	Productivity tons / acre	Area thousand acres	Year
599.1	208	1.0	114.3	49.5	4189	4788.1	3.42	1400	1995
691.4	326	0.31	116.4	49.6	4204	4895.4٤	3.48	1405	1996
956.0	295	1.0	121.1	52.3	4524	5480.0	3.54	1550	1997
-172.8	624	0.36	96.26	52.7	4623	4450.2	3.63	1225	1998
1864.2	307	1.0	147.2	44.2	3952	5816.2	3.73	1559	1999
775.5	360	1.0	114.8	57.2	5225	6000.5	3.83	1569	2000
463.7	1030	1.0	109.7	50.8	4763	5226.7	3.90	1340	2001
1819.5	698	2.0	142.5	44.1	4285	6104.5	3.95	1547	2002
1155.5	779	3.0	123.0	51.7	5019	6174.5	4.10	1508	2003
1492.7	1110	4.0	130.7	49.1	4858	6350.7	4.13	1537	2004
1078	1489	6.0	121.4	45.8	5046	6124.0	4.20	1459	2005
1605.2	1435	8.0	131.2	42.5	5139	6744.2	4.23	1593	2006
1644.8	1787	172	131.4	46.0	5232	6876.8	4.11	1673	2007
1927.4	261	31	136.2	58.5	5326	7253.4	4.10	1770	2008
-98.5	836	24	98.25	56.2	5619	5520.5	4.03	1369	2009
-1184.9	795	25	78.50	39.6	5512	4327.1	3.96	1093	2010
60.40	137	60	101.1	35.4	5605	5665.4	4.02	1409	2011
-198.9	225	35	96.51	44.0	5699	5500.1	4.01	1371	2012
-295.7	529	24	94.83	42.2	5715	5419.3	4.07	1332	2013
-434.2	568	45	92.63	45.3	5895	5460.8	4.00	1364	*2014
687.42	689.95	22.2	114.9	47.8	5021.5	5708.9	3.92	1453.7	Mean

* Imports and exports appreciation.

Source: compiled and calculated by:

1. Ministry of Agriculture and land reclamation, Economic Affairs Sector, (1995-2014), Agricultural Statistics Bulletin, various issues.
2. Ministry of Agriculture and land reclamation, Economic Affairs Sector, (1995-2014), food balance Bulletin, various issues.

Table 2: Results of estimating equations year time trend in productivity and economic indicators related to the rice crop during the period (1995-2014).

F	R^2	The amount of the increase or decrease	Equation	Statement
96.8	0.92	0.04	$\hat{Y}i = 3.23 + 0.13\,x - 0.005\,x^2$ (11.1) (- 8.8)	yield Tons / acre
6.27	0.44	36.53	$\hat{Y}i = 4122.96 + 389.13\,x - 17.63\,x^2$ (3.5) (- 3.3)	Production Thousand tons
56.5	0.78	89.68	$\hat{Y}i = 4082.5 + 89.68\,x$ (7.51)	Consumption Thousand tons
6.79	0.48	8.19	$\hat{Y}i = -327.98 + 270.79\,x - 13.13\,x^2$ (3.7) (- 3.5)	Exports Thousand tons

Source: Collected and calculated from the table (1).

Further indicates that the water requirements per ton ranged within a minimum about 1.1 thousand m3 / ton in 2011, and a maximum of about 1.8 thousand m3 / ton in 1995, by a yearly decrease significantly statistically was about 11.82 m3 / ton.

Also show that the necessary amount of water for the cultivation of the total area of rice ranged within a minimum and amounts to about 6.2 billion m3 in 2011 representing about 20% of the amount of water needed for agriculture, and a maximum reached 9.9 billion m3 in 2006, representing about 24.1% of the amount of of water required for the purposes Agriculture, it turns out not to significantly function

Table 3: Evolution of water indicators for the rice crop during the period (1995-2014).

% Of water used in rice production	Water field for agricultural purposes Billion m 3	Water rice production Billion m 3	Water requirements M 3 / ton	Water rated M 3 / acre	. year
23.17	36.62	8.484	1772	6060.0	1995
21.35	39.60	8.454	1729	6017.1	1996
24.79	34.95	8.663	1583	5589.2	1997
25.95	32.90	8.538	1734	6969.4	1998
24.83	33.87	8.410	1446	5394.5	1999
24.63	34.67	8.539	1425	5442.4	2000
21.13	34.76	7.345	1405	5481.0	2001
23.75	35.37	8.400	1375	5429.9	2002
22.52	36.55	8.230	1331	5457.6	2003
22.16	37.86	8.390	1322	5458.7	2004
18.65	39.40	7.350	1199	5037.7	2005
24.13	40.95	9.880	1463	6202.1	2006
25.10	42.08	10.56	1536	6312.0	2007
25.30	42.85	10.84	1494	6124.3	2008
24.62	34.56	8.510	1542	6216.2	2009
17.97	37.79	6.790	1569	6212.3	2010
19.96	30.87	6.162	1088	4373.0	2011
24.76	32.65	8.084	1115	5896.6	2012
24.94	34.72	8.660	1597	6501.0	2013
25.68	35.32	9.071	1663	6650.0	2014
23.27	36.417	8.468	1469.4	5841.3	Mean

Source: Collected and calculated from the 1. Ministry of Agriculture and land reclamation, the Economic Affairs Sector (1995-2014), Agricultural Statistics Bulletin.

