Sustainable Horticultural Crop Production in Israel

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Introduction.

The country of Israel is a very dry and arid region. I chose this country to study because I wanted to learn more about its sustainability and greenhouse production. This is a region that is very different from Minnesota's environment and to learn the difference in practices from one environment to another would be very intriguing. I have gained a lot of insight on how they have overcome many of their harsh environmental conditions including, lack of water, salty soils and excessive heat. Implementation of new technologies to make production successful in areas throughout Israel is a great achievement.

Description

Israel borders the Mediterranean Sea and is between Egypt and Lebanon in the Middle East. The total area of the country is 22,077,000 ha. This gives the country 2033000 ha of land and 44000 ha of area covered in bodies of water. Jerusalem is the capital of Israel and the official language there is Hebrew and Arabic. The total population is approximately 7,172,000 people (Export Enterprises).

Israel has incredible rainfall statistics. The north may receive a heavier rainfall of 700 millimeters each year while the central region may only receive between 400 and 600 millimeters. In contrast to those statistics the south may only receive a small amount of rain, 25 millimeters each year. Overcoming this regional lack of water is one management issue that Israel takes seriously, as discussed below (Jewish Virtual Library).

History

In early Israel, olives were important products that were being grown and produced. This began in the 4th millennium BCE. Individual villages began to base their economy on agriculture around the Mediterranean regions. At the beginning of the third millennium BCE horticulture was first able to grow and develop because metal axes were made strong enough to break down forest regions. This allowed for the production of olive groves and other types of food productions (Eitam).

In the 19th century the Israeli's wanted to transform the land from its barren state into one for development of agricultural uses. Agriculture research began during 1870 and an agriculture station was set up in Tel Aviv in 1921. This became today's Agricultural Research Organization, http://www.agri.gov.il/en/home/default.aspx, which is now a major institute of research and development. Israel has pioneered many agricultural related practices including trickle-drip irrigation, soil solarization and the sustained use of industrial waste water for agricultural practices. Drip irrigation allows Israel to have one of the most efficient water systems in the world. This was seriously needed, since Israel uses up virtually every drop of available water each year (Jewish Virtual Library).

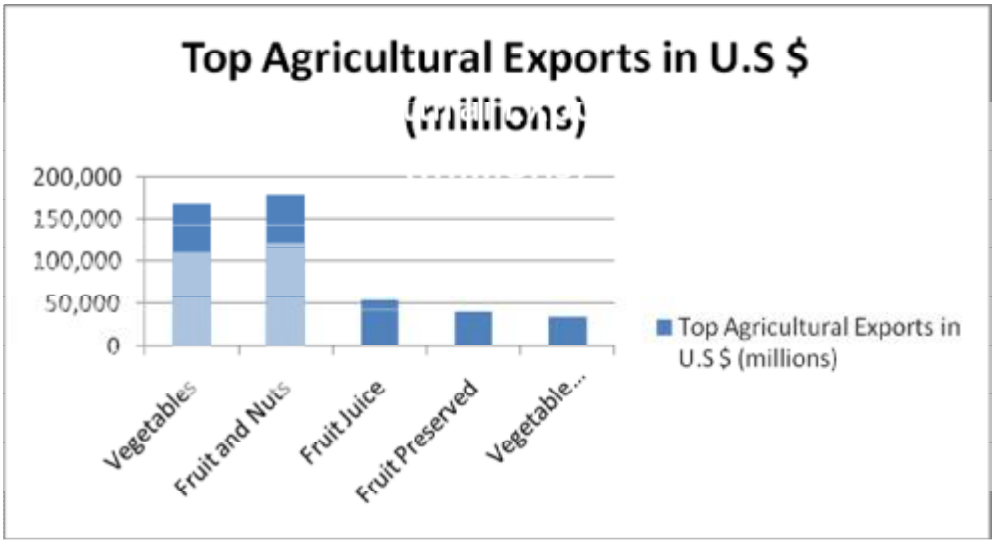
Sustainability Plan

The Israeli government wants to make the base of their government one of sustainable practices that includes a dynamic economy, natural resources used in smart conservative ways, protection for ecosystems throughout the country and giving equal opportunity to all current and future generations. They have made plans to implement sustainable practices with the Plan of Implementation that is active from 2003 until 2020. Each ministry throughout the country will

set up a Strategic Plan for Sustainable Development which will include their plan of implementation, funding, goals and the time needed to complete these goals. This plan will be updated and revised every three years as necessary. Since the word sustainability has many different meanings and definitions the government of Israel stresses to follow through with sustainable development and follow a set of guidelines that defines sustainability. The editor of the Jerusalem Institute publication, Prof. Eran Feitelson, states that "Indicators are signposts that can point the way to sustainable development. Although there is no agreed and exact definition of sustainable development, indicators may show the direction toward which we are moving and even pave the way toward sustainable development" (UN, Israel). The Israeli government has goals to become as sustainable as economics in Israel can handle. (UN, Israel)

