

## Estimation of Virtual Water for Current and Target Saudi Exports for Dates

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**Abstract:** This study aimed at estimation of virtual water for current and target exports from dates to 2020. In order to achieve its goals, the study adopted partial amendment model and some economic equations. the study resulted in a set of results including the following: (1) The Kingdom of Saudi Arabia exports dates to several international markets, Arab countries are the most important of them, it reached approximately 76.4% of Saudi exports of dates during the period from 2009 to 2013, (2) the average export price of dates ranged between 2.89 thousand riyals / tons minimum for Arab league countries, and 10.0 thousand riyals / ton maximum for European countries not member in the European Union, (3) target exports amounts from dates are expected to be increased from 91.2 thousand tons valued at 91.87 million dollars in 2015 to 131.1 thousand tons, valued at 143.06 million dollars in 2020, (4) the cumulative total of virtual water for Saudi Arabia exports reached about 4.2 billion m<sup>3</sup> at the end of 1990-2013, (5) the mount of virtual water for target Saudi exports from dates is expected to be increased from 401.28 million m<sup>3</sup> valued at 136.44 million riyals in 2015 to 576.84 million m<sup>3</sup> valued at 196.13 million riyals in 2020, (6) The average ratio of virtual water value to target Saudi Arabia exports from reached about 37.9% during the period of 2015-2020, (7) this study recommends that Saudi shall not increase its exports of dates for its target level until 2020 due to the high cost of used water, which was estimated by 37.9% of the value of target exports from date by taking into account the cost of other production elements. Exportation of dates under current and expected prices will not be cost-effective for the Kingdom of Saudi Arabia.

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### 1.Introduction:

Dates are the most important fruit crops which occupies an important economic status in Saudi agriculture, since date areas reached 156.85 thousand hectares, representing 68.72% of the fruit area and approximately 21.04% of crop area reached 745.64 thousand hectares in 2012 (Ministry of Agriculture, 2013). However, the scarcity of water resources and low non-renewable groundwater levels, the cultivated palm area increased from 72.38 thousand hectares in 1990 to 156.9 thousand hectares in 2012. It was helped in palm and dates shoots, which increased from 30.23 million riyals in 1998 to 100,73 SR in 2012 (Ministry of Agriculture, 2013). In spite of the increase in domestic production of dates from 527.9 thousand tons in 1990 to 1.1 million tons in 2013, the rate of date exports from of dates to domestic production decreased from 3.85% in 1990 to 0.99% in 1999, then increased to 9.26% in 2013, therefore it caused volatility and instability in contribution percentage for the value of date exports in the structure of agricultural exports in the Kingdom of Saudi Arabia.

### Research objectives:

The objective of this study is to estimate virtual water for current and target Saudi exports for dates by achieving the following objectives:

1. Study the current geographical distribution for Saudi exports from dates during the period 2009-2013.
2. Estimate the quantity and value of the targeted exports to Saudi dates to 2020.
3. Estimate used virtual water in the production of target quantity to be exported until 2020.

### 2.Study methodology:

This study is based on estimating the amount of target exports on Partial Adjustment Model which is one of long-term dynamic models. The Partial Adjustment Model will be estimated as primary step for short term, according to the following:

$$Y_t = \alpha\lambda + (1-\lambda)Y_{t-1} + b_1\lambda X_1 + b_2\lambda X_2 + b_3\lambda X_3 + \dots e_t$$

**Whereas:**  $\lambda$  represents adjustment coefficient ranged between zero and one. If the value of  $\lambda$  near to zero, it will indicate that a small part of the imbalance between the actual and balanced is adjusted during one time period, meanwhile if the value of  $\lambda$  of is near to one, it will indicate that a large part of the gap between the actual situation and target one is covered

during one period of time. Thus, the value  $\lambda$  determines the speed of adjustment. Adjustment Lag equals  $\lambda - (1-\lambda)$  as adjustment coefficient will be derived in the long run as follows (William, 2003):

$$Y_t = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + \dots + \varepsilon_t$$

Whereas:  $Y_t$  represents the target level for the amount of date exports of dates, while variables  $X_1, X_2, X_3, \dots, X_n$  represent the actual level of specific variables to the amount of exports of dates.