1. Central Agency for Public Mobilization and Statistics (1995-2014), Irrigation and Water Resources Bulletin.

Table (4): The results of estimating equations of general time trend for some water indicators related of rice crop during the period of (1995-2014).

F	R^2	Amount increase or decrease	Equation	Statement
5.2	0.38	-11.82	$\hat{Y}i = 1838.6 - 78.81\,x + 3.19\,x^2$ *(-2.98) *(2.61)	Water requirements m3 / ton

Significant at the level 1%*

Source: Collection, calculated from the table (3)

Third, estimate the water footprint and indicators

Calculates the water footprint of the crop by estimating the amount of water used in domestic production, and the amount of water gained from imports, and its counterpart lost as a result of exports during the period (1995-2014). It was found from the data and findings contained tables (5,6) show that local rice production and average water requirements per ton, the local water used in the production of rice within a minimum amount ranged at around 6.2 billion m3 in 2011, and a maximum of about 10.8 billion m3 in 2008, the average for the period amounted to about 8.47 billion m3.

Given the magnitude of the exported quantities of rice it has been the amount of exported water within a minimum range and amounts to about 149.1 million m3, maximum and amounts to about 2.74 billion m3 in 2007, and the average extra amount of water with the quantities exported during the study period of about 1.01 billion m3. While inland water footprint ranged within a minimum and amounts to about 5.54 billion m3 in 2010, and a maximum of about 10.5 billion m3 in 2008, representing about 74.4%, 140.9% of the average inland water footprint, amounting to about 7.45 billion m3. And by a statistically significant annual increase amounted to 121.1 million m3 during the study period.

The amount of virtual water imported within a minimum and in light of the amount of Egyptian imports of rice and the average water requirements per ton, due to the low imported from the crop amounts ranged and is about 0.54 million m3 in 1996, and a maximum of about 264.4 million m3 in 2007, representing about 1.7%, 811% of the average amount of virtual water imported, amounting to about 32.6 million m 3, while showing not a significant function.

While the external water footprint ranged within a minimum and amounts to about 83.8 million m3 in 2011, and a maximum of about 2.5 billion m3 in 2007, representing about 9.4%, 278.4% of the average external water footprint, amounting to about 891.2 million m3. And by a statistically significant annual increase amounted to about 11.52 million m 3 during the study period

From the above it is clear that of total water footprint of the rice crop ranges within a minimum and amounts to about 3.8 billion m3 in 2005, and a maximum of about 10.1 billion m3 in 2008, representing about 58.5%, 155.4% of the average total water footprint, amounting to about 6.5 billion m3, and by an annual decrease significantly statistically it amounted to about 30.5 million m3 during the study period.

By studying the total water footprint of the rice crop indicators during the same period show the results table (5) that the dependence on external water imports ranged within a minimum and amounts to about 1.4% in 2011, and a maximum of about 46.95% in 2005, representing about 9.2%, 308.9 % of the average rate of dependence on external water resources, amounting to about 15.2%. And by increasing annual statistically significant was about 0.24% .

Imports inland waterways (local) dependence on ratio ranged within minimum around 101.4% in 2011, and a maximum of about 147% in 2005, representing approximately 88.02%, 127.6% of the average rate of dependence on inland waterways imports, amounting to about 115.2%. While it is showing not seg. function.

Quantity of water used in production = total production × water requirements per ton

Quantity of virtual water exporter = Total exports × water requirements per ton.

The inland water footprint = Quantity of water used in production - Quantity of virtual water exporters.

Virtual water imported quantity = Total imports × water requirements per ton

External water footprint = Quantity of virtual water imported from abroad - Quantity of virtual water exporters.

Total = The inland water footprint and water footprint + External water footprint.

%Dependence on External water resources = (external water footprint ÷ Total water footprint) × 100.

%dependence on local water resources = (internal water footprint ÷ Total water footprint) × 100.