Production Statistics

Gross Domestic Product (GDP) in billions was calculated to be around 254.699 in 2008. For Israel the biggest customers of its exports are the United States, Belgium, Hong Kong, United Kingdom, and Germany (Export Enterprises). Some of Israel's top horticultural exports include vegetables, fruits and nuts, fruit juices, fruit preserves and vegetables preserved or prepared (ITC). These horticultural exports are shown in relation to each other in Graph 1.1.



Graph 1.1. Top agricultural exports in Israel (Source: ITC).

Since Israel is such an arid country it is vital that farmers find certain crops that will produce a profitable yield with little irrigation water needed. 220,000 hectares in Israel of crops are produced in the field; 160,000 hectares have winter crops that include wheat, hay legumes and safflower. The rest is used for summer crops such as cotton, sunflowers, chickpeas, beans, corn, groundnuts, and watermelon. The summer crops are irrigated while the winter crops are only watered when it rains. Seventeen percent of Israel's agriculture production is that of vegetables. Large quantities of vegetables are exported. Israel uses the warm temperature to grow high quality vegetables during their competitor's off season. Some tomatoes and melons can now be grown with saline irrigation and have been called "Desert Sweet" as a brand name (Fedler, 2002). Fruit production produced US $280 million in 1997's agricultural exports and two thirds were citrus fruit. These fruit exports include: avocados, kiwis, litchi, guavas, mangoes, sweet bananas, dates, apples, pears, cherries, grapes (some grown with saline too).The oldest citrus exports include: oranges, pink and white grapefruit, lemons, pomelos and tangerines. Some of these citrus exports do include concentrates and juice products (Fedler, 2002).

Since 1994 the vegetable production in Israel exploded, especially for exportation. Production is fairly simple there with very little automation. There has been little updating since drip irrigation has been installed in the majority of greenhouses for vegetable production. Water restriction is a national issue and has been a restricting factor of horticultural crops. Since Israel has been occupying Golan Heights, they make sure nearly the entire country has water resources at its disposal. The people throughout the country have become accustomed to using more water and since there is an increase in civilian use there is less water available for horticultural use. There is little that horticulturalists can do to save water since they currently rely on drip irrigation systems (Boonekamp, 2005).

Forty years ago floriculture was new to Israel. It boomed quickly and in 1999 there were 250 million US dollars worth of floriculture related products grown in Israel. This left Israel ranked second to Holland (Halevy, 1999). In the year 2004, flowers and garden plants were 8% of an 18 billion dollar total output (Jewish Virtual Library). Currently in Israel they are using similar engineering techniques to the human genome project to enhance floriculture products shape, color and smell. A molecular biologist, who is working with the scent compounds of flowers stated, “This means that the petunia now produces scent compounds found normally in roses. It’s not that the petunias now smell of roses, but they do give off a much stronger scent then before. They smell differently. It creates a new pallet” (Blackburn, 2007). This is just the beginning of the research that can be done in the floriculture industry in Israel.

Historical Practices

At this date I have not been able to access significant historical data before drip irrigation became present in Israel. This seems to be an important event in the country’s history because of its arid conditions and the difficulty the climate poses on horticultural production. A man by the

name of Simcha Blass was a great engineering entrepreneur in Israel and dug into the great study of hydrology. With his crop experiments he kept encountering the same problems, lack of water. This inspired him to become more active in researching the field of hydrology (Levia, 2005). The plastics revolution greatly influenced Blass and his idea of low-pressure drip irrigation in the 1950s. These irrigation systems are very efficient because they apply the water directly to the soil and decrease evaporation loss. These can be used in greenhouses or out in a field. If used outdoors they are most commonly buried near the roots so that the water can be taken up directly and at a rapid pace. These drip systems can also use saline water unlike other watering systems. These differ because the salt is continuously being washed away from the root area and the plant is not affected by this excess amount of salt. This is very good for countries with climates that are located in hot arid regions near large bodies of saline water such as Israel. Blass signed a contract for his design with a company that has now become Netafim (Israel export & International cooperation Institute, 2006).