This study also adopted the following economic equations for virtual water for dates:

1. The amount of used water in the production of dates = date area  $\times$  water needs for land unit (hectare).

2. The rate of used unit for the production of date = the amount of used water in the production of dates  $\div$  domestic production of dates.

3. The amount of virtual water for date exports = the amount of date exports  $\times$  the rate of date production unit from the amount of used water.

4. The amount of virtual water for date exports = the amount of virtual water for date exports  $\times$  economic cost of water usage.

#### Research data sources:

This study is based on secondary data published in:

1. Export statistics bulletin issued by the Department of general Statistics and affiliated Information of the Ministry of Economy and Planning.

2- Agricultural Statistical Yearbook published by the Department of Studies, Planning and Statistics of the Ministry of Agriculture.

3- Database from Food and Agriculture Organization (FAO).

#### Previous studies:

some economic studies has dealt with the economics of production and export of dates in the Kingdom of Saudi Arabia, where the (Ministry of Agriculture, 2006) has conducted a study to show that the Gulf Cooperation Council (GCC) are the most importer of fresh high-value Saudi dates, as well as other dates while the other Arab countries are the most importer of dried and small Saudi dates. The study also showed high price competitiveness of the Kingdom in the French market, and weak price competitiveness of Saudi dates in both the German and the Indian market despite high productive competitiveness of Saudi Arabia in all markets. (Ghanem and Nashwan, 2009) have estimated the revenue and economic cost for the use of water resources in the production of the exported quantities of the most important fruits and vegetables in Saudi Arabia. This study has showed that the value of water

is relative to the economic value of Saudi exports to the most important fruits and vegetables ranged from a minimum reached 3.59% of tomatoes, with maximum reached 24.63% of the dates during the period 2003-2007. The study of (Nashwan *et al.*, 2012) showed that the total amount of used water in the net of Saudi exports of dates reached about 2.51 billion m<sup>3</sup> representing 3.76% of the total amount of used water in the production of dates during the period from 1990 to 2009. The study also showed that a change by 10% in the amount of used water in a net of Saudi exports of dates would lead to a change in the same direction to the total of used water in the production of dates by 0.2%. Finally, (Al-Qunaibet *et al.*, 2014) studied the economic approach for available water resources for agriculture in Saudi Arabia. It was shown that dates occupies second place in the structure of the proposed installation crop, with an area of dates by 120.52 thousand hectares representing 24.76% of the total cropped area of 486.66 thousand hectares.

It is already clear from previous studies that they dealt with the competitiveness of the dates in the international markets, and estimation of the revenue and economic cost for the use of water resources in the production of the exported quantities, and estimation of the used water in net exports, in addition to the economic approach for water resources for agriculture in Saudi Arabia. Therefore this study differs from previous studies as it is interested in the estimation of the quantity and value of virtual water for current and target exports of dates to 2020, as well as the estimation of relative importance of water cost in the value of target export for dates.

### 3. Results

#### Geographical distribution of the current Saudi exports of dates:

The study of the current geographical distribution of Saudi exports pattern of dates during the period of 2009- 2013, has been showed that in the data of table (1) that the Saudi exports dates to several international markets, notably the GCC and other Arab countries. The average amount of Saudi exports of dates reached 76.69 thousand tons, valued at 309.9 million riyals during the period of 2009-2013. The other Arab countries ranked the first level for importing the date, with an average amount of imports reached 38.78 thousand tons, representing 50.57% of the average total amount of Saudi exports of dates. The second rank was Gulf Cooperation Council (GCC) for date importing by 25.81%, followed by non-Arab Muslim countries, Asian and African countries other than the Arab and Islamic ones by 13.18%, 3.76%, 3.62%, respectively. There

is also a disparity in the average export price of dates, where the average export price reached an amount of 2.89 thousand riyals / ton minimum for other Arab countries and 10.0 thousand riyals / ton maximum for European countries not member in the EU. Through calculation for the average export price of the dates

of the various states for the average export price to other Arab countries as a less-importing countries in terms of the price of dates; it is clear that the average export price to European countries not member in the EU is more than its equivalent in other Arab countries by 46.0%.