Table (5): The evolution of the amount of water used in domestic production and the amount of water earned from import and the amount of outgoing water by rice crop exports in Egypt during the period (1995-2014)

Water footprint indicators		Total footprint water million m3	External water footprint million m3	Quantity of virtual water imported Million cubic meters	he inland water footprint million m3			year
%dependence on local water resources	%Dependence on external water resources				inland water footprint Million cubic meters	Quantity of exporter virtual water million m3	Quantity of water used in production by million m3	
104.7	-4.734	7748.6	-366.8	1.772	8115.4	368.58	8484	1995
107.7	-7.685	7327.2	-563.1	0.536	7890.3	563.65	8454	1996
106.0	-6.020	7730.6	-465.4	1.583	8196.0	466.99	8663	1997
117.0	-16.96	6375.0	-1081	0.624	7456.0	1082.0	8538	1998
105.9	-5.881	7523.6	-442.5	1.446	7966.1	443.92	8410	1999
106.8	-6.808	7514.4	-511.6	1.425	8026.0	513.00	8539	2000
132.5	-32.48	4451.9	-1446	1.405	5897.9	1447.2	7345	2001
114.8	-14.76	6483.3	-957.0	2.750	7440.3	959.75	8400	2002
116.8	-16.77	6160.2	-1033	3.993	7193.2	1036.8	8230	2003
126.8	-26.77	5460.6	-1462	5.288	6922.6	1467.4	8390	2004
147.0	-46.95	3786.7	-1778	7.194	5564.7	1785.3	7350	2005
136.7	-36.68	5692.6	-2088	11.70	7780.6	2099.4	9880	2006
146.5	-46.51	5334.2	-2481	264.2	7815.2	2744.8	10560	2007
103.4	-3.400	10106	-343.6	46.31	10450	389.93	10840	2008
121.0	-20.98	5968.9	-1252	37.01	7220.9	1289.1	8510	2009
127.9	-27.87	4334.6	-1208	39.23	5542.6	1247.4	6790	2010
101.4	-1.413	5929.1	-83.78	65.28	6012.9	149.06	6162	2011
102.8	-2.780	7621.2	-211.9	39.03	7833.1	250.88	8084	2012
111.5	-11.51	7008.7	-806.5	38.33	7815.2	844.81	8660	2013
112.0	-11.98	7256.7	-869.7	74.84	8126.4	944.58	9071	2014
117.46	-17.447	6490.7	-972.5	32.197	7463.3	1004.73	8468	Average

Source: collection, calculated from the table (1.3)

Table (6): The results of estimating the general time trend equations for water footprint and indicators related the rice crop in Egypt during the period (1995-2014).

F	R^2	Amount the increase or decrease	Equation	Statement
4.1	0.33	121.1	$\hat{Y}i = -102.6 + 272.3\ x - 12.2\ x^2$ (2.9) (-2.8)	Quantity of virtual water exporter million m3
4.3	0.34	11.52	$\hat{Y}i = -78.8 + 265.2\ x - 12.08\ x^2$ (2.9) (-2.9)	External water footprint million m3
2.91	0.21	-30.5	$\hat{Y}i = 8432.6 - 472.97\ x + 21.07\ x^2$ *(- 2.09) *(2.02)	Total water footprint million m3
4.82	0.36	0.24	$\hat{Y}i = -6.82 + 6.12\ x - 0.28\ x^2$ (3.1) (-3.05)	**%**Dependence on external water imports

Significant at the level 5%*
Source: collection, calculated from a table (5).

Estimate strategic stocks and coefficient food securityFourthly:-

The Strategic stocks estimate of the crop rice by calculating Amount the surplus allocated for local consumption and the deficit during the period (1995- 2014), the results in table (7) shown thatInstability period cover production for consumption for rice crops so A minimum is about 172.6 days in 2012, and a maximum of about 228.8 days in 2006. It also instability period to cover imports for local consumption is within a minimum and is about 133.5 days in 2004,And a maximum is about 228.8 days in 2006. He also fluctuated period to cover imports for local consumption is within a minimum is about 133.5 days in 2004, and maximum is about 286.5 days in 2010. However, it is noted that the coverage of imports for local consumption period is low and this index is not good for keeping the Egyptian water resources, It reflects a clear concept for the lack of attention to within the meaning of virtual water principle, which means working to increase imports of agricultural crops severe water consumption and to reduce dependence on domestic production of those crops to preserve the water resources for our country of the risk of water scarcity, As a result of increased reliance on domestic production, and then an increase in the deficit in the water balance Of water. The excess Surplus of the crop for domestic consumption during the years 1996- 1997- 1999- 1995- 2002- 2003- 2004- 2006- 2007- 2008 to 2012, as much as the total surplus of about 7197.2 thousand tons, while deficit in the provision of rice happened domestic consumption during the other years 1998- 2001- 2005- 2009- 2011- 2013 to 2014 as much as the total deficit of about 5281.4 thousand tons. According to the concept of strategic reserves as an outcome of both surplus and deficit during the study period, it is estimated that the strategic stockpile of rice in Egypt at about 1915.8 thousand tons, and in the light of the average annual domestic consumption of the crop and of about 5021.5 thousand tons, as far as food security coefficient of rice by about 0.382 during the period (1995 -- 2 014).

