EVALUATING THE VIRTUAL WATER TRADE IN THE EGYPTIAN AGRICULTURAL SECTOR IN LIGHT OF THE WATER FOOTPRINT TO ACHIEVE SUSTAINABLE DEVELOPMENT

Submitted By

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Suez Canal University,1989

A thesis submitted in Partial Fulfillment
Of
The Requirement for the Doctor of Philosophy Degree
In
Environmental Sciences

Department of Environmental Agricultural Sciences
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ABSTRACT

EVALUATING THE VIRTUAL WATER TRADE IN THE EGYPTIAN AGRICULTURAL SECTOR IN LIGHT OF THE WATER FOOTPRINT TO ACHIEVE SUSTAINABLE DEVELOPMENT

This study is aiming to evaluate the Virtual Water Trade in the Egyptian Agricultural Sector in light of the Water Footprint to achieve sustainable development

Due to increasing demand for water for development and to face the population growth, the uses of water resources of Egypt became one of the important issues. At the same time the country desire to increase agricultural exports and reduce imports, which requires some sort of balance between the current water stress and the country desires without sacrificing the sustainability of water resources uses. The virtual water and water footprint concept which emerged in the 1990's as indicators on water use in the production of goods and services to assess the Egypt virtual water trade form each of the cereal crops represented in rice, wheat, maize, soybean and vegetable crops represented in potatoes , dry onions, tomatoes, green beans, as well as fruit crops represented in oranges, grapes, dates, bananas, during the period (2001 - 2010). The production figures has been presented including cultivated areas (in 1000 feddan), total production (metric tonnes) and land unit productivity (ton/feddan). The trade volume and values (exports - imports) for each crop was addressed. The virtual water (m^3/tonne) and water footprint (m^3/year) as well as the water import dependency has been calculated for each crop. The water unit productivity for each crop was figured out (kg/ m^3) and Egypt water resources and utilization in agriculture production during the study period has been presented.

The results showed that the average cultivated areas as an annual average during 2001-2011 (in 1000 feddan) was for cereal crops as rice 1,491, wheat 2,784, maize 2,052 and soybeans 23. For the vegetable crops

was it was 260 for potatoes, 96 Dry Onion, 58 Green beans and 502 tomatoes. The average fruit crops areas were orange 2,015, grapes 1,320, dates palms 1,224 and bananas 941. The total production data (1000 metric tons) showed: wheat 7,437, maize 6,712, rice 6,072, soybeans 30 and for vegetable crops it was for potatoes 2,758, Dry onions 1,316, green beans 260 and tomatoes 8,073. For fruit crops: oranges 2,015, grape 1,320, dates 1,224 and bananas 941. The average annual volume of virtual water trade in form of the selected crops during the study period (2001-2010) expressed in *million* m^3 was 1,344 *million* m^3 exports versus 13,068 *million* m^3 from import and that the cereal crops exports represents 68% and imports representing 99.85%.

The average unit water productivity of crops expressed in kg/m^3 during the period 2001-2010, showed that productivity was higher in vegetable crops, reaching 5.05 for tomatoes, potatoes 4.53, Dry onion 3.64 and 2.26 for green beans. Fruit crops came as the second in the water unit as Bananas 2.15, dates 2.12, and 2.03 for grapes. The cereal crops were the less productive, reaching 1.09 for wheat, 1 for maize, 0.81 for rice and 0.34 for soybeans. The total water footprint calculation for the crops during the period 2001-2010 showed , the average the total water footprint for all selected crops is 38,672 *million* m^3 */year* and the share of cereal crops 33,282 *million* m^3 */year* (86.06%), and the vegetables 2,532 *million* m^3 */year* (6, 55%) and fruit crops 2,858 *million* m^3 */year* (7.39%). With regard water import dependency, the highest percentage was of soybean crop, 95.96%, wheat 48.15%, maize 40.63%, potatoes 2.65% and the rest of the crops under study were less than 1%.

In light of the water footprint, water import dependency, water unit productivity for each crop, it is important to revisit the rice cultivated areas and its export policies which helps in the growth of maize cultivated areas. For both wheat and soybeans, foreign investment out country boarders may be the solution to ensure the continuity of their supplies to Egypt. For vegetable crops it has been found that there are export opportunities and achieve returned without affecting Egypt's water resources for each of the potatoes, dry onions, green beans and tomato crops with more focus on reducing losses in yield and increase water unit productivity as stated in the "sustainable agricultural development strategy towards 2030 to Egypt. As for fruit crops, the results indicated

that the oranges, grapes, dates exports can continue with the same volumes without impact on the water resources of Egypt with some efforts to increase water unit productivity as well as increased unit area productivity. Although the total water footprint of crop bananas and the water import dependency was not high, but the internal water footprint volume are high compared to other fruit crops and then must reduce export until access to the increase in productivity per unit of water. Generally, the study showed the need to focus on increased water unit productivity and increase land unit productivity of with more efforts to promote the concept "crop per drop "

Key Words:

Virtual Water; Water Footprint; Water Import Dependency; Sustainable development; Cereal Crops; Vegetables; Fruit Crops; Rice; Wheat; Maize; Soybean; Potato; Onion; Green Beans; Tomato; Orange; Grape; Dates; Banana

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List of List of Units and Abbreviations

%	Percentage
AHDR	Aswan High Dam Reservoir
ASL	Above Sea Level
Avg.	Average
AWU	Agricultural Water Use
BCM	Billion Cubic Meters
bm3	Billion Cubic Meters
CAPMAS	The Central Agency for Public Mobilization and Statistics in Egypt
CWP	Crop Water Productivity
CWR	Crop Water Requirements
CWU	Crop Water Use
DWU	Domestic Water Use
EFP	Environmental Footprint
EGP	Egyptian Pound
et. ,al	and Others
EU	European Commission
EWFP	External Water Footprint
FAO	Food and Agriculture Organization of the United Nations
Feddan	Land area measure used in Egypt (1 Feddan = 4200 square meters). (1 Feddan = 0.42 ha), (1 Hectare = 2.38 Feddans
GIS	Geographic Information System
Gm3/yr	Billion Cubic Meters per year
GVWE	Gross Virtual Water Export
GVWI	Gross Virtual Water Import
ha	Hectare, an international land area measure (1 ha = 10000 square meters)
IWFP	Internal Water Footprint
IWMI	International Water Management Institute
IWU	Industrial Water Use

List of List of Units and Abbreviations - *Continued*

Kg.	Kilogram
M3/Yr/Cap	Cubic Meter per Year per Capita
MEGP	Million Egyptian Pound
MOALR	Ministry of Agriculture and Land Reclamation, Egypt
MWRI	Ministry of Water Resources and Irrigation
NVWI	Net Virtual Water Import
SWERI	Soil, Water, and Environment Research Institute
Tone	metric tonnes (1 Tone = 1000 Kilogram)
USA	United States of America
USFOREX	United States Foreign Exchange Services
VW	Virtual Water
VWEV	Virtual Water Import Volume
VWIV	Virtual Water Export Volume
VWV	Virtual Water Volume
WF	Water Footprint
WID	Water Import Dependency
WS	Water Scarcity
WTO	World Trade Organization