Ministry of Water and Irrigation

Water Resource Policy Support

MARKETING JORDANIAN VEGETABLES AND FRUITS IN THE CONTEXT OF IRRIGATION WITH RECLAIMED WATER

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WATER REUSE COMPONENT

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Executive Summary

Jordan is ranked among the world's ten countries with greatest water scarcity. Thus, it is not surprising that the use of reclaimed water for irrigation is becoming significant in the country's agriculture. Use of reclaimed water is gaining particular importance in the Jordan Valley, which produces a high proportion of the country's valuable vegetables and fruits. These crops are an important part of the country's agricultural exports.

Although Jordan has attempted to ensure that wastewater is treated and recycled in ways do not present health hazards, problems have emerged. In the early 90s, Saudi Arabia banned imports of fresh vegetables produced in Jordan, citing contamination from treated wastewater as one of the main reasons for the ban. This resulted in the loss of Jordan's most significant international customer for vegetables.

Vegetable exports currently amount to about seven percent of all exports and thus are a very important foreign exchange earner for Jordan. The Saudi market had accounted for one third of Jordan's vegetable exports. Since the ban, vegetable exports have never regained the level that they had achieved when Saudi trade was permitted.

It is well known that reclaimed water and river water with high *fecal coliform* counts is used to irrigate vegetables in some parts of the world, without apparent repercussions on marketing. Thus, it might be claimed that Jordan should not have a problem and that no special measures are necessary. However, Jordan has already lost a major customer for its fresh vegetables. Despite repeated attempts to have the Saudi ban lifted, it continues in force. Furthermore, Jordan has some special circumstances with respect to water reuse.

The high visibility of Wadi Zarqa and the irrigation that occurs there, and the high proportion of reclaimed water – up to 100% in some years – used in certain parts of the Jordan Valley pose special concerns. Furthermore, Jordan's water reuse is expected to triple over the next 20 years. Add to this the fact that food safety concerns are increasing worldwide and that international markets are demanding more transparency on such issues, including possible biological contamination of fresh produce. All of these factors combine to indicate that Jordan needs to take a pro-active stance on food safety and produce marketing.

The demand for greater food safety has been fueled both by rapidly increasing size of buying organizations, particularly large chain stores in the high income countries, and by recent food safety problems in some countries. Large private sector buyer organizations are pushing the establishment of procedures to improve food safety. The clearest example of this is the Euro-Retailer Produce Working Group (EUREP), an organization of major European retailers. This group is in the process of developing a set of Good Agricultural Practices (GAPs) and related procedures known as EUREPGAP.

These will soon be required of domestic and foreign producers and marketers in order to be *accredited* to sell to members of the Group.

In addition to requiring that growers follow GAPs, product is being *randomly tested*, to be sure that any pesticide residues or pathogens are within acceptable limits. Great emphasis is placed on records that allow any product found to be contaminated to be traced back to its origin, so that the problem may be corrected.

If Jordan wishes to increase its exports to high-value markets such as Europe and upper-echelon retailers in the Gulf countries, it will need to have more producers and marketers that qualify for EUREPGAP or similar accreditation. This means that growers will have to be informed about water quality and that they will need to follow GAPs that include safe management of irrigation water.

A few Jordanian producer-exporters have already established quality assurance and accreditation systems. One or two large growing and packing companies are regularly inspected and have been accredited by European buyers. One of these companies requires that its outside (satellite) growers follow GAPs specified by the buyers, and the buyers also inspect these growers.

The Integrated Pest Management (IPM) program in NCARTT has developed a group of certified Jordanian producers who follow recommended management practices, including limited safe use of pesticides. The products of the certified growers are tested at unscheduled intervals to ensure that residues do not exceed acceptable limits. Until now, however, the IPM project has not incorporated safe irrigation practices in its GAPs, nor does it test for pathogens.

Based on the findings of the study, it is recommended that Government promote the development of a food safety and quality assurance system that includes the following six points:

1) ***Clarify the regulatory responsibility for food safety*** in fresh vegetables by assigning this duty to the Agricultural Marketing Organization (AMO).

2) ***Improve management and availability of information*** on water quality and food safety within the JVA Laboratories, which already collect information on water quality.

3) ***Initiate applied research*** at NCARTT to clarify the relationship between water quality and sanitary condition of fresh vegetables in Jordan.

4) Based on research findings, ***consider establishing microbiological testing*** of fresh vegetables by AMO to check for pathogens on a regular basis.

5) Have NCARTT ***incorporate practices for safe use of irrigation water in GAPs*** for production of fresh vegetables and fruits, and promote their use through the extension services.

6) Promote the establishment of a ***grower certification system and/or accredited product marketing organizations*** that meet international standards.

To elaborate on the final point above, it is recommended that the Government place first priority on developing a system that will permit exporters to regain entry to the lucrative Saudi market. The essence of the Saudi complaint is that Jordanian production is based on the use of treated wastewater. However, the present study has shown that when the Saudis did import from Jordan, most of the product came from the uplands, where irrigation is from wells and not from reclaimed water. Furthermore, there are other areas, particularly in the Northern Directorate of the Jordan Valley, in the South Ghor, and in Wadi Araba, where no reclaimed water is used. It should easy to develop a program that certifies that certain product originates in one of these areas. The program would be open to inspection by Saudi officials. If the Saudis refuse to accept such a system, this could eventually become the basis for complaint under rules of the World Trade Organization.

Acronyms

AMO	Agricultural Marketing Organization (in MOA)
ARD	Associates in Rural Development
BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
EUREP	Euro-Retailers Produce Working Group
EUREPGAP	System of GAPs and GMPs being developed by EUREP
FCC	Fecal Coliform Count
FDA	Food and Drug Administration (in U.S. Department of Health)
GAP	Good Agricultural Practice
GMP	Good Management Practice
JV	Jordan Valley
JVA	Jordan Valley Authority
KAC	King Abdullah Canal
KTR	King Talal Reservoir
MCM	Million Cubic Meters
MOA	Ministry of Agriculture
MOH	Ministry of Health
MWI	Ministry of Water and Irrigation
NCARTT	National Center for Agricultural Research & Technology Transfer
TCC	Total Coliform Count
TWW	Treated Wastewater
USAID	U. S. Agency for International Development
WRPS	Water Resource Policy Support, USAID-funded project in MWI
WAJ	Water Authority of Jordan
WHO	World Health Organization
WWTP	astewater Treatment Plant

1. Introduction.

Jordan is ranked among the world's ten countries with greatest water scarcity. Thus, it is not surprising that the use of reclaimed water for irrigation is becoming significant in the country's agriculture. *Reclaimed water use*, also known as *treated wastewater use* and often referred to simply as *water reuse*, is gaining particular importance in the Jordan Valley, which produces a high proportion of the country's valuable vegetables and fruits. These crops are an important part of the country's agricultural exports.

Although Jordan has attempted to ensure that wastewater is treated and recycled for irrigation in ways that do not present health hazards for consumers of crops that are thereby produced, problems have emerged. In the early 90s, Saudi Arabia banned imports of fresh vegetables produced in Jordan, citing contamination from irrigation water as one of the main reasons for the ban. This resulted in the loss of Jordan's most significant international customer for vegetables, which was a blow to farmers and the national economy.

The problem with food safety of crops grown with reclaimed water is not limited to the Saudi market. Exporters who sell to Europe have expressed concerns about crop marketing problems that may arise due to the use of reclaimed water, and many of Jordan's own consumers claim that they are not sure whether the vegetables and fruits are safe to eat.

In view of these concerns, the consultants have been asked to conduct a study that addresses the following issues:

- Investigate and assess the marketing constraints, crop export requirements and perceptions of crop importers and consumers with respect to water reuse;
- Obtain information about the rules, perceptions, biases and customs of the World Trade Organization, the European Union and crop importing nations of the Arabian Gulf,
- Assess the feasibility of expanding the international accreditation of crops and certain farms in the Jordan Valley and elsewhere, and
- Make recommendations concerning the best policies and actions to enhance crop exporting.

In conducting the study the consultants contacted produce industry experts in the United States and conducted an Internet search to obtain information about the marketing and quality standards of a number of international agencies, including Codex Alimentarious, the World Trade Organization, and the Euro-Retailer Produce Working Group (EUREP). Meetings were held with farmers, exporters, the Fruit and Vegetable Exporters Association, local produce buyers, and relevant government officials, as listed in Appendix A. Many of the issues covered in this report were also discussed with stakeholders at a workshop held at the Dead Sea Movenpick Hotel on 11 June.

2. Importance of Fruit and Vegetable Exports in Jordan

Agricultural production in Jordan has witnessed a tremendous increase during the last four decades. Vegetable production has tripled since 1976. This was mainly due to the expansion in irrigation projects, introduction of plastic houses, and introduction of new hybrid-high yielding varieties. Production has also increased in response to expanding demand for fresh produce, domestically and in neighboring countries.

The main vegetable crops produced in Jordan are tomatoes, cucumbers, eggplants, squash and potatoes. Jordan has two primary production areas, the Jordan Valley, which is a winter crop area, and the uplands, which produce summer crops. Production (harvest) in the Jordan Valley (JV) starts in early December and continues till May of the following year. In upland areas, such as the Amman-Zarqa Basin, harvest begins in May and continues through October.

Recent studies on future adjustments of the Jordan Valley concluded that the potential for increasing vegetable production base there is very promising. This could be accomplished through:

- The intensification of technology and methodology used for vegetable production;
- The increase in cropping intensity; and
- Enlarging the production base capacity of vegetables through changing the cropping pattern.

Fruit production has shown upward trends similar to vegetables. The production has steadily increased throughout the period (1976-99) and amounted in 1994 twelve times the level of 1976. The most significant increase of fruit trees production in the JV was in citrus and bananas. Citrus are mainly exported to Gulf markets, however bananas are consumed locally.

Olive trees are the main fruit trees cultivated in the highlands under both irrigated and rainfed conditions. Olives are consumed either as pickled fruits or as olive oil. Exports of olives and olive oil is limited.

2.1 Importance of fruit and vegetable exports to the national economy.

Jordan's exports of horticultural crops reached a record number in 1982 when exports to the Gulf countries and Iraq exceeded 800 thousand tons. With declining oil revenues, an increasingly overvalued Jordanian Dinar and heavy subsidization of fruit and vegetable production in Saudi Arabia, Jordan's export declined steadily from 1982 to 1987. The 100 percent devaluation of the Dinar in 1989 produced another boom in exports of horticultural products. Total exports climbed back to 522 thousand tons in 1990.

The current exchange rate (JD 0.70 = US$ 1) was set by the Central Bank of Jordan in the early 1990s and has not changed since. Considering the

inflation that has taken place in Jordan since that time, and in view of the relative strength of the Dollar in recent years, it would appear that the Dinar is significantly over-valued at the present time. If the rate were adjusted to reflect the true parity value or if the Dinar were allowed to "float," this would undoubtedly result in a devaluation that would bring considerable strengthening in demand for export of fruits and vegetables, similar to what happened in 1989.

The importance of horticultural exports stems from the fact that it forms about 8 percent of the total national exports and 58 percent of agricultural exports, as shown in Table 1. The table also shows that exports of fresh vegetables represent about 47 percent of the total agricultural exports.