**Table (1): The geographical distribution of the quantity and value of Saudi exports of dates during the period of 2009-2013**

Item	Exports			The relative importance%		For export prices
	Quantity in thousand tons	value in million riyals	Export price Thousand riyal / ton	quantity	Value	
Gulf Cooperation Council (GCC)	19.79	110.0	5.56	25.81	35.50	192.4
Other Arab countries	38.78	112.1	2.89	50.57	36.17	100.0
Muslim countries except Arab countries	10.11	44.9	4.44	13.18	14.49	153.6
Asian countries except the Arab and Islamic countries	2.88	11.9	4.13	3.76	3.84	142.9
African countries except the Arab and Islamic countries	2.78	13.7	4.93	3.62	4.42	170.6
North American countries	0.66	4.3	6.52	0.86	1.39	225.6
South American countries	0.03	0.2	6.67	0.04	0.06	230.8
EU countries	1.39	11.4	8.20	1.81	3.68	283.7
European countries other than EU	0.02	0.2	10.00	0.03	0.06	346.0
A group of other countries	0.25	1.2	4.80	0.33	0.39	166.1
Total	76.69	309.9	4.04	100.0	100.0	139.8

Source: compiled and calculated from the Department of Statistics and Information. Export statistics, the period from 2009 to 2013.

### Estimation of the quantity and value of target Saudi exports of dates to 2020:

The amount of target exports of dates ( $Y_t$ ) is determined by set of economic factors, including: (1) the amount of Saudi exports of dates in the previous year ( $Y_{t-1}$ ), (2) the average export price by dollars / ton ( $X_1$ ), (3) domestic production of dates in thousand tons ( $X_2$ ), (4) domestic consumption of dates in thousand tons ( $X_3$ ), by conducting stepwise Multiple Regression Analysis of the explanatory variables specific to the amount of Saudi exports of dates during the period of 1990 - 2013 in the linear and double algorithm image, algorithm model is preferred in short term and expressed in the following equation:

$$LnY_t = -8.228 + 0.244LnY_{t-1} + 0.134LnX_{1t} + 1.504LnX_{2t}$$

$$(-2.58)^{***} \quad (2.19)^* \quad (2.37)^* \quad (3.49)^{***}$$

$$R^2 = 0.68 \quad F = 14.27 \quad D.W. = 2.15$$

$$LM \text{ test} = 0.29 \quad Archtest = 0.03$$

It is clear from the parameters estimated that the value of (1 -  $\lambda$ ) in short-term model reached 0.244.

Then estimated value of adjustment coefficient ( $\lambda$ ) is about 0.765, thus it could be a long-term expression in the form with the following equation:

$$LnY_t = -10.884 + 0.177LnX_{1t} + 1.989LnX_{2t}$$

It is clear from estimated model that a change of 10% in both export and domestic production of dates price leads to a change in the same direction to the target amount of exports amounting 1.77%, 19.89% each respectively. The model is distinguished by good prediction ability, due to inequality approaching of Theil coefficient (U-Theil) from zero to 0.05. In the light of Breusch-Godfrey serial correlation LM Test, the value (F) 0.29 which is not significant statistically, indicating a free estimate form autocorrelation of residuals problem. It also is clear from the Arch Test that the value of (F) reached 0.03 which is statistically significant, indicating that the estimated model does not have a self-link in the chain variation (Walter Vandal, 1992).

To predict the amount of target exports of dates to 2020, export price and domestic production of dates have been predicted. It is obvious from date contained in table (2.3) that export price of dates is increased from 1007.3 dollar/ ton in 2015 to \$ 1091.2 / ton in 2020, an annual average estimated by 1048.4 dollar / ton.

