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SOME EXPECTED IMPACTS OF THE PEACE TREATY ON HORTICULTURAL PRODUCTION IN THE JORDAN VALLEY (JORDAN)

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In October 1994, Jordan signed the peace treaty with Israel. One of the most important benefits of the treaty was securing Jordan's water rights from the Jordan and Yarmouk Rivers. It is still early to predict if these additional amounts of water might be allocated for agricultural uses. This paper reports the results of a study in which different scenarios for water availability were analysed. The impacts of allocating different levels of water to horticultural production were studied. A mathematical programming model was used to test these impacts. The results indicate that water is the most limiting production factor in the Jordan Valley. Allocating more water will increase farmers' gross margins and increase crop intensity. The findings also demonstrate that even if the current level of irrigation water is cut by forty per cent, farmers will continue in business and their gross margins will remain positive.

1. INTRODUCTION

The agricultural sector of Jordan occupies an important place in the national economy in terms of providing the country with a large portion of its food needs and as a major source of hard currencies. Unlike the situation in typical developing countries, however, agriculture in Jordan contributes a relatively small share of income to the economy. The Jordanian economy is dominated by the services sector, which generates about 61 per cent of the Gross Domestic Product (GDP) and employs two-thirds of the labour force.

Agricultural production fluctuated from year to year. During the period 1975-1994, the highest production was achieved in the year 1990 while the lowest was in 1977 (Ministry of Agriculture, 1994). Although agricultural production was increasing in real terms, its relative contribution to the Gross

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Domestic Product was decreasing. The decrease in agricultural contribution could be explained by the increase in the contribution of other sectors, mainly the construction and services sectors.

Irrigated agriculture is an important component of the agricultural sector. Fruits and vegetables are mainly produced under irrigation in the highlands, eastern desert, and in the Jordan Valley. Fruits and vegetables are harvested in the Valley from October to May. The higher elevations produce a wide range of horticultural crops from May to November. Producers of horticultural products have invested heavily in greenhouses for winter production.

A wide variety of vegetable crops are produced in Jordan. However, the major vegetables are tomato, eggplant, squash, cucumber, cabbage, cauliflower, and potato (Qasem et al., 1994). These crops are also considered as the major agricultural exports of Jordan. They are exported to Saudi Arabia and the other Gulf States. Smaller quantities are also exported to some European countries during the winter season.

Exports are a vital source of hard currency to the Jordanian economy. The major exports of Jordan are phosphates and potash, chemicals and agricultural products.

Fruits and vegetables make up about 85 per cent of the value of Jordan's agricultural exports. In 1982, exports to Saudi Arabia and the Gulf States exceeded 800,000 metric tons. With declining oil prices and an overvalued Jordanian dinar and a heavy subsidisation of fruit and vegetable production in Saudi Arabia, Jordan's agricultural exports declined. A further decline of fresh horticultural exports was witnessed during the Gulf crises (1991-1993). In 1993, the total exports of fresh fruits and vegetables amounted to 223,300 and 73,019 metric tons, respectively (Agricultural Marketing Organisation, 1994).

2. AGRICULTURAL EVOLUTION IN THE JORDAN VALLEY

The Jordan Valley is considered as the major production region for fresh fruits and vegetables in Jordan. The valley is extended from the northern part of Jordan to the Dead Sea. Its climate is moderated by its location over 700 feet below sea level. The soils in the valley are good and since 1969 adequate water has been available to irrigate about 30,000 hectares. Fruits and vegetables are harvested in the valley from October to May.

Jordan as well as other countries in the region belong to the arid to semi-arid zones which are characterised by highly fluctuating rainfall and scant water resource. There are growing concerns about water shortages in Jordan. Farmers in the Jordan valley are shifting from gravity irrigation to drip irrigation to improve water use efficiency. A recent study on water management in Jordan found that, in 1990, 59 per cent of irrigation methods through Jordan was drip irrigation (Buskirk et al., 1992). The study concluded that farmers should shift to drip irrigation because the efficiency of drip irrigation reaches up to 80 per cent, while the efficiency of surface, basin, and furrow reaches only 60 per cent.