Table 3.1 Total and agricultural exports by commodity (1996-2000)

Year	1996	1997	1998	1999	2000	Average	% of Ag. Exports
Total Exports (JD)	1,039,801	1,067,164	1,046,382	1,051,353	1,079,738	1,056,888	
Food and Live Animals (JD)	160,112	181,333	165,037	127,379	116,355	150,043	
Live Animals (JD)	63,108	71,528	33,659	24,294	15,655	41,649	28%
Dairy Products and Eggs (JD)	2,911	7,285	10,035	7,068	6,488	6,757	5%
Cereals and Cereal Preparations (JD)	3,896	3,364	2,417	1,969	2,253	2,780	2%
Vegetables (JD)	65,256	69,585	88,640	66,475	59,107	69,813	47%
Fruits and Nuts (JD)	16,792	21,891	18,462	11,716	12,740	16,320	11%
Fodder (JD)	934	1,481	5,221	7,907	12,415	5,592	4%
Other	7,215	6,199	6,603	7,950	7,697	7,133	5%

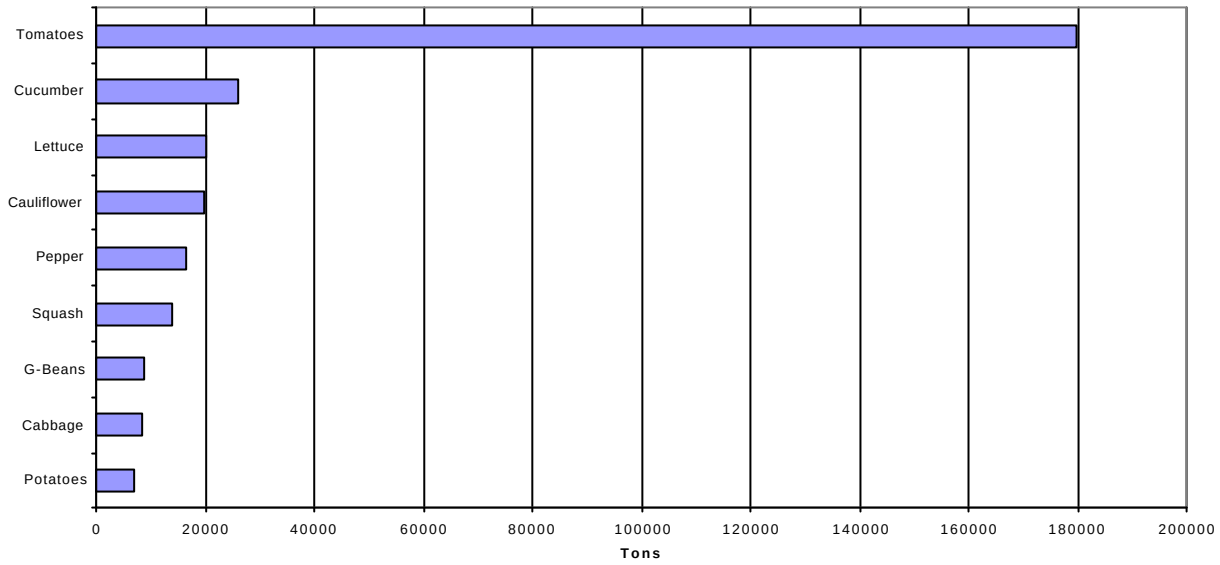
Source: Central Bank of Jordan, monthly statistical bulletin, vol.37 No.3, March 2001

2.2 The commodities involved in Jordan's exports

During the period 1990-1999, exports of fresh vegetables alone formed about 78% of the total exports of fresh horticultural produce. Average exports during this period amounted to about 293,000 tons, composed of 39 products. Five products-tomato, cucumber, lettuce, capsicum (peppers) and squash represented about 84 per cent of total vegetable exports during 1999, as shown in ascending order in figure 1.

Arab countries continued to be the major importers of Jordan's horticultural products during the period 1991-99. On average, the share of the Arab countries of total exports amounted to 98.9% and the rest 1.1-% was exported to West and East Europe. Of the fresh produce exports to the Arab countries and West Europe, JV exports represented 54% of fruits but only 38% of the vegetables. Thus, the highland areas are the main source of the valuable vegetable exports.

Figure 1 Main exported Vegetables in 1999



2.3 Countries that buy Jordan's vegetables.

Figure 2 shows that export of vegetables peaked in 1990, which was largely a result of the devaluation of the JD, and in 1991 they dropped to their lowest level for the decade, due mainly to the Gulf War crisis.

Figure 2. Vegetable Exports by Destination (90-99)

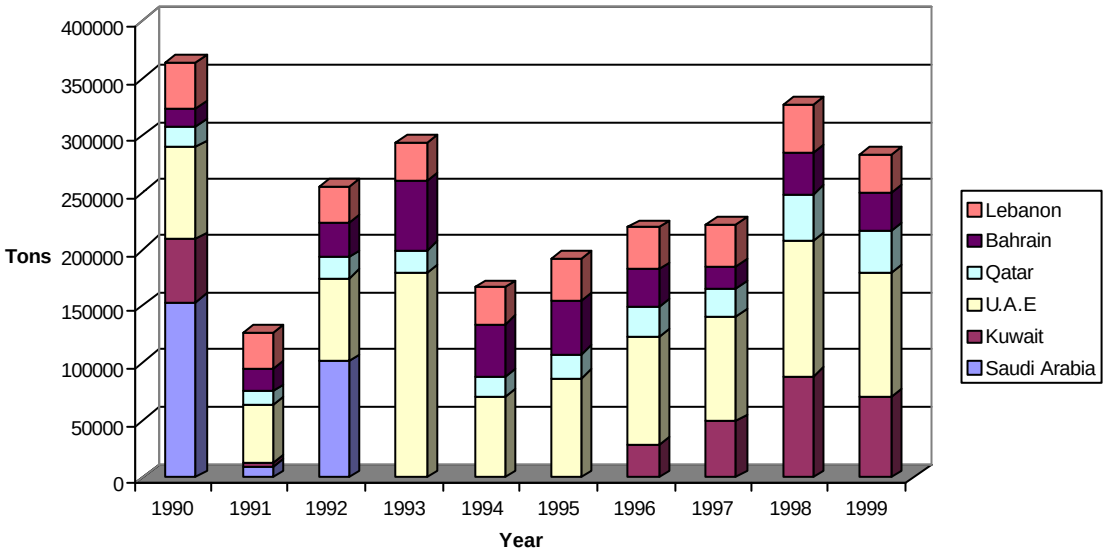


Figure 2 shows that Saudi Arabia was the main buyer of Jordanian vegetables, until 1992. Saudia Arabia accounted for over one third of vegetable exports in both 1990 and 1992. The figure also shows that the UAE has long been a major market for Jordanian exports and that trade with Lebanon, Qatar and Bahrain has also been quite steady. Kuwait has

resumed significant buying during the past five years, following a cessation of purchases after the War.

Jordan's main competitors in the Gulf market are Turkey, Egypt, Syria and Lebanon in certain periods of the year.

2.4 The Saudi ban on vegetable imports from Jordan.

The Saudi Government halted vegetable exports after 1992, citing biological contamination of product and the use of treated effluent as its main reasons. Since it was first put in place, Jordan has tried to convince the Saudis to lift the ban on several occasions. In 1996, a team of experts visited Jordan on behalf of the Saudi Minstry of Trade, and another mission from the Saudi Government came at the end of 2000, to review the ban. Despite these missions the ban has not been removed.

Following the 1996 visit, the Ministry of trade prepared a memorandum that documented its decision to continue the ban. The memorandum explained in detail how the team had visited the As Samara Wastewater Treatment Plant, Wadi Zarqa, and farms in the highlands as well as in the Jordan Valley. The team's final recommendation was stated as follows:

> After the visit of the technical team from Saudi Arabia to Jordan, their conclusions were that Jordan Valley, which is the most important area that produces vegetables in Jordan, depends on treated effluent for irrigating these vegetables. Because it is not allowed in Saudi Arabia to irrigate vegetables with treated effluent, it is not allowed to import vegetables from Jordan, expecially when it was found that the vegetables imported from Jordan are contaminated with *Escherichia Coli*, pathgens and microbes that cause food poisoning. (Saudi Arabia, 1996).

Jordanian exporters state that buyers from other Gulf countries simply never raise the issues of water quality or biological contamination. However, Jordan's exports have tended to target workers and lower income segments in Gulf markets. If the quality of Jordanian product can be improved, such as through better packaging and grading, it would be possible to penetrate the higher income segment of the Gulf market, which is increasingly being served by chain supermarkets such as Banda, Al Athyem, and Safeway. In reaching the higher income segment, however, the question of irrigation water quality is more likely to emerge.

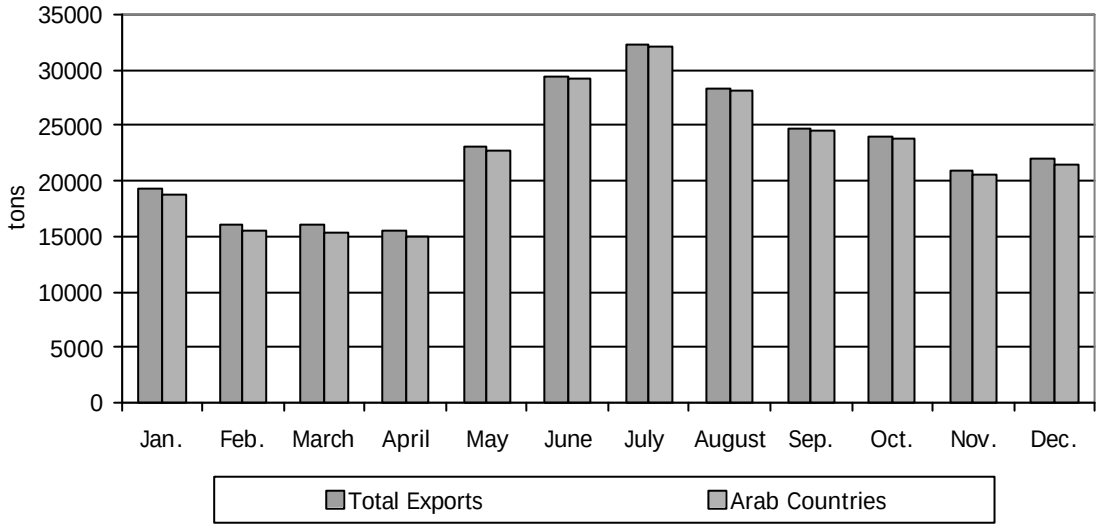
2.5 Origin of vegetables in Jordan.

The proportion of vegetable exports to Arab countries from the Highlands (62% of exported vegetables) is higher than vegetable exports that come from the JV (38%). In contrast, the proportion of fruit exports from the JV is higher than exports from the highlands. This is because, the major exported Jordanian fruits are citrus which are grown only in the JV.

In the future, if reclaimed water is used to substitute for surface water in irrigation of the Northern Directorate of the JVA, this is likely to have a negative impact on citrus production and on citrus exports from the Jordan Valley since the Northern area is currently the main citrus production area.

Figure 3 shows that, on average, Jordanian exports of fresh vegetables reach their maximum during the months of June, July and August. Vegetable exports in 1994 and 1995 were below the average of 1990-1999. Total vegetable exports were 364,307 tons and 319,966 tons in 1998 and 1999 respectively, while the average during the 1990-1999 was 271,797 tons. Figure 3 also shows that almost all exported vegetables were to the Arab markets such as Kuwait, Bahrain, Qatar, Dubai and Lebanon.

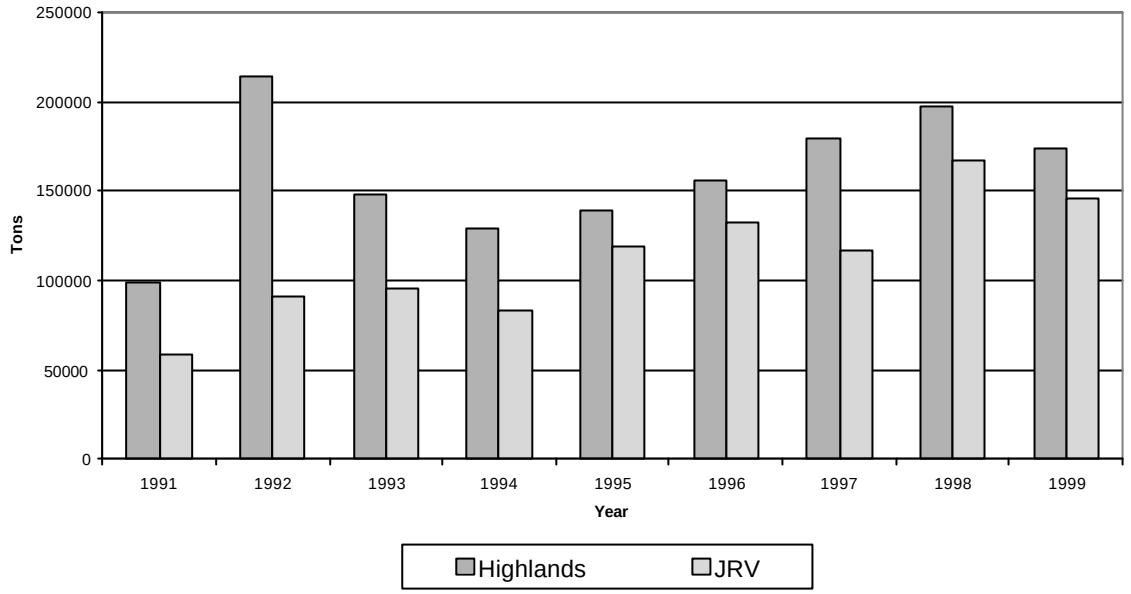
Figure 3 Average of Monthly Vegetable Exports by Destination During (1991-99)



2.6 Origin of fresh produce within Jordan

The Highlands and the JV are the major two sources of horticultural exports. An average of 38% of vegetable exports was produced in the JV during the period 1991-1999. Vegetable exported quantities from the JV fluctuated from one year to another and ranged from 46 percent of total exports in 1998 to a low of 30 percent in 1992. During the period 1994-1998, vegetable exports from both the highlands and the Jordan Valley increased steadily as shown in figure 4.