It also is expected that the domestic production of dates will be increased from 1.24 million tons in 2015, to 1.48 million tons in 2020, an annual average estimated by 1.36 million tons during 2015- 2020. In light of the predictive values for export price and domestic production of dates, it is expected that the amount of target exports from date will be increased from 91.2 thousand tons by up to 7.3% of the

expected domestic production in 2015 to 131.1 thousand tons by 8.8% of the expected domestic production in 2020. In light of the predictive values of the export price of the dates are expected to increase the targeted exports to Saudi dates value of 91.87 million dollars in 2015 to 143.06 million in 2020, an average annual estimated at 115.96 million dollars during the period 2015-2020.

**Table (2): the equations of the general trend for the development of export and domestic production of dates during the period 1990-2013.**

Model	$R^2$	F	Item
$Ln X_1 = 6.499 + 0.016T$ (70.70)** (12.13)**	0.52	147.08	Export price
$Ln X_2 = 6.216 + 0.035T$ (259.74)** (20.92)**	0.95	437.91	Domestic production

\*\* Significant when the probability level is 1%.

Source: compiled and calculated from: (1) Ministry of Agriculture, Department of Studies, Planning and Statistics. Agricultural Statistical Yearbook, various issues for the period 1990-2013, (2)

Food and Agriculture Organization (FAO) the period 1990-2011, (3) Department of Statistics, Information, export statistics, the period from 1990 to 2013.

**Table (3): predictive values for the price of export, domestic production and amount and value of the targeted exports of dates during the period 2015-2020.**

Year	The average of export price with dollar / ton	Domestic production in thousands of tons	Target exports		
			Quantity in thousand tons	Value in million dollar	The rate of exports to domestic production
2015	1007.3	1243.9	91.2	91.87	7.3
2016	1023.5	1288.2	98.1	100.41	7.6
2017	1040.0	1334.1	105.5	109.72	7.9
2018	1056.8	1381.6	113.4	119.84	8.2
2019	1073.8	1430.8	121.9	130.90	8.5
2020	1091.2	1481.8	131.1	143.06	8.8
Average	1048.4	1357.6	110.2	115.96	8.1

Source: compiled and calculated from mentioned equations in table (2) standard economic form for long-term.

### Estimation of Virtual water for current and target Saudi exports from dates:

The virtual water of Saudi exports from dates has been estimated by multiplying the amount of Saudi exports of dates in the average of producing unit share from dates from used water. It is obvious from the data in table (4) that, in the light of water needs for the dates estimated by 27.6 thousand m<sup>3</sup> / hectare (Al-Omran, 2008) the amount of used water in the production of dates has been increased from about 2 billion m<sup>3</sup> in 1990 to 4.33 billion m<sup>3</sup> in 2013. That is to say that the amount of used water in the production of dates has been increased by annual growth rate of 5.08%. the amount of used water in the production of the exported quantities has been also increased out of 76.73 million m<sup>3</sup> representing 3.84% of the amount of used water in the local production of dates in 1990 to 401.49 million m<sup>3</sup> representing

9.27% of the amount of used water in the local production of dates in 2013. As for the economic cost of using water in date production estimated by 340 riyal/ thousand m<sup>3</sup> (Al-kahtani and Ghanem, 2013), the amount of virtual water for Saudi exports from date has been increased from 26.09 million riyals in 1990 to 136.51 million riyals in 2013, so the value of virtual water for Saudi exports from date has been increased by annual growth rate of 18.4%. By calculating the amount of accumulative water amount for Saudi exports from dates; it is obvious that the total of virtual water that has been exported outside reached approximately 4.2 billion m<sup>3</sup> at the end of 1990-2013. The amount of virtual water for target Saudi exports until 2020 has been estimated by constant average of unit share from date from used water estimated by 404 thousand m<sup>3</sup> during 1990-2013. It is obvious from the data in table (5) that the

amount of virtual water for target Saudi exports from date has been increased by 401.28 million m<sup>3</sup> by 136.44 million riyals in 2015 to 576.84 million m<sup>3</sup> for 196.13 million riyals in 2020. Therefore the amount and value of virtual water for target Saudi exports from date has been increased by annual growth rate

of 8.75% respectively. Through the equilibrium exchange rate of the national currency by 3.75 / USD, the average rate of the value of virtual water to the value of Saudi exports from dates reached 37.9% during 2015-2020.