The peace treaty which was signed in October 1994 between Jordan and Israel included a significant component for water distribution. According to the peace treaty document (Jordanian Information Committee, 1994), it is clear that an additional amount of 55 million cubic metres of water will be received as follows: 1) 45 million from Yarmouk River and 2) 10 million from desalinisation plant of Jordan River water.

Another expected implication of the peace treaty which is closely connected to the water issue in the Jordan Valley is tourism. It is expected that tourism activities will boom in the Dead Sea area. About fifteen thousand hotel rooms will be built on the Dead Sea beach in the coming years. This means that water required by tourist uses will be increased and it will compete with irrigation water in the Valley.

The purpose of the research reported in this paper is to determine the expected impact of the new water situation on the production of vegetables in the Jordan Valley. A production plan for a representative vegetables farm in the Jordan valley will be constructed using mathematical modelling. The plan will take in consideration the constraints of land, water, and market facing the farmer. The plan will emphasise water allocation. Different scenarios will be built to investigate the implication of an increase and a decrease in the water supply for irrigation purposes.

Farms in the Jordan valley could be classified into: 1) specialised citrus farms which are entirely planted with citrus trees; 2) specialised fruit farms which are entirely planted with bananas, apples, and apricots; and 3) specialised vegetables farms which are entirely planted with vegetables such as tomatoes, cucumbers, eggplants, squash, potatoes, peppers, and onions. The majority of farms receive water from the Jordan Valley Authority through King Abdulla Canal and King Talal Dam. During the last two decades a massive investment was made in irrigation projects. The majority of farmers are turning to drip irrigation systems instead of flood water. Irrigation water arrives to farms in the northern and middle Ghors by means of pressured pipes which help in drip irrigation and prevent water losses.

In 1990, the number of specialised vegetable farms reached to 2,826 farms (Nasar, 1990) distributed over three directorates in the Valley as follows: 1) 650 farms in the northern Ghors; 2) 1,526 in the middle Ghors; and 3) 650 farms in the southern Ghors. The average farm size ranges between 30 and 33 dunums[2] (3.0-3.3 hectares). Vegetables are produced during winter (Teshrini) and early summer (Khamisi) seasons. Tomatoes, squash, eggplants, cucumbers, potatoes, peppers, and onions composed 70 per cent of the total cultivated area in the Valley during the winter season. However, tomatoes, squash, potatoes, capsicums, eggplants, sweet melons, and Jew's mallow composed about 90 per cent of the total cultivated area in the summer season.

3. MATHEMATICAL MODEL

Linear programming models are built mainly to quantify the impact of governmental policies such as price intervention, market quotas, input and capital subsidies, technology enhancement, and trade restrictions. These models are conducted by using a representative or typical farm resource situations (Epplin and Stoecker, 1989). On the farm level, farmers so often make decisions about what crops to be produced, how to produce them, and which technology to be used. Such questions are answered with the help of whole farm models taking into consideration the current financial and physical restrictions. The mathematical composition of the model for the representative farm will be as follows:

$$\text{Maximize } Q \sum^{n} C_j X_j \qquad (1)$$

[2] 1.0 dunum = 0.1 hectare.

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such that

$$\sum_{j-1}^{n} a_{ij} X_j \le b_i \text{ (for all I, I = 1} \Rightarrow \text{m)} \qquad (2)$$

$$X_j \ge 0 \qquad \text{(for all j, j = 1} \Rightarrow \text{n)} \qquad (3)$$

Where:

Q = the objective function to be maximised;
Cj = the gross margin of the jth activity;
x; = the level of the jth activity;
aij = the technical requirements of the jth activity for the ith resource or constraint;
bj = the ith constraint level;
n = the number of activities; and
m = the number of constraints;

4. THE ANALYSIS

For a representative vegetable farm in the Jordan Valley an initial farm model is constructed. This initial model represents the current situation in the Valley. The assumptions of the initial model are modified to formulate different scenarios. Assumptions concerning resource availability will be varied to derive different production plans under the new changes. The new changes will simulate new policy options under the new circumstances.

A linear programming matrix of 49 constraints and transfer rows and 32 activities is formulated. Two land constraints representing the farm size in the Jordan Valley are included. The average farm size is 32.00 dunums (3.2 hectares). The two values represent the available amount of land during the winter and summer seasons.