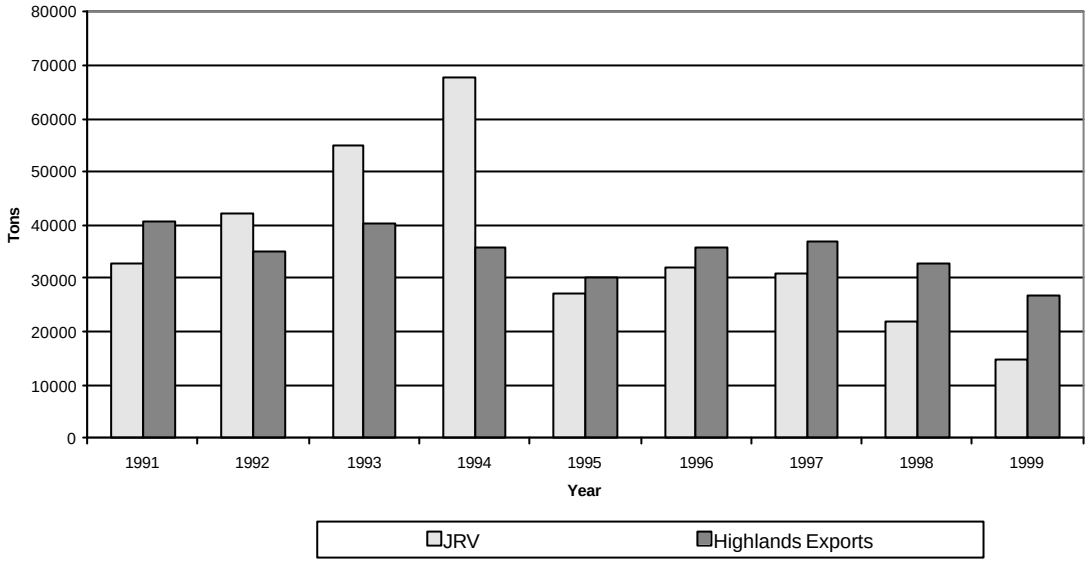
Figure 4 Vegetable Exports By Origin (1991-1999)



During the period 1990-1995, exports of fresh fruits, excluding melons, constituted about 17.6% of the total exports of fresh horticultural produce. Annual exports during the same period averaged about 62,988 tons. Citrus fruit represents about 87% of total fruit exports. Fruit exports were composed of 26 products of which three products, namely oranges, clementines and lemons, represented 46%, 17% and 16% of total fruit exports, respectively

Figure 5 indicates that fruit exports sharply declined after the year 1995. This is primarily due to the fact that the largest part of Jordan's exports of oranges, till 1995, was of Palestinian origin mainly from Gaza and West Bank. These oranges were kept in refrigerated stores in Jordan pending export to the neighboring Arab markets, or sale in the local market. Exports of Palestinian oranges were registered as Jordanian exports. Following the year 1995, exports of citrus of Palestinian origin have not figured as Jordanian exports. The relatively weak performance of fruit exports in recent years has probably also been linked to the over-valuation of the Jordanian Dinar, as explained above.

Figure 5 Fruit Exports By Origin (1991-1999)



2.7 Vegetable exports to Saudi Arabia

One of Jordan's main objections to the Saudi ban has been that most of the vegetables which Saudi Arabia purchased came from highland areas where the irrigation water comes from wells, which are expected to be free of pathogens. This point is analyzed below, with data from 1990-92, the last three years in which the Saudis purchased Jordanian vegetables.

The monthly distribution of the main four vegetable crops exported to Saudi Arabia is portrayed in figures 6-9. Exports statistics shows that more than 80% of tomato exports were conducted during the summer season, which is when highland crops are harvested. Thus, it is clear that most of the product shipped to Saudi Arabia was not irrigated with reclaimed water.

Furthermore, not all of the Jordan Valley production is irrigated by reclaimed water: only the Middle Directorate and parts of the South (Karameh) Directorate receive treated water from the King Talal Reservoir. The Northern Directorate does not receive any reclaimed water.

Although it is clear that only a small proportion of the vegetables that were purchased by the Saudis were irrigated with reclaimed water, it must also be recognized that there was no way for Saudi buyers to be sure which product was or was not produced with this water.

Figure 7. Monthly Exports of Cucumber to Saudi Arabia (Average 1990-92)

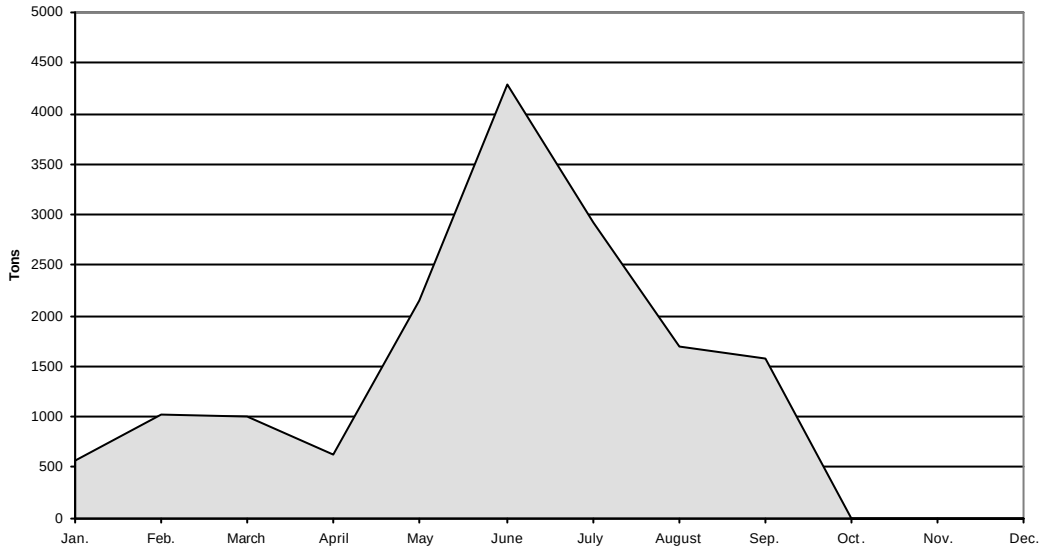


Figure6: Monthly Export of Tomatoes Saudi Arabia(average19901992)

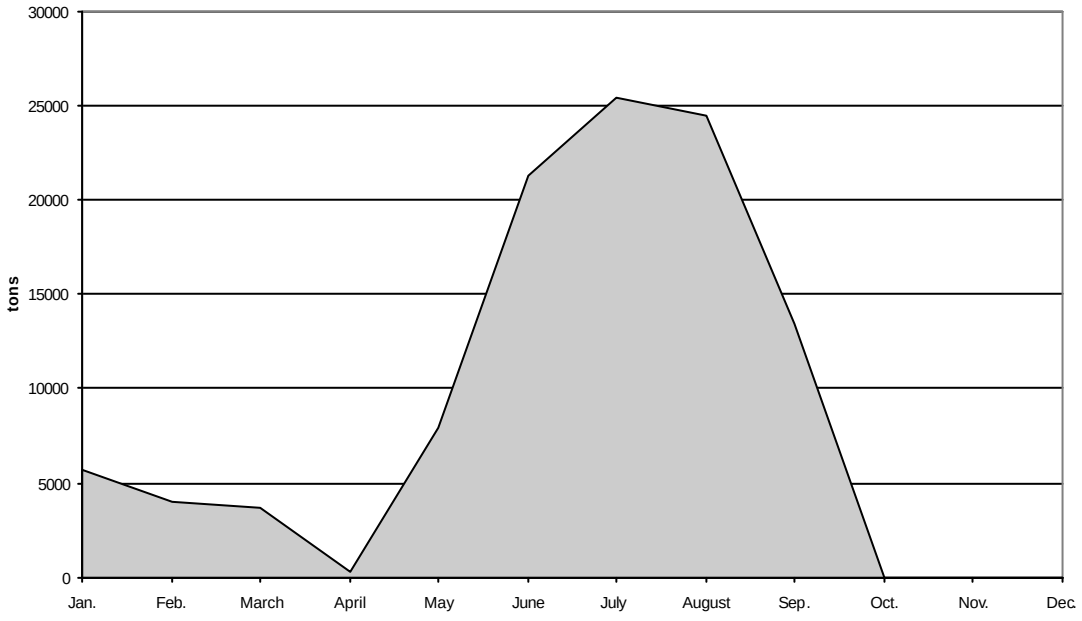


Figure 8. Monthly Exports of Eggplants to Saudi Arabia (Average 1990-92)

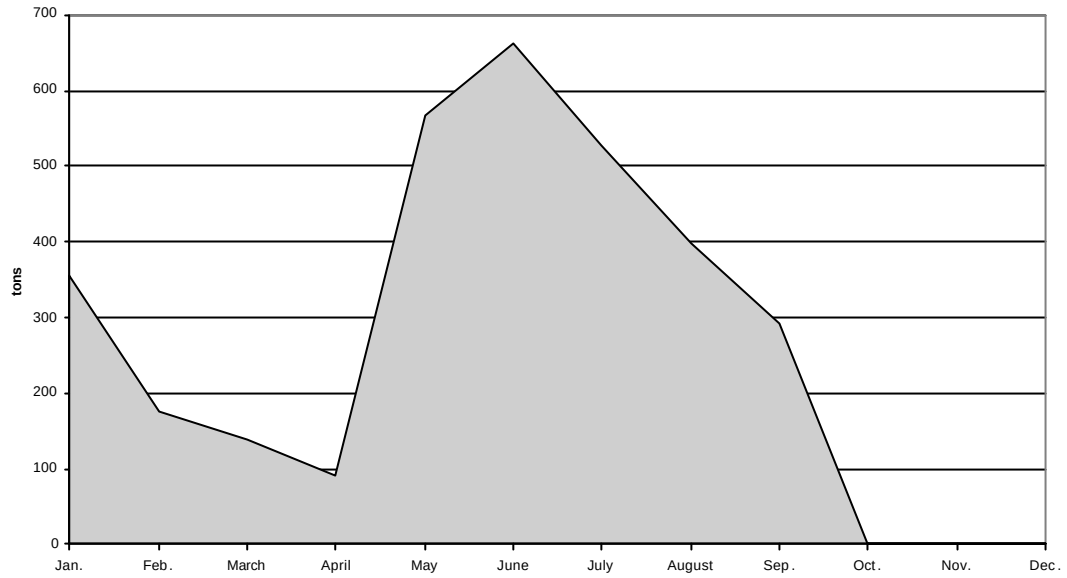
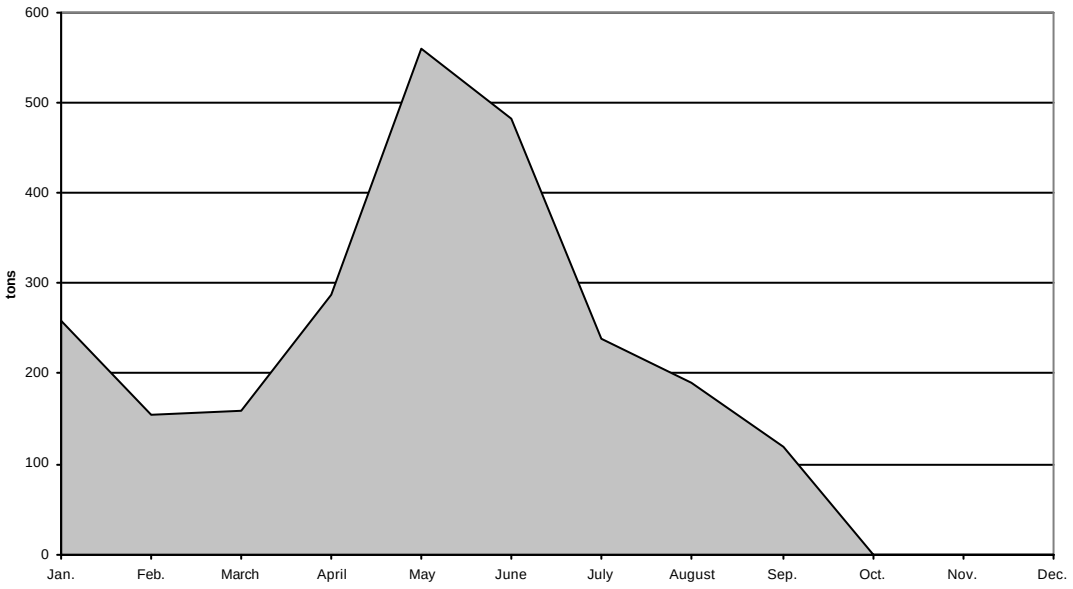