1- Daily domestic consumption = total consumption ÷ number of days a year (365 days)
2. The sufficiency of production = total production ÷ daily domestic consumption .
3. The period of coverage of imports = Total imports ÷ daily domestic consumption .
4. The change in the strategic reserves (surplus or deficit) = [(total length of the periods of production and the coverage of imports - 365)× local daily consumption - Quantity of exports.
5. Strategic stocks surplus = outcome - the outcome of the deficit.
6. Food security coefficient = strategic stocks ÷ average annual domestic consumption

Table (7): The development of production and of coverage of imports for local consumption and the amount of change in the Strategic stocks and food security coefficient of rice crop in Egypt during periods (1995-2014).

The change in the strategic reserves in thousand tons		periods production sufficiency and imports cover the daily consumption			exports quantity by thousand tons	imports Quantity by thousand tons	daily domestic consumption thousand tons	Annual consumption Thousand tons	year
deficit	Surplus	Total	The period of coverage of imports	The period of production sufficiency					
0	392.1	417.29	0.09	417.2	208	1.00	11.477	4189	1995
0	365.71	425.06	0.03	425.0	326	0.3١	11.518	4204	1996
0	662	442.21	0.08	442.1	295	1.00	12.395	4524	1997
796.44	0	351.39	0.03	351.4	624	0.3٦	12.666	4623	1998
0	1558.2	537.27	0.09	537.2	307	1.00	10.827	3952	1999
0	416.5	419.24	0.07	419.2	360	1.00	14.315	5225	2000
565.3	0	400.61	0.08	400.5	1030	1.00	13.049	4763	2001
0	1123.5	520.16	0.17	520.0	698	2.00	11.740	4285	2002
0	379.5	449.25	0.22	449.0	779	3.00	13.751	5019	2003
0	386.7	477.45	0.30	477.2	1110	4.00	13.310	4858	2004
405.0	0	443.41	0.43	443.0	1489	6.00	13.825	5046	2005
0	178.2	479.58	0.57	479.0	1435	8.00	14.079	5139	2006
0	29.8	491.75	12.0	479.7	1787	172	14.334	5232	2007
0	1697.4	499.21	2.12	497.1	261	31	14.592	5326	2008
910.5	0	360.16	1.56	358.6	836	24	15.395	5619	2009
1954.9	0	288.19	1.66	286.5	795	25	15.101	5512	2010
16.50	0	372.84	3.91	368.9	137	60	15.356	5605	2011
0	7.6	379.9	2.24	377.7	225	35	15.614	5699	2012
307.4	0	379.19	1.54	377.7	٥٢٩	٢٤	15.658	٥٧١٥	2013
325.4	0	380.54	2.88	377.7	٥٦٨	٤٥	16.151	٥٨٩٥	2014
264.07	359.86	425.73	1.503	424.2	689.95	22.2	13.758	5021.5	Mean
1916		Strategic stocks							
0.382		Food security coefficient							

Source: Collected and calculated from the table (1).

Fifth: The contribution of domestic production, imports and agricultural invest abroad to achieve food security for the rice crop

Study the relative importance of domestic production , imports and Egyptian agricultural investment abroad to achieve security for the rice crop, it is clear from the results in table (8) that،

That in the absence of Egyptian agricultural investment abroad during the period (1995- 2014), food security depended crop on both domestic production and imports, under food security coefficient 0.382, and the relative importance of the contribution of domestic production to the relative food security of rice and within a minimum of about 37.1%, and the maximum of about 39.1% at a confidence level of 95%. The relative importance of the contribution of imports ranged in achieving food security relative to harvest within a minimum and a negative value of the minimum and maximum amounts to about 1.1% atthe same degree of confidence, making it clear that the food security of the rice crop in Egypt not depends mainly on imports, and thus shows how wasteful virtual water used in crop production volumes as imports are minimal.

Table (8): Domestic production and imports contribute to the achievement of food security Percent of rice without Egyptian agricultural investment abroad during the period (1995-2014).

imports	domestic product	food security coefficient	strategic stocks thousand tons	Statement
0.1350	38.097	0.382	1916	1995-2014
0.00135	0.38097	The possibility of contributing to the achievement of food security		
0.38097	0.00135	The possibility of not contributing to the achievement of food security		
0.05	0.05	The standard error for the possibility of contributing to the achievement of food security (default)		
0.0099	0.0099	The standard error at a 95% confidence interval (Brnillola distribution)		
0.00135 ± 0.0099	0.38097 ± 0.0099	The possibility of contributing to the achievement of food security at a 95% confidence		
The percentage contribution to food security at a 95% confidence				
1.125**%** 0.0086-**%**	39.087**%** 37.107**%**	**maximum** **minimum**		

Source: collection, calculated from the results in table (7)

While in Egyptian agricultural investment abroad, the food security of the ric crop depends on domestic production, imports and abroad agricultural investment so when we study of the relative importance of domestic production to achieve different levels of food security Percentage to the rice crop, it is clear from the results in table (9) that in light of achieving the level of 0.5 to the coefficient of the food security of the crop, so the relative importance of the contribution of domestic production to the relative food security within a minimum and is about 28.76%, and the maximum of about 47.43% at a confidence level of 95%. While achieving the full level of the coefficient of food security (ie a food security coefficient per 1) ranges relative importance of the contribution of domestic production to achieve security.