Two water constraints are also added to the model. The two constraints represent the available amount of water for irrigation during the winter and summer seasons. The amount is calculated based on the released quantity of water by the Jordan Valley Authority to each farm in the Valley. The released amount of water varies according to the type of farm. Citrus and fruit trees specialised farms get higher shares of water than specialised vegetable farms. On average, a vegetable farm gets about ten litres of water per second for eight hours per week for the entire year. That means the farm gets [10 (l/second) X 60 (seconds) X 60 (minutes) X 8 (hours) X 52 (weeks) = 14,976] cubic metres per year. This amount is divided equally into two amounts available for the winter and the summer seasons (i.e., 7,488 cubic metres per season).

Thirteen market constraints are included in the model. The market constraints are calculated based on the disposable for consumption of each crop during summer and winter. The disposable for consumption is transferred into acreage on the grounds of the average yield of each crop. The market constraints and their levels in terms of acreage are included in Table 1. These constraints are added to avoid unrealistic solutions of the LP model.

Thirty two balance (transfer) rows are added to the model. The transfer rows are added to adjust for returns and expenditures in the model. Rows for selling activities add to the objective function, while rows for buying activities reduce the value of the objective function. A negative input-output coefficient indicates that increasing the level of the activity increases the amount available for use.

The objective function values of the production activities include negative and positive signs. The negative signs indicate that production (without marketing) reduces the value of the objective function.

Each column in the model represents a unique production process. Columns in the model are called activities.

Activities might include the crops produced in the farm and any other selling or buying activities of resources used in the production process.

Thirteen producing, thirteen selling, and six buying activities were included in the model. The producing activities include winter and summer crops. The winter enterprises are tomatoes, squash, eggplants, cucumbers, potatoes, sweet peppers (capsicums), and onions. While summer crops are tomatoes, squash, potatoes, sweet melons, eggplants, and Jew's mallow (Mulukhaiah).

In the objective function, the selling value shows the farmgate price of each crop paid to producers. The summation of the selling activities values provide the total farm income.

Buying activities include water buying, labour buying, husbandry labour buying, fertiliser buying, and land preparation buying activities. The buying values in the objective function indicate the price per unit of input. The summation of buying activities values provide the total variable costs.

Input and output coefficients indicate the quantity of each resource used to produce one unit of activity. The coefficients are derived from the enterprise budgets for the studied farm type.

Secondary data of farm budgets for vegetables produced in the Jordan Valley is used. These budgets were estimated for the 1991-92 production season by Economic and Social Council for Western Asia (ESCWA) in collaboration with the Ministry of Agriculture (UNESCWA, 1993).

A detailed budgets for nine major crops produced in the Jordan Valley are used in the analysis. The budgets included yields (kg/dunum), average farmgate prices (Jd/Rg), total returns (Jd/dunum), variable costs (Jd/dunum) and gross margins (Jd/dunum).

5. SCENARIOS

For a representative vegetables farm in the Jordan Valley an initial model is constructed. The assumptions of the initial model will be modified to formulate different scenarios. Different scenarios are developed to simulate some of the expected changes in the country (Table 2). The scenarios relate to water availability (i.e., the seasonal amount of water released by Jordan Valley Authority (JVA) to the specialised vegetables farms). The three scenarios are conducted to determine the cropping pattern and the cropping intensity under different levels of irrigation water availability. These scenarios are: an optimistic scenario of increasing water supply by twenty per cent and two pessimistic scenarios of reducing water supply by twenty and forty per cent, respectively.

6. RESULTS

The results of the analysis demonstrate obviously that water is the limiting production factor in the Jordan Valley. Irrigation water comes mainly from public irrigation projects by either pipelines or open channels at a discharging rate of 10 litres per second for eight hours per week for 52 weeks.

Table 2 includes optimum farm plans at different levels of water discharging rates. The farm plans include the acreage of selected crops that maximise farmers' gross margin. For example, under the current situation of water availability, the farmer would maximise his gross margin by producing all winter and summer crops except eggplants, capsicums and onions. It is clear from the table that when more water is made available, cropping intensity reaches to higher levels. At the most optimistic scenario, when the water discharging rate is increased by twenty per cent to reach 17,971 cubic metres per annum, cropping intensity reaches to 118 per cent (i.e., 37.87 dunums are cultivated over the two production seasons). However, a decrease in water supply means a reduction in the cropping intensity. Under the four different scenarios, almost half of the land was left unused. This is mainly due to the shortage of water supply especially during the summer season.