Figure 9. Monthly Exports of Squash to Saudi Arabia (Average 1990-92)

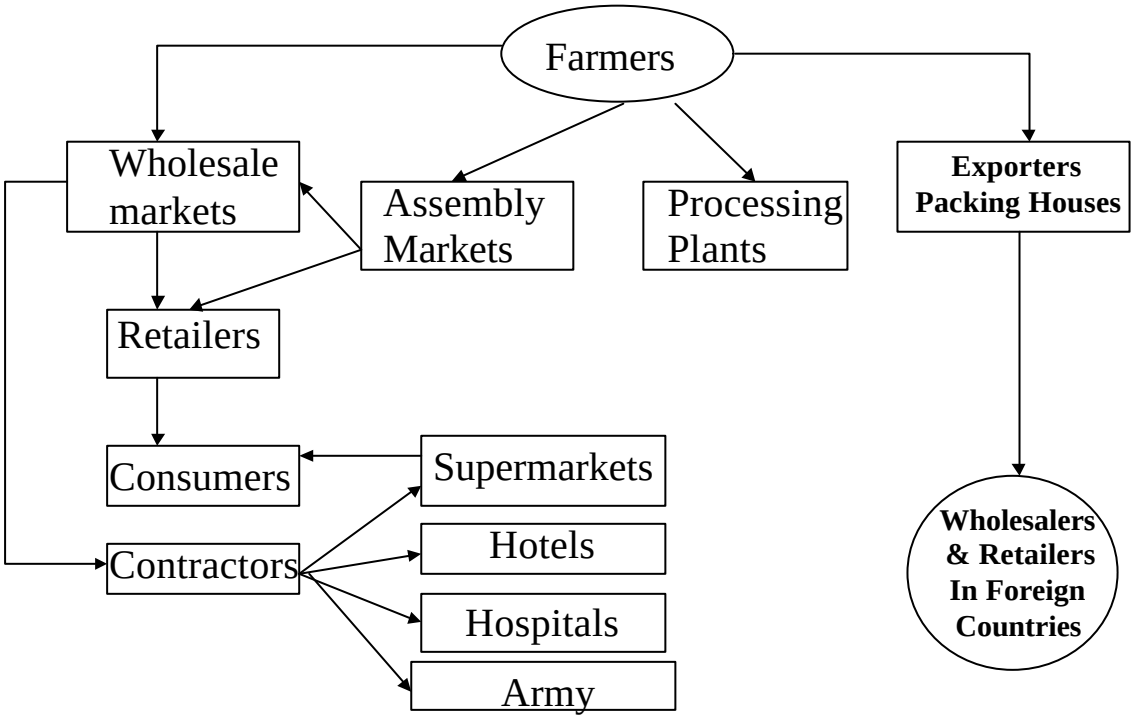


2.8 Marketing channels

The marketing of fresh horticultural produce in Jordan was always a private sector oriented system concern, with few exceptions. Figure 10 shows the marketing channels for fresh horticultural produce in Jordan. These marketing channels involve the movement of produce to one of the wholesale markets. The produce is dispatched to a commission agent, who auctions it to wholesalers, retailers and exporters. Farmers can sell their produce on their farms, to exporters, to processors, or at roadside stands outside the major urban centers. Retailers, exporters and traders compete for the purchase of produce basically through open auctions in the wholesale markets. Much of the product is packed on the farm itself and does not go through special packing houses.

A study conducted by the Agricultural Marketing Development Project (AMDP) found that 62.3% of farm sales go to commission agents in the Amman, Irbid, Zarqa and Al-Arda wholesale markets and that the remaining 37.7% is sold directly from farms to wholesale traders (6.5%), exporters (6.5%.), processors (14.5%), retailers (5.5%) and consumers (4.7%).

Figure 10 Marketing Channels of Fresh horticultural Products in Jordan



2.9 Relevant Organizations:

Agricultural Marketing Organization (AMO). AMO is a public organization specialized in the marketing of agricultural products. It was established as an semi-autonomous agency in 1987. The Minister of Agriculture is chairman of the AMO governing board. The main responsibilities of AMO can be summarized as follows:

- *Marketing research and information services*: This function represents the strongest element of the AMO mandate. AMO has developed a marketing information base that is potentially valuable for producers and traders in marketing of fresh fruits and vegetables both in domestic markets and abroad. Information includes prices, import/export regulations and/or conditions of domestic and foreign markets.

- *Monitoring of domestic markets*: AMO monitors the external appearances of marketed fresh horticultural products, and enforces grading and public health parameters. AMO tests for pesticide residues in fresh fruit and vegetables marketed domestically and abroad. The testing is carried out in cooperation with the Pesticide Residue Analysis Center of the Ministry of Agriculture. Every week, samples of fresh produce are collected randomly from the major wholesale markets and send to the Pesticide Residue analysis Center in Baqa'a. AMO does not test product for biological pathogens.

- *Monitoring of exports and imports*: AMO has established monitoring offices in seven border points through which exported and imported fruits and vegetables are checked. Monitoring is restricted to statistics and general compliance of commodities to conditions specified by AMO.

- *Export improvement through mobilization of private sector groups*: During the last decade, AMO implemented several activities designed to identify new export markets, organizing private sector groups to address needs of new markets and extending technical services on how to improve quality and standards of exported commodities.

Ministry of Agriculture (MOA). MOA was traditionally responsible for marketing of all agricultural commodities. In 1987, AMO was given the public sector mandate to organize, implement and monitor fresh fruit and vegetable marketing. The two important issues of who controls imports and exports permits were resolved. In 1990, the Government approved the policy of export promotion as part of the economic adjustment program and exports were then subjected to regulatory export procedures which do not include permits. Imports of fresh fruits and vegetables have remained subject to permits which define amounts, duration and types of imports . Import permits were issued for commodities that are not produced domestically as well as for

those that are not in season. Imports permits were also issued to a few items produced domestically but only when local supply was far below demand. Potatoes, onions and apples were the three crops that usually were imported due to shortages in domestic supply.

In 1994, the Government of Jordan agreed to liberate fresh fruit and vegetables from quantitative trade barriers but especially to discontinue import permits. This was part of a package of adjustments to be implemented through the Agricultural Structural Adjustment Loan (ASAL) signed between the Government and the World Bank. In 1995, trade of fresh fruits and vegetables was liberated from prior permit conditions required by MOA or AMO and became subject to normal regulatory procedures enforced by the Ministry of Industry and Trade. Most imported commodities are now subjected to importation customs and other fees which may reach 50 percent of imports value. An exception to this, are imports from Arab countries that are members of the Arab common market or other countries with which trade of agricultural commodities is subject to bilateral protocol agreements. Once duration of these protocol agreements expires, imports will then be treated through the normal regulatory trade channels including customs.

Fruit and Vegetable Exporter Association. The Jordanian Exporters and Producers Association for Fruits and Vegetables, was established in 1993. The Association has more than 120 members who represent the major fruit and vegetable exporters in the country. The main objectives of the Association are:

- To achieve the largest volume and best quality of Jordanian fruit and vegetable exports to all regional and international markets through entry into new export markets, diversification of types of fruits and vegetables produced in Jordan consistent with present and future demands of traditional and new export markets, collection and dissemination of export marketing information; and organization and implementation of export promotional activities including exhibits, leaflets and logos.

- To cooperate with the public sector institutions in the organization and implementation of measures that will improve export business through the identification and implementation of research and case studies on standing marketing problems including methods of harvesting, post-harvest handling, packaging storage and transportation; development of an effective grades standards and inspection system for fruit and vegetable exports; the improvement of regulatory services which promote exports.

- To increase the competitiveness of Jordanian fruits and vegetable exports in regional and international markets through introduction of seals, logos and other techniques which identify quality and distribution of Jordanian exports; reduction of export costs especially through the introduction and establishment of cost effective packaging materials,

grading and packing centers, pre-cooling and storage facilities and transportation; and coordination of air cargo, truck and ocean transportation schedules;

3. Trends in Food Safety and Quality Assurance in International Marketing of Fruits and Vegetables.

International trade in fresh fruits and vegetables has expanded rapidly in recent years due to increased incomes and demand in importing countries, as well as improved transportation and communication facilities. Demand has also increased by recognition of the nutritional value of fruits and vegetables. As trade has expanded, so have concerns for food safety. Attention to food safety has resulted from the detection of outbreaks of foodborne illness due to the presence of pathogens such as *Escherichia coli* and *Cyclospora* on imported fresh produce in the United States. Growing awareness of the role of certain agricultural chemicals as carcinogens, and thus the potential dangers associated with pesticide residues, has also raised consumer concern over food safety.

In some cases, food safety problems have disrupted export trade. At some points, for example, the United States has banned imports of raspberries from Mexico. During 2001 U.S. health officials have prohibited the import of cantaloupes packed by some Mexican companies, following the discovery that water-borne contaminants caused severe intestinal illnesses in consumers. Food safety concerns are not confined to fresh fruits and vegetables. Disruptions in livestock trade among European countries, prompted by the recent outbreak of foot and mouth disease, demonstrate how seriously food safety problems can impact an industry or even the entire economy of a country.

3.1 International quality assurance and food safety programs.

Concerns for food safety have resulted in the development of improved quality assurance (QA) programs by national and international government agencies, as well as by private businesses engaged in trade of fresh fruits and vegetables. The current situation is in somewhat of a state of flux, with several new programs being developed by private and government groups in different countries and regions. The private and government initiatives tend to complement each other. No single system has become the standard. In general, however, it can be said that rather than focusing on *quality control* – the testing of end-product to be sure that it is safe – most of the new programs focus on systems for *process control* that are designed to ensure that the production and marketing environment is safe.

Process control attempts to ensure that potential sources of contamination are eliminated throughout the *system* for producing and handling fresh vegetables and fruits. Thus, while safeguards are implemented to ensure that fresh vegetables or fruits will not be contaminated by unsafe irrigation water, other potential sources of contamination – process water in packinghouses, unsanitary packaging or transport facilities, and workers who carry disease or who do not observe hygienic practices – are also addressed in most of the new QA systems.

Codex Alimentarius. Quality standards and food safety issues relating to foods that are internationally traded come under the authority of the *Codex Alimentarius Commission,* a joint activity of the UN Food and Agriculture Organization (FAO) and the World Heath Organization (WHO). The Commission provides a forum where member countries and international organizations can meet and exchange information and ideas relative to food safety and trade issues. The Commission develops food standards that are used to facilitate trade between member countries. This has resulted in international standards for grades and sizes of specific fresh fruits and vegetables.

Codex works on committees composed of delegates from member countries. Codex has developed pesticide residue standards for foods. Currently, the Codex Committee on Food Hygiene is working on a *Code of Hygienic Practice for the Primary Production, Harvesting and Packaging of Fresh Fruits and Vegetables*. This *Code,* which is still only in draft form, may ultimately require testing of fresh vegetables for microbiological contamination.