Percentage food of rice within a minimum of about 16.81%, and the maximum of about 59.38% at the same degree of confidence,

Table (9): The contribution of local production With imports and a Egyptian abroad agricultural investment to achieve Percentage food security of the rice crop during the period (1995-2014)

Domestic production to achieve different levels of food security						Statement
1	0.9	0.8	0.7	0.6	0.5	Hypothetical scenarios for the coefficient of food security
0.38097	0.38097	0.38097	0.38097	0.38097	0.38097	The possibility of contributing to the achievement of food security
0.61903	0.51903	0.41903	0.31903	0.21900	0.11903	The possibility of not contributing to the achievement of food security
0.10859	0.09943	0.08934	0.07796	0.06459	0.04762	The standard error for the possibility of contributing to the achievement of food security
0.21284	0.19488	0.17511	0.15280	0.12660	0.09334	The standard error at a 95% confidence
0.38097± 0.21284	0.38097± 0.19488	0.38097± 0.17511	0.38097± 0.15280	0.38097 ± 0.12660	0.38097	The possibility of contributing to the achievement of food security at a 95% confidence
The percentage contribution to food security at a 95% confidence						
59.38	57.59	55.61	53.38	50.76	47.43	maximum
16.81	18.61	20.59	22.82	25.44	28.76	minimum

Source: collection, calculated from the results in table (7)

With regard to the study of the relative importance of imports in achieving different levels of food security Percentage to the rice crop, it is clear from the results in table (10) that in light of achieving the level of 0.5 to the coefficient of the food security of the crop, ranging from the relative importance of the contribution of imports to the relative food security within a minimum and a about - 4.94, And the maximum of about 5.21% at the 95% confidence level. While in light of achieving the full level of the coefficient of food security (ie the food security coefficient per 1) range from the relative importance of the contribution of imports to the relative food security for wheat within a minimum and is about -7.06%, and the maximum of about 7.33% at the same degree of confidence. Finally, within relative importance of agricultural investment Egyptian abroad to achieve different levels of food security Percentage of wheat, it is clear from the results in table (11) that is achieving the coefficient of the food security of the crop at level of 0.5, the relative importance of the contribution of the Egyptian agricultural investment abroad the in achieving security Percentage food security ranging within a minimum and amounts to about 2.5%, and the maximum of about 21.1% at a confidence level of 95%.While in been achieving the full level of the coefficient of food security (ie a food security coefficient per1) ranges relative importance of the contribution of the Egyptian agricultural investment abroad in the relative food security of the rice crop within a minimum and is about 40.5%, and the maximum of about 83.1% at the same degree Confidence.

Sixth: To estimate the quantity and value of virtual water gained from foreign trade to achieve food security

1. **Estimate the quantity and value of virtual water, according to the average for the period (1995-2014).**

Table (10): The contribution of imports With a local production and Egyptian agricultural abroad investment in the to achieve Percentage food security of the rice crop during the period (1995-2014).

imports to achieve different levels of food security						Statement
1	0.9	0.8	0.7	0.6	0.5	Hypothetical scenarios for the coefficient of food security
0.00135	0.00135	0.00135	0.00135	0.00135	0.00135	The possibility of contributing to the achievement of food security
0.99865	0.89865	0.79865	0.69865	0.59865	0.49865	The possibility of not contributing to the achievement of food security
0.03672	0.03479	0.03286	0.03066	0.02846	.02588	The standard error for the possibility of contributing to the achievement of food security
0.07197	0.06819	0.06441	0.06009	0.05578	0.05072	The standard error at a 95% confidence
0.00135 ± 0.07197	0.00135 ± 0.06819	0.00135 ± 0.06441	0.00135 ± 0.06009	0.00135 ± 0.05578	0.00135± 0.05072	The possibility of contributing to the achievement of food security at a 95% confidence
The percentage contribution to food security at a 95% confidence						
7.332 -7.060	6.954 -6.684	6.576 -6.306	6.144 -5.870	5.713 -5.443	5.207 -4.937	**maximum** **minimum**

Source: collection, calculated from the results in table (7)

Table (11): Contribution Egyptian agricultural abroad investment With a local production and Egyptian agricultural investment in the abroad to achieve Percentage food security of the rice crop during the period (1995-2014).