In general, results of different scenarios indicate that cucumbers, potatoes, and squash are the most important winter crops even at different crop intensities. The results also demonstrate the lesser importance of other crops such as onions, eggplants, and peppers.

Results of summer crops indicate that tomatoes were the most important crop under all scenarios. This is because summer tomatoes are easily sold to processing plants in the Valley at good prices. The results also show that the rest of the summer vegetables are relatively important to producers.

All models under-utilised the land resource mainly due to the binding constraint of water and market ceilings. Facilitating exports of fresh vegetables and providing incentives to exporters might raise the market ceiling which in turn could increase the utilisation of the available resources and improve producers’ net income.

7. CONCLUSIONS

A major benefit of the peace treaty signed in October 1994 was to insure Jordan's rights from the Yarmouk and Jordan Rivers as the first shares. This situation will result in increasing the available water especially in the Jordan Rift Valley. It is still early to predict if these additional amounts of water will be allocated for agricultural uses or any other uses. The thrust of the researcher's efforts in this paper has been to analyse the expected impact of allocating additional amounts of water or reducing the current shares allocated for horticultural production in the Valley.

This study has demonstrated that water is the most limiting factor in the Jordan Rift Valley. The effects of allocating more water or reducing current shares to horticultural production are clearly measurable in terms of the objective function value and cropping intensity. If water is made more available, farmers' gross margins will increase and land utilisation may improve.

Improving irrigation techniques by shifting to drip irrigation will increase the available water by 20% which, in turn, will increase crop intensity in vegetables farms. This suggests that regional development of water resources by the government of Jordan and the neighbouring countries may take into consideration supporting vegetable producers to shift to drip irrigation practice.

The overall results of the different models formulated for the representative farm indicate clearly that there is room for adjusting the production patterns. This adjustment will result in increasing the gross farm income which is the major objective of the farmers and the policy makers in the country. The adjustment may include, in addition to improving the irrigation system, introducing high value export-oriented crops such as asparagus, cut flowers, and carnations. Recent research by the Agricultural Marketing Organisation (AMO) has showed that there are many high value crops which are highly demanded by consumers in Europe and South East Asia especially during the winter season. An economic analysis using border prices of outputs and inputs would help in identifying the most efficiently produced crops in the Valley.

Table 1

Market Constraints Imposed on the Model

(in dunums: 1.0 dunum = 0.1 hectare)

Market Constraint	Level in Dunums per Farm
Winter tomatoes	5.5
Winter squash	5.0
Winter eggplant	2.5
Winter cucumbers	4.6
Winter potatoes	4.0
Winter capsicums	4.2
Winter onions	3.5
Summer tomatoes	9.0
Summer squash	1.0
Summer potatoes	1.0
Summer melons	11.0
Summer eggplants	1.5
Summer Jew's mallow	1.0

Table 2
Optimum Farm Plans at Different Annual Disposable Water Levels
(in cubic metres)

Crop	14,976 CM (Current)	17,971 CM (Optimistic)	11,980 CM (Pessimistic)	8,985 CM (Pessimistic)
Winter crops				
Tomatoes	4.67	5.50	1.33	0.00
Squash	5.00	5.00	5.00	1.77
Eggplant	0.00	1.80	0.00	0.00
Cucumber	4.60	4.60	4.60	4.60
Potatoes	4.00	4.00	4.00	4.00
Capsicums	0.00	0.00	0.00	0.00
Onions	0.00	0.00	0.00	0 00
Summer crops				
Tomatoes	9.00	9.00	9.00	7.37
Squash	1.00	1.00	1.00	1.00
Potatoes	1.00	1.00	1.00	1.00
Melons	1.97	3.47	0.48	0.00
Eggplant	1.50	1.50	1.50	1.50
Jew's mallow	1.00	1.00	1.00	0.00
Total acreage (dunums)	33.74	37.87	28.91	21.24
Cropping intensity	105.4%	118.3%	90.3%	66.4%
Objective function value JD	9109.03	9666.90	8453.40	7459.23

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