Many countries and trading groups, such as the European Union, rely on Codex standards and procedures, rather than developing their own norms.

Private sector leadership in Europe. Private sector buying organizations are playing a leading role in requiring that producers of fresh fruits and vegetables use safe production practices. Euro-Retailer Produce Working Group (EUREP), an organization formed by major European buyers of fruits and vegetables, has recently been very active in this regard. Over the past four years they have produced a "normative document for international certification," known as EUREPGAP. The objective of this program is to raise overall standards for the production of fresh fruit and vegetables, including but not limited to food safety aspects. By participating in this program, vegetable and fruit suppliers and related handling facilities such as packinghouses, gain certification that clears the way for exporting to participating European buyers.

Under EUREPGAP, irrigation practices are only one element in a QA system that includes plant varieties and rootstocks, soil management, fertilizer and chemical use, post-harvest treatments, health and welfare of workers, and environmental protection. With regard to irrigation water quality, EUREPGAP procedures state the following:

> Based upon risk assessments, irrigation water sources should be analysed at least once a year for microbial, chemical and mineral pollutants by a suitable laboratory. The analysis results should be compared against accepted standards and adverse results acted upon (EUREP 2000, page 6)

The EUREPGAP system involves accreditation based on ensuring that individual growers and/or Produce Marketing Organizations (PMOs) adhere to good agricultural practices (GAPs) and good management practices (GMPs), as outlined in EUREPGAP protocols, and as verified by an approved third-party auditing body. A system of record keeping and documentation is

established so that it is possible to trace the history of the product back from the final consumer to the farmer, in the event that some quality or safety problem occurs. This is referred to as *trace-back*.

World Trade Organization. Although the World Trade Organization regulates trade between member countries, the organization has not developed its own standards for food quality or food safety. The objective of the Agriculture Agreement of WTO is to reform trade and to make trade policies more market-oriented. It specifically attempts to eliminate *non-tariff barriers* to trade. Among those engaged in agricultural trade, it has been widely recognized that some countries use sanitary and phytosanitary requirements as a form of trade barrier to protect their own producers, or perhaps for other political reasons (WTO, 2001).

In order to prevent the misuse of sanitary and phytosanitary requirements, WTO rules[1] stipulate that such requirements must be based on sound scientific principles and evidence, including an assessment of the risks to human health or to plant or animal life. Further, they must comply with established international standards. In the latter context, the *Codex Alimentarius* is mentioned as a recognized standard setting body. A member country is not allowed to require that other countries follow specific procedures to achieve certain standards, provided that they can demonstrate that alternative procedures attain the same result.

The WTO agreement further notes that "When a Member has reason to believe that a specific sanitary or phytosanitary measure introduced or maintained by another Member is …not based on the relevant international standards…an explanation of the reasons for such …measure may be requested and shall be provided by the Member maintaining the measure." If the required justification is not produced, or if it should fall short of the WTO requirements the injured country would have the right to proceed against the other country under WTO guidelines.

Saudi Arabia is currently in the process of joining WTO. If Jordan should wish to pursue its attempts to have the Saudi government drop its ban on Jordanian vegetable imports, the WTO rules cited above provide some basis for proceeding. If, for example, Jordan were to develop a certification program that verifies that certain product is grown in areas that do not use reclaimed water, it appears that the Saudi government would have to agree under WTO rules.

U.S. System. In the United States, private sector buyers are also leading efforts to establish QA systems that include food safety. Until recently, the tendency has been for each major importing company (e.g. Safeway Stores or Kroger) to establish its own QA and food safety requirements, rather than developing a common system that applies to all, as appears to be the goal of the EUREP group.

[1] See WTO, Agreement on the Application of Sanitary and Phytosanitary Measures.

In 1998, the U.S. Food and Drug Administration (FDA) issued the *Guide to Minimize* Microbial *Food Safety Hazards for Fresh Fruits and Vegetables* (FDA, 1998). This document provides *guidance* to farmers, packing facilities, and transporters; the procedures it recommends are not mandatory, and there is no third-party verification as is required in the EUREP system. While the FDA *Guide* does attempt to define GAPs and GMPs, its scope is limited to the elimination of microbial hazards. It does not attempt to incorporate environmental or labor issues. Similar to the EUREP system, however, the FDA *Guide* emphasizes the establishment of a trace-back system. The FDA *Guide* is intended for use by private producers and marketers in the U.S. and by those in countries that wish to export to the U.S[2]. The FDA also has also been expanding the use of its HACCP (Hazard Analysis and Critical Control Point) system for assuring food safety, but this system has yet to be applied to fresh fruits and vegetables (FDA, 1999).

FDA does some random microbiological testing of specific products. It tests both U.S. domestic product and imported items. Currently, for example, it is running tests on cantaloupe, cilantro, and tomatoes. Until now, such testing has only been done for a fixed period to determine whether problems exist. Now, however, FDA is considering the implementation of a continuing program to be called the Microbiological Detection Program (MDP). Initially, MDP would test samples of tomatoes, lettuce, and celery. There is no plan to have regular tests on every shipment of product or to require "sanitary certificates" on each shipment.

3.2 Countries in the Middle East.

Standards in Arabian Gulf Countries. For the Arabian Gulf countries, agricultural trade, including fresh produce, generally falls under standards of the Arab League. These have been patterned after rules of the European Union and they relate primarily to grade and size standards. *Phytosanitary* (plant and animal health) and *sanitary* (human health) issues are left either to the regulations of individual countries or to the *Codex Alimentarius* rules of the FAO/WHO. As noted in Chapter 2, in its ban on imports of vegetables from Jordan, Saudi Arabia cited its own regulation that prohibits the use of treated wastewater to irrigate vegetables.

Traceability system under development in Israel. Currently, the Standards Institution of Israel, in conjunction with the private marketing organization AGREXCO, is using EUREPGAP as a framework for a project which aims to develop an "Information Network for the Traceability of Safe Agriculture" for Israel. The objective of the project is to develop a system through which "…all interested parties will be able to exchange information concerning all risk-related issues involved through out the entire production process." One component of the system will be audit reports on producers and handlers, issued by inspection and certification bodies (Krudo, 2001).

[2] For example, a consortium of producers associations has recently issued its *Field Cored Lettuce Best Practices,* citing the FDA *Guide* as the underlying directive to safe practices for lettuce growers. (National Food Processors Association, International Fresh-cut Produce Association, and United Fresh Fruit & Vegetable Association, U.S.A., April 2001.)

3.3 Food safety and Quality Assurance in Jordan

In Jordan, regulatory responsibilities for food safety are not clear when it comes to fresh fruits and vegetables. Generally speaking, food safety is a responsibility of the Ministry of Health, but MOH claims that it has no authority when it comes to fresh fruits and vegetables[3]. According to the Director of Food Safety in MOH, such concerns fall under the purview of the Agricultural Marketing Organization (AMO) in the Ministry of Agriculture (MOA). AMO does claim oversight for "quality control," but they state that they are not the responsible agency for food safety. While their mandate states that they oversee "public health parameters," their actual inspection of fresh produce is based only on visual appearances and not on testing.

AMO carries out a regular sampling program of pesticide residue analysis for fresh fruits and vegetables. Daily samples are taken in the main domestic markets, and samples are also taken from imported product. Samples are sent to the Pesticide Residue Analysis Laboratory at the National Center for Agricultural Research & Technology Transfer (NCARTT) in Baqa'a. In the event that residue problems are found – which is reported to be very seldom – AMO tries to track down the grower and advise him that he should improve his pesticide application practices. According to a 1996 report by GTZ[4], however, "internationally accepted sampling procedures are not known and not applied" by AMO. Although AMO reports that its ongoing residue sampling rarely detects residues that exceed established limits, documentation of the results of the residue testing program are not readily available[5].

Integrated Pest Management Program. The IPM project has operated in NCARTT for the past four years. It has helped participating growers establish procedures that take advantage of beneficial insects and focus on the use of appropriate pesticides while minimizing pesticide use. One aspect of this project has been to develop a certification program for farms that follow the recommended practices. The products of certified farms are subject to unscheduled pesticide residue analysis. Stickers stating that the products come from certified producers are used for marketing, and a shop has been designated to market the products of certified producers in Amman's central produce market. Some of the certified growers have regular contracts to supply Jordanian hotels and super markets. Participation in the IPM program has included many growers in addition to those who have chosen to participate in the grower certification program.

[3] The MOH Food Safety directorate does regularly supervise food-processing companies, and they have oversight of sanitary procedures in hotels and restaurants, including the training of food service workers on sanitary procedures.

[4] Dietz, H. Martin, "Development of a Quality Assurance System for Fruit and Vegetable Production in Jordan," report prepared for AMO and GTZ, July 1996.

[5] Staff of the Integrated Pest Management program in NCARTT state that, despite repeated requests, they have not been able to obtain documentation on the results of the tests carried out by the program.

Certified IPM growers pay for the sticker that are affixed to their products, and the funds derived in this way are used to cover the costs of operating the program, including farm inspection and pesticide residue sampling. Currently, only three tons of certified fresh fruits and vegetables are sold daily, although a much greater amount of "certifiable product" is available. The relatively small volume of product that is being marketed through the certified grower program raises doubts about the future sustainability of the program. The IPM project has estimated that it takes at least five tons of products per day to support one inspector and run the program.

Although AMO regularly samples product for pesticide residue analysis, Jordan has no program to test fresh fruits and vegetables for pathogens. The IPM program had initially intended to include microbiological testing as part of its certification program, but this has not been accomplished so far. One of the factors that makes microbiological testing difficult is that there are currently only one or two labs in Jordan that have the capability to do the required tests. Undoubtedly, microbiological testing would be more costly than pesticide residue testing. Nevertheless, given the hazards presented by the use of inadequately treated wastewater, it would appear that Jordan must consider implementing such testing.

Private sector quality assurance activities. At least one large private sector packing company, Modern Valley Farms, has developed a quality assurance program to ensure the quality and safety of its fresh fruits and vegetables. Located in the central directorate of the Jordan Valley, this company packs products grown on its own farms as well as those grown by outside producers. Modern Valley has been accredited by three English super market chains who regularly send inspectors to Jordan to verify that the packinghouse and the supplying farms adhere to GAPs and GMPs set by the buyers. The buyers regularly test Modern Valley's products for pesticide residues and pathogens when they arrive in England. The packer requires that all of its growers list the pesticides that they use and that they apply the products according to the specifications indicated on the chemical label. Since the company's English buyers are members of the EUREP organization, it is likely that Modern Valley will be required to seek accreditation under EUREPGAP once this new system becomes operational.

Water has been an important factor in Modern Valley's quality assurance efforts. During the past few months the company has installed an expensive reverse osmosis (RO) water treatment unit on its own farm. Furthermore, it has the policy of only packing and selling products from outside growers who are located in areas in the southern and northern directorates, where the water is expected to be "clean"[6].

The Progressive Agricultural Investment Company, another large Jordan Valley grower-packer, is in the process of obtaining accreditation from the Sun World Company of California in the U. S. Under this agreement Progressive

[6] Strictly speaking, while neither of the areas mentioned uses reclaimed water, the canal readings for FC are high in some instances. In 1999, for example, JVA tests in the upper parts of the KAC in the Northern Directorate exceeded 1000 MPN.

will be required to meet Sun World's standards for export. However, since the Progressive Company exports only fruits (grapes and dates), water quality is not such a critical factor as it is for a vegetable exporter.

MAYCO, a producer of cherry tomatoes and melons, recently received finance from the International Finance Corporation, a World Bank agency, to establish a large multi-span greenhouse operation in the South Ghor area along the southeastern edge of the Dead Sea. An important consideration in the decision to locate at this site was that irrigation water is available either from wells or side valleys that are independent of the Jordan River system and which is thus free of contamination. This helps to qualify the company's products for European buyers.

As more Jordanian producers and exporters try to break into higher price markets where high quality and food safety are significant issues, more companies will undoubtedly find it beneficial to establish quality assurance programs and to become accredited with foreign buyers that require such procedures. The Fresh Fruit & Vegetable Exporters Association of Jordan could play a role in encouraging such programs and in helping its members to qualify. It remains to be seen whether a certification or accreditation system will be developed within Jordan itself, perhaps building upon the IPM certification program that has already been established, or whether it would be preferable for Jordanian companies to become accredited under EUREPGAP.

