Sustainable Horticultural Crop Production in Iran

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Outline.

I. Introduction.

As a College of Liberal Arts freshman at the University of Minnesota Twin Cities, I was required to choose a language to study for the next two or more years. I decided on a whim that I would dedicate my next two years and twenty credits to the Persian language, the most frequently used language in Iran. Now, four semesters later, I have the opportunity to take my learned language and the knowledge of Iran that I've collected thus far and integrate it into my Greenhouse Management course. I chose Iran as my country of study because I am hoping that this project will create for me a well-rounded, interconnected view of horticulture, Iran, and the Persian language.

Iran is located in the Middle/Near East, and is part of what has been termed "The Fertile Crescent," an area of land situated between the Tigris and Euphrates Rivers that has produced many ancient civilizations and successful farmland (Dowling, 2009). Iran is bordered by Turkmenistan, Azerbaijan, Pakistan, Iraq, Turkey, Armenia, Afghanistan, the Caspian Sea, Oman Sea, and the Persian Gulf. The highest point in Iran is Mount Damavand, with a peak at the height of 5671 kilometers (Moqaddam 2007). It is also located between 25 and 40 north latitude and 44 and 63 east longitude and has a population of 65 to 70 million people (CIA 2009).

Iran contains 12 different types of climate, and while much of its land area is dry and cannot be cultivated, each climate and its corresponding region contribute to a country that is able to grow many varieties of crops (Table 1). Iran is also divided into many regions and provinces, as shown in Figure 1. The Caspian region is known for producing citrus (*Rutaceae*), olive (*Olea europaceae*), and tea (*Camellia sinensis*). The Persian Gulf and some other provinces produce dates (*Phoenix dactylifera*) and bananas (*Musaceae)*, the Central Plateau produces apples (*Malus domestica*) pears (*Rosaceae*), peaches (*Prunus persica*), grapes (*Vitis*), and cherries (*Cerasus*). Southern Iran is known for its dates (*Phoenix dactylifera*) and citrus (*Rutaceae*), South-Eastern Iran for pistachio (*Pistacia vera L.*), western Iran for its almond production (*Prunus dulcis)*, and the Caspian and Southern regions are both known for producing greenhouse-grown crops; such as vegetables and ornamentals (Talaei, 2006). Spinach, which is derived from the Persian word "esfenaj," was first cultivated in Iran (Wikes 2009), along with the Tulip (*Tulipa)*, which is a national emblem of Iran and around 170 varieties are grown in Iran (Hesamian 2005). Wheat and barley are extensively cultivated in Iran, and cover nearly one fifth of the total irrigated land area (Siadat 1999). It is estimated that there are roughly 51 million hectares of cultivatable land in Iran, or approximately 31% of the total land area (AREEO 2009), and that in the year 2005, 3,000 cut flower producers existed in Iran (Iran Daily 2005).

Table 1. Commodities produced and regions within Iran devoted to horticultural crop production (Talaei, 2009)

Production Region	**Commodity**	**Scientific Name**
Caspian Region	Citrus, Olive, Tea, Ornamentals, Vegetables	*Rutaceae family, Olea europaceae, and Camellia sinensis*
Persian Gulf/Other	Dates, Bananas	*Phoenix dactylifera, Musaceae*
Central Plateau	Apples, Pears, Peaches, Grapes, Cherries	*Malus domestica, Maloideae, Prunus Persica, Vitis, Cerasus*

Production Region	Commodity	Scientific Name
Southern Iran	Dates, Citrus, Ornamentals, Vegetables	*Phoenix dactylifera, Rutaceae*
South-Eastern Iran	Pistachio	*Pistacia vera L.*
Western Iran	Almond	*Prunis dulcis*
Span of Iran	Cut Flowers	n/a

Figure 1. Map Of Iranian Provinces and Regions (Iran Politics Club, 2000)

II. **Definition of Sustainability.**

Iran is an interesting case when it comes to the idea of sustainability, mainly because of the socioeconomic factors that limit the implementation of nationwide sustainable practices.

While the farmers in Iran are aware of the potential negative effects of chemicals in horticultural and agricultural cultivation and are very interested in developing ways to produce crops organically (Talaei 2006), there is also a good deal of economic hardship and historical production practices that are holding some farmers back, as Iran has a long history of settlement and traditions where socioeconomic factors hold more importance than ecological concepts (Niazi 2002). An eloquent statement on the view of sustainability by the majority of Iranians is quoted from Abbas Farshad and Joseph A. Zink's (2001) ***Assessing Agricultural Sustainability*** *using the Six Pillar Model: Iran as a Case Study*: "A sustainable agricultural system is a system that is politically and socially acceptable, economically viable, agro-technically adaptable, institutionally manageable, and environmentally sound." This shows that, to most Iranian horticultural and agricultural producers, the road to sustainability not as simple as buying organic fertilizer and recycling plastic pots. There needs to be an integration of sustainable practices that keep in mind the state of advancement, technology, and fiscal issues that are prevalent in Iran today.