**Table (4): the development of virtual water quantity and value for Saudi exports during the period 1990-2013.**

Year	The amount of used water in the production of dates million m <sup>3</sup>	The average of used water per capita Thousand m <sup>3</sup> / ton	The amount of date exports in thousand tons	Virtual water for exports		Acculturative virtual water for exports in million m <sup>3</sup>
				Quantity in million m <sup>3</sup>	Value in million riyal	
1990	1997.69	3.78	20.3	76.73	26.09	76.73
1991	2090.98	3.96	18.3	72.47	24.64	149.20
1992	2196.41	3.98	18.4	73.23	24.90	222.43
1993	2310.12	4.10	18.2	74.62	25.37	297.05
1994	2376.80	4.17	16.6	69.22	23.53	366.27
1995	2589.71	4.39	34.3	150.58	51.20	516.85
1996	2783.74	4.51	30.8	138.91	47.23	655.76
1997	2929.46	4.51	25.3	114.10	38.79	769.86
1998	2938.30	4.53	24.9	112.80	38.35	882.66
1999	3912.30	5.49	7.1	38.98	13.25	921.64
2000	3931.62	5.39	28.2	152.00	51.68	1073.63
2001	3836.68	4.69	31.9	149.61	50.87	1223.25
2002	3863.45	4.66	33.9	157.97	53.71	1381.22
2003	3903.19	4.41	34.9	153.91	52.33	1535.13
2004	4106.88	4.36	47.5	207.10	70.41	1742.23
2005	4160.42	4.29	51.5	220.94	75.12	1963.16
2006	4206.24	4.31	44.1	190.07	64.62	2153.23
2007	4298.15	4.37	48.8	213.26	72.51	2366.49
2008	4333.20	4.39	50.9	223.45	75.97	2589.94
2009	4470.37	4.51	60.1	271.05	92.16	2860.99
2010	4281.31	4.32	73.4	317.09	107.81	3178.08
2011	4306.15	4.27	77.8	332.21	112.95	3510.29
2012	4329.06	4.20	69.3	291.06	98.96	3801.35
2013	4333.2	3.94	101.9	401.49	136.51	4202.84
Average	3520.23	4.40	40.35	175.12	59.54	-

**Source: compiled and calculated from:**

1. Ministry of Agriculture, Department of Studies, Planning, and Statistics. Agricultural Statistical Yearbook, various issues for the period 1990-2013.
2. Food and Agriculture Organization (FAO) for the period 1990-2011.
- 3- Department of Statistics, Information, and export statistics, the period from 1990 to 2013.

**Table (5): predictive values of virtual water for target Saudi exports from dates during the period 2015-2020.**

Year	Target exports		Virtual water for exports			The rate of water value of water to the value of exports of dates%
	Quantity in thousand ton	Value in million riyal	Quantity in million m <sup>3</sup>	Value in million riyal	Value in million riyal	
2015	91.2	91.87	401.28	136.44	36.38	39.6
2016	98.1	100.41	431.64	146.76	39.14	39.0
2017	105.5	109.72	464.20	157.83	42.09	38.4
2018	113.4	119.84	498.96	169.65	45.24	37.8
2019	121.9	130.90	536.36	182.36	48.63	37.2
2020	131.1	143.06	576.84	196.13	52.30	36.6
Average	110.2	115.96	484.88	164.86	43.96	37.9

Source: compiled and calculated from data contained in tables (3, 4).



Finally, it is obvious from the results of this study that the total of accumulative virtual water for Saudi exports from dates reached 4.2 billion m<sup>3</sup> at the end of 1990 to 2013 in light of the scarcity of water resources and low non-renewable groundwater levels which constitute a strategic water reserves in the kingdom of Saudi Arabia. It is noticed that the value of virtual water to the value of target Saudi exports from dates reached 37.9% during 2015- 2020. Taking into account the cost of other factors of production, the export of dates in the light of current and expected price will not be cost-effective for the Kingdom of Saudi Arabia. Therefore, this study recommends that we should not increase date exports other than its target until 2020 level.

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