4. Production of Vegetables and Fruits with Reclaimed Water in Jordan.

Most fruit and vegetable production in Jordan is irrigated. It takes place in two principal settings, the Jordan Valley and the Highlands. Some highland production is rainfed, but most is based on irrigation from wells. In either case, there is little question about the biological suitability of the water. In the Jordan Valley and in lesser valleys, however, irrigation has traditionally been based on surface stream flows and natural springs. It is in the valley settings where it has become more common to intermix reclaimed water with fresh surface water and where questions about food safety arise.

Jordan's principal source of reclaimed water is the As Samara Wastewater Treatment Plant, located near Zarqa in the Amman-Zarqa Basin. This is the main treatment facility for Amman, Jordan's capital and largest city, and for Zarqa, the largest industrial area. Treated effluent from As Samara and several other smaller plants[7] is discharged to Wadi Zarqa, from whence it flows into the King Talal Reservoir (KTR), prior to release into the irrigation canals of the Middle Directorate and the Karameh (South) Directorate of the Jordan Valley Authority (JVA). During some periods of the year, the entire flow of Wadi Zarqa is composed of effluent from treatment plants.

For purposes of this discussion, three types of irrigation that depend fully or partially on treated wastewater (TWW) are identified as follows:

- **Direct use** of refers to TWW that is conveyed from a treatment plant to a designated area for authorized use in irrigation. Currently, direct use is employed to irrigate tree crops and forage in the immediate vicinity of several treatment plants in Jordan. Under current Jordanian law, TWW cannot be used to irrigate crops such as lettuce, cabbage, and cauliflower that are eaten raw (MWI/ARD, 2001d).

- **Indirect use** is the term used to characterize irrigation based on effluent reuse, after it has been treated and discharged to the environment. Normally, the natural environment results in improved biological quality and reduces some of the human health hazards that might be associated with direct use. In many settings, when TWW is released to the environment it would be diluted by fresh surface water, which would also improve the quality. Indirect use is the term used to characterize the water that is used in the Middle and South Directorates of the JVA, after it has first been released to Wadi Zarqa and held temporarily in KTR. Under Jordanian law or regulations there are no restrictions on the types of crops that may be grown with indirect use of TWW for irrigation.

[7] Treated effluent from smaller plants at Jerash, Abu Nuseir, and Baq'a currently amounts to less than 10 % of the total discharge, while As Samara provides more than 90%. See (MWI/ARD 2001a).

- **Unauthorized use** occurs when farmers use water to irrigate in ways that do not comply with existing laws or regulations. Under current rules, irrigation with water from Wadi Zarqa and similar streams that lie immediately downstream from treatment plants is not authorized for irrigation of fresh-eaten vegetables[8].

The output of effluent from treatment plants is expected to expand dramatically during the next 20 years. The plants on Wadi Zarqa alone are expected to increase their discharges from the current 51 MCM to 177 MCM by 2020 (MWI/ARD 2001c). According to the World Bank's latest "Water Sector Review Update" for Jordan, water reuse in the Jordan Valley is expected to increase from the current level of about 56 MCM (18 percent of total supply) to about 137 MCM (34% of total supply) by 2020 (World Bank, 2001)[9]. This means that *indirect use* in the Jordan Valley will more than double over the next two decades. *Direct use* of water for irrigation near treatment plants in the highlands is also expected to expand during the same period (MWI/ARD 2001a).

4.1 Problems with Water Reuse.

There are currently several problems with reuse for irrigation. These raise concerns for the health of consumers of products grown with reclaimed water and are usually referred to as *food safety* issues.

The As Samara Wastewater Treatment Plant (WWTP) is operating over its capacity, due to growth in population and municipal water use. The *fecal coliform counts* (FCC) and the *biological oxygen demand* (BOD) of this water are often higher than the established standards. There is further pollution in Wadi Zarqa, downstream from As Samara. While not fully documented, this is probably due to a combination of livestock waste, unauthorized releases from some industries, inadequate septic tanks of nearby inhabitants, and run-off from urban areas.

Unauthorized irrigation in Wadi Zarqa, and perhaps also in other valleys below the smaller WWTPs, presents a serious problem. Due to the many sources of pollution noted above, in addition to the sometimes-high levels of discharge from the As Samara Treatment Plant, the FC counts are often above the 1000 MPN/mL standard for treatment plant effluent. A recent Water Resource Policy Support (WRPS) project study conducted during the winter of 2000-01 found that about 4,000 dunums of the total 17,000 dunums being irrigated in the Wadi was planted to vegetables, many of which would probably be eaten raw (MWI/ARD, 2001a). This vegetable production occurs

[8] It is not clear whether irrigation in Wadi Zarqa would be viewed differently if the water being released from the As Samara Plant was up to standard (e.g. FC count consistently less than 1000 MPN/100 mL). Once the planned upgrade of the plant is complete (sometime after 2004), will the irrigation in Wadi Zarqa then be considered to be an authorized (direct) use?

[9] In fact, as discussion below will explain, the proportion of reclaimed water has been much higher than this in some directorates of the JVA during recent drought years, and the proportion for the JVA as a whole has been far higher than the 18% mentioned in the Bank's report.

despite efforts of the Ministry of Health (MOH) to stop it. In some years, MOH has gone so far as to destroy vegetable crops being grown in the area.

In addition to the direct human health threat that the irrigation of raw vegetables in Wadi Zarqa represents, it creates a marketing problem. The water in the wadi looks and smells foul. Although the FC in the Wadi's water comes from many sources other than treatment plants, it has the appearance of being wastewater that has not been fully treated. The area is close to Amman, it is highly visible, and consumers have no way to tell when the produce they buy comes from this area.

Despite the problems with the safety of water in Wadi Zarqa, the quality of the water normally improves greatly after it flows into the KTR, where it is usually held for about several months prior to release to the Jordan Valley. Nevertheless, during times of heavy rains and winter flooding the Wadi Zarqa water passes through the KTR at higher than normal rates, which at times causes FCC to exceed Jordan's existing standard (1000 MPN/mL) for unrestricted, *direct use* in irrigation.

While existing management plans call for mixing KTR water with an equal or greater portion of suface water from the King Abdullah Canal (KAC), the water available from the KAC has been insufficient to accomplish this during recent years. In 1998, the supply to the Middle Directorate averaged 91 percent KAC water, and in 1999 it was 100 percent – that is, it was used full strength throughout the year. Although the proportion of KTR water in the Karameh District supply has rarely exceeded 80 percent[10], it nevertheless often does exceed the 50 percent limit of the management plan (MWI/ARD 2001b). The fact that the FCC in the water from the KAC is sometimes also significant suggests that the quality of KTR water is not the only issue[11].

4.2 Water Quality Standards & Implications for Irrigation in the Jordan Valley.

Various countries have developed standards for the direct use of TWW in irrigation, and individual states have done so in the U.S. These standards are normally based on FC *counts,* taken as an indicator of the possible presence of pathenogenic bacteria[12]. Sometimes *total coliform count* (TCC) is also used, although this is a broader measure which includes microbes that are probably not a direct threat to human health. While a highly useful indicator, the FC count fails to detect other potentially harmful pathogens such as *fecal*

[10] Witin Karameh, some individual canals received higher mixtures than the 80%.

[11] The main source of KAC water is from the Yarmouk River, which originates in Syria. Presumably, the presence of fecal coliform in this water is a reflection of contamination from livestock and human non-point source polluting activities along the river. Jordan has fenced parts of the canal to prevent direct livestock contamination. The FCC declines as the distance from the source of KAC increases.

[12] It is well known that pathogens, including bacteria, protozoa, viruses and intestinal nematode eggs, exist in wastewater, and that there is a danger that some of these hazardous microorganisms may survive treatment. Thus, human disease can be transmitted when inadequately treated water is used in the irrigation of crops, particularly when the crops are eaten raw (Yates and Gerba, 1998).

streptococci, various types virus such as hepatitis A and E, and they do not measure the potential presence of intestinal nematodes such as hookworms.

In general, the higher income countries have developed relatively strict water reuse regulations that are expensive for treatment plants to comply with. Such strict standards, based mainly on a "no risk" philosophy, are often impossible to achieve for developing countries that face limited treatment budgets and badly need to recycle water for irrigation.

The World Health Organization (WHO) has developed less stringent guidelines, intended to be suitable for use by developing countries. The WHO standard for unrestricted use of treated wastewater used in irrigation requires that the FCC be less than 1000 per 100 mL and that the count of *helminth eggs* be less than one per liter (WHO, 1989). Helminth eggs[13] are the eggs of intestinal nematodes such as Ascaris and *Trichuris* species and hookworms, but they are also considered to be an indicator for large settleable pathogens, including *amoebas*. The experts who developed this standard considered the threats measured by helminth eggs to be more serious than the bacterial threats measured by the FC count. In Jordan, however, helminth egg levels are normally low in treated effluent and not viewed a problem.

MWI/ARD (2001d) has recently recommended that Jordan adopt new standards that are stricter than the WHO standards for direct irrigation use of TWW (MWI/ARD, 2001d). He proposes that all crops, including raw-eaten vegetables, could be irrigated with direct use, provided that *fecal coliform* (FC) counts are less than 200 MPN per 100 ml, and provided that drip irrigation is used in conjunction with plastic mulch. MWI/ARD (2001d) has further proposed that all crops other than fresh-eaten vegetables could be irrigated under direct use, provided that the FC count is less than 1000 MPN/100 mL.

As noted above, under Jordanian law irrigation in the Jordan Valley is not viewed as direct use that would result in the imposition of cropping restrictions. Nevertheless, available data appear to indicate that FC counts in the Jordan Valley sometimes exceed the WHO standards for direct reuse of TWW. According to JVA's water monitoring data for Sampling Point 650 (10 km downstream from KTR), FC levels exceeded 1000 MPN for more than 30 percent of the samples taken during the three consecutive years 1997-1999. The highest monthly counts exceeded 3000 MPN for each of these years.

While more detailed analysis of FC counts needed, some of the monitoring data suggests that the problem may not be entirely attributable to KTR and Wadi Zarqa. According to independent monitoring carried out by the Royal Scientific Society (RSS), water quality is improved greatly by retention in KTR but it *declines after leaving KTR*. The RSS annual monitoring report for the 1998-99 year shows reports that FCC readings are higher 10 km downstream at Sampling Point 650 than they are at Sampling Point 600 at the KTR outlet (RSS, 1999). This suggests that there are other sources of contamination. It

[13] Intestinal parasites, as measured by helminth eggs, are not considered to be a problem in Jordan

appears that livestock, run-off from urban areas, or perhaps unauthorized disposal of waste by industrial activities are causing water quality to deteriorate after it leaves KTR.

JVA and RSS data both show that the water from King Abdullah Canal contributes *fecal coliform* to Jordan Valley canals. Nevertheless, by the time it has traveled some 60 km to the mixing point with KTR water, the FCC level in KAC has been substantially reduced from what it is at the diversion from the Yarmouk River. For 1998-99 the RSS monitoring report indicates that while the FCC exceeded 1000 MPN in 3 of the 12 months at Sampling Point C1, just prior to mixing, it exceeded this level for 9 out of 12 months at Point C2 just after mixing.

While the microbial counts in Jordan Valley canals appear to be a cause for concern, it must be recognized that the WHO standards and the stricter standards recommended in MWI/ARD (2001d) are meant to apply to the *direct use* of TWW. They do not necessarily apply to *indirect use*¸ as occurs in the Jordan Valley, after the treated water has spent considerable time and traveled a significant distance through the environment. **Apparently, there are no international norms that specify when TWW that is returned to the environment need no longer be considered as TWW.**

In justifying its standards for use of TWW in irrigation, the WHO report compared them to the FC counts found in many of the world's rivers used for irrigation. Based on data gathered during 1979-84, they found that about 45 percent of the world's rivers used for irrigation had counts exceeding 1000 and 15 percent had fecal coliform levels in excess of 10,000 per 100 mL. (WHO, 1989). Although the data on Jordan Valley irrigation canals is somewhat limited – for example, there do not appear to be any readings which pertain to canals within the Middle or Kerameh directorates – the FC levels are not particularly high in comparison to world rivers.