External agricultural investment to achieve different levels of food security						**Statement**
1	0.9	0.8	0.7	0.6	0.5	Hypothetical scenarios for the coefficient of food security
0.618	0.518	0.418	0.318	0.218	0.118	The possibility of contributing to the achievement of food security *
0.382	0.382	0.382	0.382	0.382	0.382	The possibility of not contributing to the achievement of food security (food security coefficient)
0.10863	0.09945	0.08933	0.07810	0.06449	0.04747	The standard error for the possibility of contributing to the achievement of food security
0.21291	0.19492	0.17509	0.15308	0.1264	0.09304	The standard error at a 95% confidence
0.618 ± 0.21291	0.518 ± 0.19492	0.418 ± 0.17509	0.318 ± 0.15308	0.218 ± 0.1264	0.118 ± 0.09304	The possibility of contributing to the achievement of food security at a 95% confidence
The percentage contribution to food security at a 95% confidence						
83.091	71.292	59.309	47.108	34.44	21.104	**maximum**
40.509	32.308	24.291	16.492	9.160	2.4960	**minimum**

*The possibility of contributing to the achievement of food security = default scenarios coefficient of food security - the possibility of not contributing to the achievement of food security.

Source: collected and calculated from the results in table (7)

From the above it became clear that the strategic reserves of the rice crop in Egypt amounted to 1915.8 thousand tons, and the average local annual consumption for a yield of about 5010.9 thousand tons, and then the food security coefficient reached 0.382, and the average water needs per ton of approximately 1469.4 m 3 as an average for the period (1995 --2 014). Has been estimating the amount of virtual water gained from foreign trade by estimating the necessary strategic stock size to achieve different levels of food security and Percentage rice, and the minimum and maximum contribution rate of Egyptian agricultural investment abroad and imports to achieve food security at confidence of 95%,

Table (10.11), we estimated the minimum and maximum for each of the amount of rice imported and its other from the Egyptian agricultural investment abroad.

It is clear from the results in table (12) that the amount of rice imported to achieve the full level of food security a maximum of about 367.4 thousand tons at a 95% confidenceIn view of the average water requirement unit is of about 1469.4 m 3 / ton, the virtual quantity earned water of rice imports to achieve the full level of food security a maximum of about 539 900 000 m 3, the financial value of about 170.1 million pounds at the same degree of confidence. The amount of rice from the Egyptian agricultural investment abroad ranging as to achieve the full level of food security within a minimum and is about 2.03 million tons, and the maximum of about 4.16 million tons at the same degree of confidence.

Under the average of water requirement to the unit is about 1469.4 m 3 / ton, and the quantity virtual water earned of Egyptian agricultural investment abroad to achieve the full level of food security of rice ranges within a minimum to about 2.98 billion m 3,by financial value of about 939.5 million pounds, and a maximum limit of about 6.12 billion m 3, the financial value of about 1.93 billion pounds at the same degree of confidence.

it means that the total quantity of virtual water for foreign trade to achieve the full level of food security of rice ranges within a minimum about 2.98 billion m 3, with its value about 939.55 million pounds, and maximum to about 6.66 billion m3, its value around 2.1 billion pounds when the same degree of confidence.

2. **Estimate the quantity and value of virtual water, according to the average for the period (2011-2014)**

In view ofdomestic consumption average of rice during the period (2011- 2014) and of about 5728.5 thousand tons, is expected to increase strategic stock from 2.86 million tons to achieve the level of 0.5 to food security, to about 5.73 million tons in achieving total level of food security. It is clear from the results in table (13) that the amount of imported rice to achieve the full level of food security a maximum of about 420 thousand tons at a 95% confidence.

In view of the water requirements average of the unit produced around 1365.8 m 3 / ton, the amount virtual water earned of rice imports to achieve the full level of food security a maximum of about 573 700 000 m 3, the financial value of about 180.7 million pounds at the same degree of confidence.

Table (12): The amount and value of virtual water of foreign trade to achieve food security, according to the average domestic consumption of rice crop during the period (1995-2014).

Food security levels for the rice crop 1995/2014						Statement
1	**0.9**	**0.8**	**0.7**	**0.6**	**0.5**	
5010.9	5010.9	5010.9	5010.9	5010.9	5010.9	Average annual consumption per thousand tones
5010.9	4509.81	4008.72	3507.63	3006.54	2505.45	Stockpile by thousand tons
quantity of rice imported in thousand tons						
367.399	313.61	263.61	215.51	171.76	130.46	max
-	-	-	-	-	-	min
Quantity of virtual water earned from import by million m3						
539.856	460.82	387.35	316.67	252.39	191.7	max
-	-	-	-	-	-	min
value of virtual water earned from import LE million*						
170.055	145.16	122.02	99.751	79.503	60.384	max
-	-	-	-	-	-	min
Quantity of rice from the Egyptian agricultural investment abroad in thousand tons						
4163.61	3215.13	2377.53	1652.37	1035.45	528.75	max
2029.87	1457.03	973.758	578.478	275.399	62.536	min
Quantity of virtual water earned from the Egyptian agricultural investment abroad million m 3						
6118	4724.32	3493.55	2428	1521.5	776.95	max
2982.68	2140.96	1430.84	850.02	404.67	91.89	min
the value of virtual Water earned of the Egyptian agricultural investment abroad million pounds						
1927.17	1488.16	1100.47	764.82	479.27	244.74	max
939.546	674.402	450.715	267.76	127.47	28.945	min
Total Quantity of virtual water earned million m3						
6657.86	5185.1	3880.9	2744.7	1773.9	968.64	max
2982.68	2140.96	1430.84	850.02	404.67	91.89	min
Total value of earned virtual water million pounds						
2097.23	1633.3	1222.5	864.57	558.77	305.12	max
939.546	674.402	450.715	267.76	127.47	28.945	min

*The estimated average unit price from irrigation water about 0.315 pounds, based on the reference (5.6).