Netafim currently sells these low pressure drip irrigation systems that Blass invented. Netafim is a worldwide irrigation company that finds smart water solutions to obtain a sustainable future in greenhouse production. The company is a supplier worldwide for greenhouses and new technologies (Israel export & International cooperation Institute, 2006). They provide many technologies for irrigation that include sensors to track soil moisture content for the plants by use of tensiometer, capacitance sensors, lysimeters and meteorological stations (Netafim, 2002). They also provide methods for recycling water and methods to help greenhouses do so in a proper and clean manner. Netafim also provides many other services and aid in greenhouse heating and cooling, and provides the greenhouse structures themselves for consumers throughout the world to purchase. There are greenhouse structures that are offered

ranging from simple high tunnel structures to complex greenhouse structures with automation and implements new technology (Netafim, 2002).

As for agricultural settlements there are the Kibbutz, Moshav, and Moshav Shitufi. The Kibbutz have land that is leased through the Jewish National Fund and given assignments, services, social activities. They have recently begun to expand their services to include food processing and producing building materials. The group referred to as the Moshavin, a workers' smallholder cooperative that mainly control the marketing of produce, are people who individually farm each plot of land separately. The last group of people are the Moshav Shitufi and this group consists of 47 villages that are similar to the Kibbutz but have privately owned properties that are very similar to the Moshav Shitufi. They are more like rural communities and over the years have become urban communities (Encyclopedia of the Nations).

Sustainability

In Israel a new energy efficient greenhouse was designed called the Trio system. This system consists of a separation from the upper and lower chambers of the greenhouse by a thermal screen. There is a heat pump that captures heat energy that heats the upper chamber and a condenser that releases the energy to the area beneath the thermal screen. This process repeats this cycle to recycle the heat energy (Trio Ltd, 2006). This is extremely efficient because heat is lost through the roof of the greenhouse, but instead of burning fuel for heat it has a transfer of energy from one area to another. Water vapor is also removed by this system to regulate the humidity levels inside the greenhouse. When keeping the temperature consistent and the humidity levels low it is easier to control disease, pests, and produce a climate where plants can transpire at an efficient level. (Trio Ltd. 2006)

This system can maintain heat down to a temperature of 5 degrees C. It can then create a 6-9 degree increase in relation to outside temperature without any external source of heat. In some cooler climates a secondary source of heat is also applied and used with the Trio system. This is very effective because it decreases the input of the external source of heat energy making this a sustainable alternative to fossil fuels (Trio Ltd. 2006).

Trio Energy Systems Ltd. was founded in 2006 and by the next year they had deployed their system to current production greenhouses and today are marketing their product worldwide (Trio Ltd, 2006).

Popular crops grown in Israel

Fruit and vegetable producers seem to be the most abundant and successful. They are able to increase their acreage and variety of products grown each year. A good example of this is Mehadrin Tnuport Export (MTex), a large fruit and vegetable producer that increases their acreage by 500 and 700 ha each year (Berkel, 2008). Their largest crop is citrus fruit but they keep expanding their produce base which now includes oranges, mandarins, lemons, grapefruits, pomelos, sweeties, kumquats, avocados, mangoes, sharon fruit, litchis, grapes, pomegranates, dates, carrots, potatoes and sweet potatoes (Berkel, 2008).

Because of the quality and ideal climate and soil conditions in Israel, citrus is the product most abundantly produced throughout the country. In 2001 alone the citrus that was exported successfully brought in 123 million dollars. In 1999, the citrus produce came to 869,000 tons and 39% of this was grapefruit (Encyclopedia of the Nations). The grapefruit will be grown throughout the country with specific varieties grown in areas where they are most suited. If the soil content and water used in grapefruit production has a high salt content it will retard the water

uptake through the root system and will reduce the amount of fruit each tree can produce (Morton, 1987).

As mentioned previously, the floriculture industry is also booming in Israel. It is possible for Israel to export 250 million dollars worth of floriculture products to the United States. The industry of new and different crops is growing throughout Israel but this still cannot compete with the old favorites of roses and carnations which are the major floriculture crops (Halevy, 1999). This is also very interesting since 100 percent of roses are grown hydroponically in Israel (Pizano, 2009). In a nation with a large shortage of water it is interesting to see a large greenhouse production growing hydroponic roses.