4.3 Irrigation Technology and Safe Irrigation Practices.

The irrigation technology used in the Jordan Valley may also affect the food safety of crops grown in the Jordan Valley. A very high proportion of the vegetables and fruits in the two directorates are grown under drip irrigation. In many cases drip lines are covered with plastic mulch to control weeds and conserve moisture. It is believed that the plastic mulch constitutes a barrier that limits the possibilities for contamination of the crop by pathogens that may be carried in the irrigation water. It may be possible to demonstrate that this is a safe technology for production of raw-eaten vegetables (tomatoes, eggplant, lettuce, cabbage, spinach, and similar crops) under JV conditions. Research would be needed to establish the validity of this distinction.

The National Center for Agricultural Research and Technology Transfer **(NCARTT).** NCARTT was institutionalized through the Bylaw No 42 for 1993 within the Ministry of Agriculture. NCARTT Council is formed from major stakeholders in research in the country and chaired by the Minister of Agriculture. NCARTT was formed as a specialized center attached to the

Minister of Agriculture and therefore does have a clear national mandate to plan and organize agricultural research in the country. In 1993, NCARTT in cooperation with national and international cooperators evolved an agricultural research strategy. The strategy called for the organization of research activities in five national programs. These Research Programs are:

- Irrigated agriculture
- Rainfed Agriculture
- Water and Irrigation Management
- Range and National Resources
- Animal Health

NCARTT conducts research on agricultural production problems in the Jordan Valley, and it develops *good agricultural practices* (GAPs) based on this research. In some cases, safe use of irrigation water is already part of these practices. For example, NCARTT recommends that farmers in the Jordan Valley not use ordinary canal water to mix chemicals that are sprayed on crop leaves and fruits.

Even if Jordan Valley water poses certain health hazards – which is not certain – there may be ways to manage irrigation safely so that potential problems are avoided. It is important, however, that safe irrigation practices be explicitly incorporated in the GAPs. For example, this might include development of a list of crops that should only be grown under drip irrigation with plastic mulch, or possibly a list of safety periods that should be observed between the time of the final irrigation and the harvest date. Safe practices should incorporate the findings of the applied research recommended above.

Extension services. The need to disseminate GAPs to farmers and to demonstrate their use is obvious. Although Jordan's Agricultural Extension Service (AES) does have personnel assigned to the Jordan Valley, they lack sufficient vehicles and other means to be effective in disseminating available information and recommendations. Agricultural Extension will need to be strengthened if it is to be expected to carry the message of safe water use to farmers.

As an alternative, or in addition to strengthening AES, the mandate of the Irrigation Advisiory Service (IAS) of the JVA could be expanded to include safe irrigation practices that take water quality into account. Currently the IAS is limited in size (five professional staff) and its activities are focused on water scheduling. If the IAS mandate were expanded, its new agenda would presumably include management of both chemical and biological factors. This would require additional technical expertise and equipment.

The extension agency (AES and/or IAS) should incorporate information and guidance on safe irrigation practices in its work with farmers. Farmers need to understand how pathogens can be transferred from irrigation water to consumers of certain crops, and they need to learn about production practices that can avoid this, if possible.

Monitoring the Quality of Jordan Valley Irrigation Water. Assuming that JVA canal water presents some health risks, and considering that better information is likely to be required for effective international marketing of fresh produce, it is important that good data on irrigation water quality be available to farmers and marketers.

Monitoring the quality of irrigation water distributed by the JVA is the responsibility of the JVA Directorate of Environment and Laboratories. Some independent monitoring is also conducted by the RSS. The JVA collects regular samples for tests of chemical and biological water quality, and the results of these tests are reported in regular monthly and annual reports within JVA and MWI.

It is not easy for farmers to gain access to the JVA monitoring information. The JVA Laboratories reports and the RSS reports are largely internal documents, and the information is not quickly and easily available to most farmers[14]. Currently it is difficult, for example, for a farmer to learn just when the FC counts may be high in his particular canals.

The routine biological tests made by JVA Laboratories cover *total coliform* count (TCC), *fecal coliform count* (FCC), *nematodes*[15], and *biological oxygen demand* (BOD) (MWI/ARD, 2000). The biological tests are taken at 30 sampling points whereas chemical tests are taken at about 90 sites. They cover more than 200 chemicals and chemical compounds, as well as measures of salinity, and pH. The JVA monitoring also includes plant tissue tests for heavy metals. The frequency of the tests varies according to the type of indicator. Some of the chemical tests are taken only monthly or yearly. The coliform counts are taken twice per month.

In the annual reports, the coliform counts are reported only as annual averages (geometric means) for each site. Thus, it is not possible from these reports to determine when peak periods occur during the year[16]. Thus, if a farmer were to decide to plant some crops only during periods when the counts in his canal are expected to be low, based on current data analysis it would not be possible for him to determine when such periods normally occur.

Apparently, not all of the results of the JVA tests are published. For example, the annual report for 1999 contains no indication of the helminth egg counts, nor is there any report of plant tissue levels of heavy metals.

Laboratory staff told the consultants that they do not have information on the significance of heavy metal readings for human health. Nevertheless, they did state that the tissue levels for heavy metals are no higher in the Middle Directorate, where KTR water is used, than they are in the North Directorate

[14] One farmer complained that even when he takes a sample of the water from his canal to the RSS for testing, the RSS first reports the findings to the JVA.

[15] Presumably, the test run for "nematodes" would be a count of *helminth eggs*.

[16] The WHO protocol for testing TWW used in direct irrigation calls for a geometric average of tests taken during the irrigation season.

where no reclaimed water is used[17]. This would appear to indicate that irrigation with KTR water does not pose a danger to human health through heavy metal contamination.

In summary, the monitoring information that is being collected could be managed and disseminated in ways that would make it more useful to farmers and that would promote the safe use of the irrigation water. Better information would also enhance marketing. The following improvements would be of help:

- Find ways to make biological monitoring information (FC and *helminth* egg counts) available to farmers in a timely way, and in a format that is easily understood in relation to safe production practices. The extension service (IAS or AES) could help in disseminating this information and in showing farmers how to use it.

- Analyze the data on a monthly basis, rather than just reporting annual averages. Monthly graphs for each canal, comparing the FC patterns among years, would help farmers determine whether there are any periods when the counts are consistently high or low, or whether the highs and lows are only sporadic.

While there is a point for biological sampling (FC) in the main canal, just after the mixing point between KTR and KAC water, there are no separate sampling points for specific canals within the Middle or Karameh Directorates. Since experience shows that there can be significant changes in biological quality that are not related to the quality of the source water,[18] it would be desirable to add several additional sampling points to the JVA monitoring system to provide separate readings on the subject canals.

[17] They also reported that the heavy metals levels in both areas are higher when the sampling occurs next to roads where motor vehicles normally pass. Apparently, this provided them with some assurance that their tests are working.

[18] There is a significant drop in the FC counts on the KAC as it travels through the Northern Directorate. This undoubtedly reflects the affects of aeration and solar radiation. On the other hand, there is the increase in FC count that occurs in the outlet canal from KTR, between Sampling Points 600 and 650, as described above.

5. Plan for Marketing Fresh Vegetables and Fruits In the Context of Reclaimed Water Use.

The fact that reclaimed water is used for irrigation, even if only indirectly, creates a problem for marketing fresh vegetables and fruits grown in Jordan. Saudi Arabia, which had been one of the major buyers, has banned the importation of all fresh vegetables from Jordan. While other international buyers have not imposed bans, the fact that recycled water is used in some areas creates a problem for producers who want to sell to foreign buyers in upper income countries or to buyers with higher quality standards in other regions. Foreign buyers or domestic consumers often cannot be sure that fresh vegetables and fruits grown in Jordan have not been grown with contaminated water. Alternatively, they cannot be sure that suitable practices have been followed to ensure that the products are safe to eat without being cooked. Thus, uncertainty about the safety of vegetables and fruits grown in Jordan presents a marketing problem.

It is well known that reclaimed water and river water with high FC counts is used to irrigate vegetables in some parts of the world, without negative repercussions on marketing. Thus, it might be claimed that Jordan does not have a problem and that no special measures are necessary. However, Jordan has already lost a major customer for its fresh vegetables. Despite repeated attempts to have the Saudi ban lifted, it continues in force. Furthermore, Jordan has some special circumstances with respect to its reclaimed water use. These are the high visibility of Wadi Zarqa and the irrigation that occurs there, and the high proportion of reclaimed water – up to 100% in some years – used in certain parts of the Jordan Valley. Furthermore, water reuse is bound to increase in the future. Add to this the fact that food safety concerns are increasing and that international markets are demanding more transparency with respect to safety issues, including possible biological contamination of fresh produce. All of these factors combine to indicate that Jordan needs to take a pro-active stance with respect to marketing, in the context of reclaimed water use.

There are two obvious ways to reduce uncertainties about the safety of fresh vegetables grown under irrigation in Jordan.

i. The ***direct use*** of effluent from wastewater treatment plants for irrigation of vegetables destined for fresh consumption is prohibited under existing law. In the future, as the planned direct use of treated wastewater expands, it will be important either to maintain this prohibition or to establish other safeguards[19].

ii. The ***unauthorized use*** of treated wastewater in Wadi Zarqa and in other river valleys below treatment plants is currently a serious problem. Strict enforcement of existing regulations to ensure that

[19] As noted in Chapter 4, MWI/ARD (2001d) recommended that irrigation of all raw-eaten fresh vegetables be permitted where drip irrigation is used in combination with plastic mulch, provided that treated effluent is maintained at levels of under 200 MPN/100 mL of Fecal Coliform.

only authorized crops are grown in these valleys is a necessary step in eliminating the uncertainty that surrounds the quality and safety of fresh vegetables and fruits produced in Jordan.

Assuming that the two requirements outlined above are achieved, the *indirect use* of reclaimed water that occurs in the Jordan Valley after mixture with surface stream water from the King Abdullah Canal and other sources still leaves uncertainty about the safety of fresh vegetables grown in Jordan. This uncertainty is likely to increase as the use of reclaimed water increases in the future. Several additional measures are recommended to improve the safety and quality of Jordan's vegetables. These are as follows:

i. Clarify the *regulatory responsibility* for food safety in fresh vegetables.

ii. Improve *management and availability of information* on water quality and food safety.

iii. *Initiate applied research* to clarify the relationship between water quality and sanitary condition of fresh vegetables in Jordan.

iv. Based on research findings, *consider establishing microbiological testing* of fresh vegetables to check for pathogens.

v. Incorporate *practices for safe use of irrigation water* in GAPs for production of fresh vegetables and fruits, and promote their use.

vi. Promote the establishment of a *grower certification system and/or accredited product marketing organizations* that meet international standards.

Details of the six plan components are discussed below.

Clarify regulatory responsibility for food safety. Because of relatively high and expanding *indirect use* of treated wastewater for irrigation it is important that the potential for biological contamination of fresh vegetables and fruits be recognized and that the responsibility for addressing the related concerns is clearly established within the government's regulatory structure. However, the responsibility for *food safety* is not clear when it comes to fresh fruits and vegetables.

The Directorate of Food Safety (DFS) in the Ministry of Health (MOH) has responsibility for sanitary conditions in food processing, but it has no responsibility to supervise sanitary issues related to marketing fresh vegetables or fruits. The Directorate of Environmental Health (DEH), also in MOH, is responsible for oversight of the *direct use* of treated wastewater, and it has attempted to control the unauthorized irrigation of fresh fruits and vegetables in Wadi Zarqa. However, DEH has no responsibility for indirect use of reclaimed water that is mixed with fresh surface water in the Jordan Valley.

The Agricultural Marketing Organization (AMO) of the Ministry of Agriculture (MOA) has an ongoing program to test fresh fruits and vegetables for presence of pesticide residues, but it does no similar testing for pathogens. Since AMO is already partly responsible for food safety of fresh fruits and vegetables, since its mandate mentions oversight of "public health parameters," and because it is preferable to have all aspects of food safety for these products regulated by a single agency, it is recommended that the responsibility to monitor for potential biological contamination be assigned to AMO.