Source: collected and calculated from tables (1.3, 7.10, 11), and a reference (5.6)

The ranging of quantity of rice from the Egyptian agricultural investment abroad to achieve the full level of food security within a minimum and is about 2.32 million tons, and the maximum of about 4.76 million tons at the same degree of confidence.

In view of the average water requirements of the producing unit of around 1365.8 m 3 / ton, so the quantity virtual water earned of Egyptian agricultural investment abroad to achieve the full level of food security, ranging within a minimum and amounts to about 3.17 billion m 3, the financial value of about 998.4 million pounds, and a maximum of around 6.5 billion m3, financial, worth around 2.05 billion pounds at the same degree of confidence.

From the above it is clear that the total Quantity of virtual water earned from import agricultural investment Egyptian abroad to achieve the full level of food security, ranging within a minimum and amounts to about 3.17 billion m 3, the financial value of about 998.4 million pounds, maximum of about 7.07 billion m3, financial, worth around 2.23 billion pounds at the same degree of confidence.

Summary and Recommendations:-

The study is based on that it is dependence on the rice food security through domestic production, import, Egyptian agricultural investment abroad. So it targeted estimating quantity and value of virtual water earned from imports, Agricultural investment outside to achieve relative food security of rice in Egypt, And depended in achieving its objectives of economic and statistical analysis of descriptive and quantitative by estimating of the equations of the water footprint, the coefficient of relative food security, the quantity and value of virtual water, in addition to the probabilistic binomial distribution, and standard errors at the 95% confidence level. And it resulted in a set of results of the most important as the following :-

(1)The total water footprint of the rice crop ranges within a minimum about 3.8 billion m3 in 2005, and a maximum of about 10.1 billion m3 in 2008, representing about 58.5%, 155.4% of the average total water footprint, amounting to about 6.5 billion m 3, and by yearly statistically significant decrease to 30.5 million m 3 during the study period.

(2) The average ratio dependence on foreign imports water of rice is 15.2%, so the average rate of self-sufficiency from local water resources amounted to 115.2% during the study period.

(3) As a strategic Stockpile of rice in Egypt estimated about 1915.8 thousand tons, and under the average annual domestic consumption of the rice around 5021.5 thousand tons, as much as the food security of rice is about 0.382 during the period (1995-2014).

Table (13): The amount and value of virtual water earned from import and agricultural investment abroad to achieve food security, according to the average domestic consumption of rice crop during the period (2011-2014).

Food Security levels of Rice Crop						Statement
1	0.9	0.8	0.7	0.6	0.5	
5728.5	5728.5	5728.5	5728.5	5728.5	5728.5	annual consumption average per thousand tones
5728.5	5155.65	4582.8	4009.95	3437.1	2864.25	*Stockpile thousand tons size
Quantity of rice imported in thousand tons						
420.01	358.52	301.36	246.37	196.36	149.14	max
-	-	-	-	-	-	min
Quantity of virtual water earned from import million m3						
573.655	489.672	411.604	336.494	268.191	203.697	max
-	-	-	-	-	-	min
value of virtual water earned from import million pounds**						
180.701	154.247	129.655	105.996	84.48	64.165	max
-	-	-	-	-	-	min
quantity of rice from the Egyptian agricultural investment abroad in thousand tons						
4759.9	3675.6	2718	1889	1183.7	604.47	max
2320.6	1665.7	1113.2	661.32	314.84	71.492	min
Quantity of virtual water earned from the Egyptian agricultural investment abroad million m 3						
6501.03	5020.09	3712.26	2580.01	1616.75	825.59	max
3169.42	2275	1520.42	903.232	430.006	97.643	min
value of virtual Water earned of the Egyptian agricultural investment abroad million pounds						
2047.82	1581.33	1169.36	812.702	509.276	260.06	max
998.367	716.624	478.932	284.518	135.452	30.758	min
total Quantity of virtual water earned from import and Egyptian agricultural investment abroad million m 3						
7074.68	5509.76	4123.87	2916.5	1884.94	1029.3	max
3169.42	2275	1520.42	903.232	430.006	97.643	min
Total value of earned virtual water import from agricultural and Egyptian investment abroad million pounds						
2228.52	1735.57	1299.02	918.698	593.756	324.22	max
998.367	716.624	478.932	284.518	135.452	30.758	min

*Stock = average annual consumption × food security levels supposedly

* The estimating of average unit price from irrigation water about 0.315 pounds on the basis of (5.6).