If you were to rank the current production practices for this arid environment the lowest and the least efficient would be open field production with lack of drip irrigation. Because of the constant struggle with the amount of water that is available and the need to conserve water this is not an efficient means of production. A drip irrigation system, as mentioned previously, would be much more environmentally friendly. Although it is not made out of an environmentally friendly material, the water struggle in Israel is a much more important environmental issue at the present time. Currently high tunnels and low tunnels are being used to produce higher production rates of crops with better growing conditions but a more permanent structure would be more sustainable. A greenhouse containing a trio system would aid in sustainable production. The most important addition to the current state would be a water holding structure and to reuse water. The areas of the country that do attain a sufficient amount of rainfall could be taught to save and reuse water. The more arid regions and water from the Mediterranean Sea could be allocated to those regions that have limited amounts of rain water.

Sustainable Development Strategy

The most helpful sustainable practices would be to research the area of saving water. Some of these practices may include new sustainable production like: Rain cloud seeding, water basin storage, desalination and the reuse of water. Water seeding is done by dispersing silver iodide into the clouds to increase the amount of precipitation falling on the region below. This is not a new technique; rather it has been practiced for the last 40 years. Over the years they have placed aquifers below these areas to save water. If there was a greenhouse basin positioned below these areas these basins could be used for rain harvesting. This would conserve water and if enough water was saved it could aid in the heating and cooling of the greenhouse from below ground level.

Since freshwater is lacking, another option would be to take water from the Mediterranean Sea and use it. There are some crops that are salt tolerant and increasing these varieties of crops could be an option, although there is still a demand for other non-salt tolerant plants. One option would be to use desalination which is the removal of salt from the water through reverse osmosis.

Another water saving alternative would be reusing much of the freshwater that is used in greenhouse production. Using drip irrigation instead of overhead sprinklers and large overhead field irrigation is the best option for overall water savings. Although these systems are most commonly made of plastic that is not considered sustainable but for the conditions that Israel is in and the need for water, it would be considered much more sustainable then wasting water.

Reusing water that is used throughout Israel as irrigation could be a sustainable method put in place of using freshwater from the river. Reuse of water can be done by many different purification methods. Ozone is one of these purification methods that can disinfect and destroy bacteria and viruses when exposed to UV radiation for one hour. UV radiation can be used to kill

bacteria, fungi and viruses in water and is also commonly used on surfaces. Heat is one of the more common ways to eliminate pathogens by reaching a temperature of 95 degrees. This would be the least sustainable because it uses large amounts of heat energy, most commonly gas. The most common form of water reuse in growing is slow sand filtration. This filtration technique removes suspended solids from the water but it is not as active in removing small pathogens from the water (Lenntech, 1998).

Reusing water does have its downsides. Because of nutrient build up it can cause excess micro organisms to be present in the reused water. It has also been known to kill off natural biocides in the surrounding environment so it is useful to have a biological control program set up for future use. (EPA, 2004)

More research is needed in each of these areas and many questions need to be answered such as: What long term effects does desalination have on certain crops? To what extent can you reuse water? Will rain harvesting or rain cloud seeding ever be cost effect in such an arid region? Do any of these alterations aid in water conservation as much as drip irrigation?

Future sustainable controlled-environment production facility

Testing a sustainable hydroponic rose production facility could be done with the right resources and time. Although rain cloud seeding has a small increase in the percentage of rain, it was still an increase over the normal rainfall. Choosing a location in the northern part of Israel, where this increase was present, would be preferred. When building the greenhouse placing a basin underneath the structure for rain harvesting would be ideal. Even though there is very little precipitation, the precipitation that is present during the cooler months would be wise to save.

Using a hydroponic system would be efficient because the water is contained and can therefore be saved easily and then reused. Using the different techniques of reusing water that

were discussed above, you could save water and cut down on water use that could be used as drinking water for the people in the area.

In a separate area of this test greenhouse there could be a set of test plants that could be used to test desalination and its effects on the roses in a hydroponic setting.

Because rose production is a more complex growing procedure and is usually done in glass greenhouses, the Trio system, that was mentioned previously, could be used to regulate the environment in a sustainable manner. The Trio system would be a greater initial investment but would not only cut down on the use of fossil fuels but would also cut down on costs over a longer period of time.

If problems occurred within these systems there could be back up systems for emergencies. Although it is a test site it would not be profitable to lose the crop that is being grown, so locating a facility in an area with water access would be advised. It may be considered necessary to apply additional heating and cooling systems but, the Trio system is a tested production facility that should not require alterations.

Throughout history and in the present day, Israel has been very successful in the horticulture industry and has new and innovative technology that is moving itself ahead in the industry for the future. Israel has many different types of horticulture productions present in the country and becoming sustainable would only be an increased benefit for the state of the country. Sustainability is the goal for the future of the industry and should be considered in each situation in the present time.

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