Management and availability of information. It is important that farmers have good information on water quality so that they can irrigate safely with water that sometimes contains a high admixture of reclaimed water. JVA Laboratories make regular tests of chemical and biological water quality at 30 points in the conveyance and distribution network,[20] and the results of these tests are reported in regular monthly and annual reports within JVA and MWI. However, these reports are largely internal documents, and the information is not quickly and easily available to most farmers.

The routine biological tests made by JVA Laboratories cover *total coliform count* (TCC), *fecal coliform count* (FCC), *nematodes,* and *biological oxygen demand* (BOD). The coliform counts are taken twice per month, while the other measures are taken monthly. In the annual reports, the coliform counts are reported only as annual averages for each site. Thus, it is not possible from these reports to determine when peak periods occur during the year. Furthermore, the laboratories do not report the results of their tests on the presence of heavy metals in plant tissues because they have no information on the significance of the results for human health.

In summary, the information that is collected is not being analyzed or disseminated in a way that is designed to promote food safety or enhance marketing. Improvement in the management water quality information is required to help farmers be more effective in their irrigation water use, and so that the implications for product safety can be taken into account in production and marketing.

Applied research. Insufficient information is available on the relationship between water quality and food safety in Jordan. Research is needed on a number of issues. Are the biological counts that exist in the irrigation water in the Jordan Valley high in comparison to other irrigated areas of the world? Does the prevailing technology of the Valley - particularly the use of drip irrigation under plastic mulch for many vegetable crops – really reduce the risks of crop contamination as is normally thought?

More generally, research is needed to document the presence or absence of pathogens on fresh vegetables that are produced in Jordan, and to determine

[20] By comparison, chemical tests are taken at about 90 sites. They cover more than 200 chemicals and chemical compounds, as well as measures of salinity, and pH.

how this varies with the quality of the irrigation water, the type of crop, and according to the **irrigation** practices that are used. How do the pathogen levels on crops grown in the Jordan Valley compare to products irrigated with wells in the highlands or to levels commonly found on product in other parts of the world?

While testing for pathogens on fresh vegetables and fruits is sometimes conducted in other parts of the world, little if any of this work has been done in Jordan. Responsibility for such research is within the mandate of the National Center for Agricultural Research and Technology Transfer (NCARTT) of MOA, which is envisaged as the responsible organization. However, other organizations **such** as the Department of Food Science at the University of Jordan, foreign universities, and international organizations such as FAO need to be consulted in designing and carrying out this research.

Special consideration should be given to the laboratory used for running the actual tests. If possible, an independent laboratory is to be preferred, and it should be encouraged to obtain international certification. Such a laboratory would then be available for use by producers, exporters and importers of fresh produce, as needed. Given current concerns for food safety in international trade, the need for such a laboratory is likely to grow in the future.

Consider establishment of routine microbiological testing. Depending on the results of the applied research described above, it may be advisable for Jordan to establish some type of routine microbiological testing. If so, the research results could be used to design a practical, cost-effective system. This would take into account the prevalence of problems, the type of product likely to be contaminated, and the likely origins of contamination.

In designing this new program, provisions should be made for tracing the product back to the producer. The existing pesticide residue-testing program conducted by AMO is based on sampling in central markets, which sometimes makes trace-back difficult. The design of the new program should also take laboratory capabilities into account. While it appears that some private and government laboratories in Jordan are equipped to run the biological tests likely to be required for such a program, it is possible that they will require some additional pieces of equipment. Undoubtedly they will either require additional personnel or special training for existing personnel. Preference should be given to one or more private laboratories because this is likely to be less costly. The laboratories that run the tests should be required to participate in accreditation programs which require that they attain international standards of accuracy in conducting their tests.

The pathogen-testing program should be administered by AMO as a regular part of its food safety program for fresh fruits and vegetables. Similar to its practice in the pesticide residue program, AMO would take the samples and submit them to a designated laboratory for analysis. AMO would then be responsible for following up on the findings – for example, by notifying producers and/or marketers when problems are detected, and making recommendations on remedial actions. AMO will require additional budget for

the program, to cover the costs of the sampling and the laboratory work, and it will need training for its personnel to ensure that they understand the program and that they know how to follow the scientifically sound sampling procedures.

The existing pesticide residue program is not well documented since there is no periodic report of the findings. Although results are maintained in a file drawer at AMO, it difficult for interested producers, marketers or buyers to learn about them. To provide better information on food safety and promote the marketing of Jordan's fresh fruits and vegetables, it is recommended that the AMO regularly publish the results of the existing pesticide residue program and the proposed microbiological testing. It is further recommended and that copies of the reports be placed in the MOA library and be made available to anybody who requests them.

The same tests used in the AMO microbiological testing program should be made available to the private sector companies and organizations for a fee that covers costs. This will enable producers, marketers and accreditation groups to run tests for their own quality assurance activities.

Good agricultural practices to include safe irrigation. Jordan has a system for developing Good Agricultural Practices (GAPs) as a part of the ongoing research and technology development program of NCARTT. It is important, however, that safe irrigation practices be explicitly incorporated in the GAPs. For example, this might include development of a list of crops that should only be grown under drip irrigation with plastic mulch, or possibly a list of safety periods that should be observed between the time of the final irrigation and the harvest date. Safe practices should incorporate the findings of the applied research recommended above.

The need to disseminate GAPs to farmers and to demonstrate their use is obvious. Although Jordan's Agricultural Extension Service (AES) does have personnel assigned to the Jordan Valley, they lack sufficient vehicles and other means to be effective in disseminating available information and recommendations. Agricultural Extension must be strengthened if it is to be expected to carry the message of safe water use to farmers.

As an alternative, or in addition to strengthening AES, the mandate of the Irrigation Advisiory Service (IAS) of the JVA could be expanded to include safe irrigation practices that take water quality into account. Currently the IAS is limited in size (five professional staff) and its activities are focused on water scheduling. If the IAS mandate were expanded, its new agenda would presumably include management of both chemical and biological factors. This would require additional technical expertise and equipment.

Grower certification and/or accredited marketing organizations. Throughout the world there is a growing demand for quality assurance and improved food safety. This demand has been fueled both by rapidly increasing size of buying organizations, particularly large chain stores in the high income countries, and by recent food safety problems. Although standards of international regulatory bodies are being raised, the main driving

force in establishing procedures to increase food safety is the large private sector buyer organizations. The clearest example of this is the Euro-Retailer Produce Working Group (EUREP), an organization of major European retailers. This group is in the process of developing a set of GAPs and related procedures known as EUREPGAP that will soon be required of domestic and foreign producers and marketers in order to be *accredited* to sell to members of the Group.

Rather than focusing on *quality control* (i.e. the testing of end-product to be sure that it is safe) EUREPGAP and most other new quality assurance and food safety programs focus on *process control*, meaning that they seek to ensure that the production and marketing environment is safe. In addition to requiring that growers follow GAPs , product is *randomly tested*, either upon receipt by the buyer, or at other points in the marketing system, to be sure that any pesticide residues or pathogens are within acceptable limits. Records are kept so that any product found to be contaminated can be traced back to its origin, so that the problem may be corrected.

It must be recognized that there is currently not a great demand for improved product quality or safety in Jordan. Sales of certified growers in the IPM program have reached only three tons per day after four years. Most of the country's fruit and vegetable exports go to Arabian Gulf countries where they are destined for consumption by foreign workers and where buyers do not appear to be concerned by food safety issues. Nevertheless, if Jordan wishes to increase its exports to high-value markets such as Europe and upper-echelon retailers in the Gulf, it will need to have more producers and marketers that qualify for EUREPGAP or similar accreditation.

While some quality assurance and accreditation systems have been established in Jordan during the past decade, they are still limited. One or two large growing and packing companies are regularly inspected and have been accredited by European buyers. One of these companies requires that its outside (satellite) growers follow specific GAPs specified by the buyers, and the buyers also inspect these growers. The Integrated Pest Management (IPM) program in NCARTT has developed a group of certified Jordanian producers who follow recommended management practices, including limited safe use of pesticides. The products of the certified growers are tested at unscheduled intervals to ensure that residues do not exceed acceptable limits. However, the IPM project has not incorporated safe irrigation practices in its GAPs, nor does it test for pathogens.

The activities already started in Jordan provide a worthy two-pronged approach that can and should be expanded as the nucleus for quality assurance and food safety in fresh fruits and vegetables. One part of the approach would be to encourage additional producer-exporters to become accredited and meet standards established by foreign buyers. This approach is likely to work for the larger packers and growers, and it could be facilitated by AMO in cooperation with the Jordan Exporters and Producers Association for Fruits and Vegetables. The second part of the approach would be to build upon or emulate the certified IPM program of NCARTT. Safe irrigation

practices would be added to the integrated pest management practices already in use, and certification of growers would be based upon adherence to both types of practices as well as upon unscheduled testing for pathogens as well as pesticide residues.

It is recommended that the Government place first priority on developing a system that will permit exporters to regain entry to the lucrative Saudi market. The essence of the Saudi complaint is that Jordanian production is based on the use of treated wastewater. However, this study has shown that when the Saudis did import from Jordan, most of the product came from the uplands, where irrigation is from wells. Furthermore, there are other areas, particularly in the Northern Directorate of the Jordan Valley, in the South Ghor, and in Wadi Araba, where no reclaimed water is used. It should easy to develop a program that certifies that certain product originates in one of these areas. The program could be open to inspection by Saudi officials. If the Saudis refuse to accept such a system, this could be a basis for complaint under rules of the WTO.

Over the past few years Jordan has held discussions with the World Bank to obtain support for an Export Promotion Project in which MOA would take the lead. One of the objectives of this program would be to help establish modern quality standards including a National Scheme for Quality Assurance and an Accredited Export Farmer Scheme. If this project is implemented, it would be a logical way to implement the plan described above.

Components of Plan to Improve Marketing		
Objective	**Responsible Organizations**	**Remarks**
Clarify Regulatory Responsibility for Food Safety.	AMO MOA	May need to be clarified in proposed Food Safety Law
Improve Information Management and Availability.	JVA Laboratories	Consult data users and decision makers – Meaningful analysis, timely results
Initiate Applied Research.	NCARTT Univ. of Jordan JVA MOA	Test for pathogens on crops grown in JV.
Consider Regular Microbiological Testing	AMO & Outside Lab.	Regular testing only if applied research indicates need.
Revise Good Agricultural Practices.	NCARTT JVA-IAS MOA-Extension -AMO	Jordan's GAPs need to include safe irrigation practices.
Promote Accreditation and Certification In Produce Marketing.	NCARTT-IPM Project Food Exporter Ass'n MOA-Export Project AMO	Give first priority to certifying product for Saudi market

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APPENDIX A. List of Meetings / Contacts for Marketing Study

Wednesday, 6/6 Dr. Mahmoud Hayari, Director General, AMO
Eng. Mohammed Awamleh, Marketing Extension, AMO

Thursday, 6/7 Mr. Suhail Wahsheh, MWI Coord, Spec. Studies & Projects

Sunday, 10/6 Dr. Ahmad A.H. Al Barmawi, Food Safety Officer, MOH
Dr. Fuad Da'ss, Jordan Rep., Codex Food Hygiene Comm.
Dr. Abdel Nabi Fardous, Director General, NCARTT

Monday, 11/6 Dead Sea, Workshop / Stakeholders Meeting (Discussions with several Jordan Valley &Highland farmers)

Wednesday, 13/6 Mr. Kheireddin Shukri, Manager, Modern Valley Farms,
Eng. Majed J. Jawar, Progressive Ag. Investment Co.
Chairman, Fruit & Vegetable Exporters Ass'n

Thursday, 14/6 Dr. Volkmar Hasse, GTZ, Manager NCARTT IPM Project
Secretary General, Fruit & Vegetable Exporters Ass'n
Mr. Abdel Rahman Ghaith, Grower & Exporter.

Sunday, 17/6 Eng. Hussein al Ibini, Director, Environ. & Laboratories
Mr. M. Cash, Food Service Mgr, Marriott Hotel, Amman

Monday, 18/6 Eng. Naief Seder, Director, Irrigation Advisory Service

Wednesday, 20/6 Mr. F. Dury, Exec. Chef, SAS Radisson Hotel, Amman