Source: collected and calculated from tables (1.3, 7.10, 11), and a reference (5.6).

(4) Under the food security coefficient of about 0.382, it ranged from the relative importance of the contribution of domestic production to the relative food security of rice within a minimum 37.1%, and the maximum about 39.1% at a confidence level of 95%. The relative importance of the contribution of imports ranged in achieving food security relative to the rice within a minimum and has a negative value, and maximum amounts to about 1.1% at the same degree of confidence, and that in the absence of Egyptian agricultural investment abroad.

(5)With achieving the full level of the coefficient of food security (ie a proper food security coefficient 1) relative importance of the contribution of domestic production to the relative food security of rice within ranged a minimum and is about 16.81%, and the maximum of about 59.38% at a confidence level of 95%. In the been achieving the full level of the coefficient of food security (ie a food security coefficient 1), Ranges relative importance of the contribution of imports to the relative food security for wheat within a minimum and a negative value of the minimum and maximum amounts to about 7.3% at the same degree of confidence. In the been achieving the full level of the coefficient of food security (ie a food security coefficient per 1) ranges relative importance of the contribution of the Egyptian agricultural investment abroad in the relative food security of the rice crop within a minimum and is about 40.51%, and the maximum of about 83.09% at the same degree Confidence.

(6)The quantity of virtual water earned from rice import to achieve the full level of food security a maximum 539 9 million m 3, with value of about 170.1 million pounds at the same degree of confidence. The amount of rice from the Egyptian agricultural investment abroad as to achieve the full level of food security within ranging a minimum 2.03 million tons, and 4.16 million tons at the same degree of confidence.

In view of the requirement average of water to product unit of about 1469.4 m 3 / ton, the virtual water amount earned of Egyptian agricultural investment abroad to achieve the full level of food security of rice ranges within a minimum about 2.98 billion m 3, the value of about 939.5 million pounds, and a maximum of about 6.12 billion m 3, the value of about 1.93 billion pounds at the same degree of confidence.

From the above it is clear that the total virtual water of foreign trade quantity to achieve the full level of food security of rice ranges within a minimum about 2.98 billion m 3, the value of about 939.55 million pounds, and maximum and amounts to about 6.66 billion m3, with value 2.1 billion pounds when the same degree of confidence.

Through these results, the study recommends the following:

1. We need to do economic integration between local agriculture and imports and overseas agricultural investment to achieve food security for the rice crop.
2. We must take care of virtual water when put future strategy for the agricultural sector to ensure the adoption of agricultural production systems use less water.
3. Focus on imports of external agricultural investments in agricultural products which need more quantity of water especially in water Crisis.

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Estimation of Water Footprint and Virtual Water for Rice in Egypt.

Summary:

This study aimed to Estimation of Water Footprint and Virtual Water for Rice in Egypt. This study adopted in to achieve its objectives in economic analysis represented in the economic equations used to Estimation Water Footprint, Virtual Water and coefficient of Food Security, in addition to the binomial probability distribution and standard errors at 95% confidence level.

The study results can be summarized as follows; (1) Estimate the average total Water Footprint decreased of rice croup in Egypt around 6.5 billion m^3 during the period 1995- 2014. (2) Estimate the average ratio of water import dependency of rice 15.2% and thus the average ratio self-sufficiency for water 115.2% during the study period. (3) Egypt has achieved remarkable progress in food security for rice, as the volume of strategic stocks 1.92 million tons, and in light of average domestic consumption of 5.02 million tons, coefficient of food security for rice is 0.382 during the period 1995- 2014. (4) Contribution ranged of local agriculture in achieving relative food security for rice (coefficient of food security is equal to 0.382) between a minimum of 37.1% and a maximum of 39.1% at 95% confidence level during the period 1995- 2014. (5) In the light of achieving the full level of food security for wheat ranging the relative importance of Contribution of the local production between a minimum of 37.1 and a maximum of 39.1%, while ranging the relative importance of Contribution of imports between a minimum of mines value and a maximum of 1.1%, and ranging the relative importance of Contribution of foreign agricultural investment between a minimum of 40.5% and a maximum of 83.1% at 95% confidence level. (6) The total of amount virtual water Gained from Imports and Foreign Agricultural Investment to achieve the full level of food Security for rice ranging between a minimum of zero m3 valued at zero pound, and a maximum of 2.98 billion m^3 valued at 6.66 billion pounds at 95% confidence level.

This study recommends the need economic integration between local agriculture, imports and Foreign Agricultural Investment to Achieve Food Security and the introduction of the concept of virtual water when developing future strategy for the Agricultural sector to ensure the adoption of agricultural production systems used less water and focus on the import of agricultural products that needs of high water, especially in the light of escalating water.

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