III. Historical Production Practices.

Iran has historically been producing agricultural and horticultural crops in open fields aided by irrigation. Flood and furrow irrigation is one of the oldest methods of irrigating fields, where farmers send a flow of water between rows of crops (USGS 2009). Flood and furrow irrigation systems have been mostly replaced by drip irrigation because of water shortages inland of the Persian gulf and Caspian Sea (Ebrahimi 2000). The fact that flood and furrow has been replaced by drip irrigation shows that, though historical, it is not a sustainable practice because it creates water shortages and alters the salinity of the soil. (Siadat 1999). An ancient subterranean aqueduct system known as a qanat—or karez—was invented in Iran about 2,500 years ago. This system utilizes underground water supplies from mountainous regions and channels the water downhill for irrigation use (Encyclopedia Britannica 2009). This aqueduct system has been successful in Iran, as the country contains two very large mountain ranges. Many areas of Iran have historically used rainfall as a source of irrigation (Siadat 1999).

One way that farmers in the past utilized the mountainsides was by terracing, or cutting into and leveling out areas on a hillside for cultivation. This technique was quite successful, though the methods of cultivation on said terraces and other cropland was mostly done by hand or with the help of farm animals. In pre-modern Iran, or prior to the year 1960, producers and farmers generally did not have the material means to harm the environment greatly. The fact that the population was lower and most peasants knew not of fertilizers and chemicals, this period of time could be deemed sustainable (Reaei-Moghaddam et. al. 2005).

In the past, citrus cultivation was all done by hand. The trees were usually planted close together and had more trees per grove than modern-day Iran (Ebrahimi, 2000). Olive cultivation is a practice that began some 6,000 years ago in Iran, and the crop is said to be inefficiently harvested—the fruit is beaten off of the tree with sticks, bruising the fruit and injuring the tree (Encyclopaedia Iranica 2009). The cultivation of tea was started about 3,000 years ago in Iran. It was brought to the Giran region found south of the Caspian Sea, and in 1934 became popular, and the first modern tea factory was build in Iran (Kodomari 2009). Pistachio trees are a historic and beloved crop in Iran, where they originated by the Kerman province in southeastern Iran (Pistachio 2009).

IV. Current Production Statistics.

The prevalence of petroleum and petroleum products in Iran's production practices today make the horticultural and agricultural production seem miniscule. While 80% of the revenue from Iran's exports is from petroleum, the remaining 20% is shared with the fruits, nuts, and other horticultural crops by commodities such as chemicals and carpets (Table 2). Though the export and production of agricultural and horticultural crops is relatively small (Table 3), the work force behind it is quite large, with 25% of Iran's workforce laboring in agriculture (CIA 2009). The export of flowers and ornamental plants was around $15 million US dollars in 1999 (Highbeam 2009), with the monetary exchange rate being approximately 9142.8 rials (Iranian currency) to every U.S. dollar (CIA 2009). In contrast to the small export of flowers and ornamentals, Iran produced 197,000 tons (197,000,000 Kg) worth of pistachio exports and 170 tons (170,000 Kg) of saffron in 2008 (Payvand 2008), making these two of the most important horticultural crops grown in Iran.

Table 2. Exports of Iran (CIA 2009)

Product	Percentage
Petroleum	80%
Other (chemicals, fruits, nuts, carpets, etc.)	20%

Table 3. Gross Domestic Product of Iran (CIA 2009)

Product	Percentage
Agriculture	10.80%
Industry	44.30%
Services	44.90%

V. Current Production Practices.

Between the years 1960 and 1980, Iran underwent vast changes in plant production and cultivation methods. During this time of reform, modern production systems overthrew historical, peasant-fueled methods of production—introducing machinery, chemicals, fertilizers, farming enterprises, and corporations. For example, in the years prior to the reform there were approximately 5,000 tractors in all of Iran, but by the end of the 1980s, at least 80,000 tractors were in operation throughout Iran (Reaei-Moghaddam et. al. 2005). Deforestation, erosion, and water shortages also became troublesome during that time period, and various exotic tree species were introduced into semi-arid areas of Iran to combat wood shortages and erosion (Webb 1974).

In more recent years, however, growers in Iran have been trying to incorporate historical and technological methods of production to try to save their land. Flood and furrow irrigation is still used in some parts of Iran, while the strictly rainfall irrigation method is preferred over other modern advancements in irrigation for the cultivation of some horticultural crops. Approximately 16.5% of the total orchards in Iran are rain fed, and almonds and pistachios are particularly well suited for this type of irrigation because of their high tolerance of water-related stress (Rahimi et. al 2009). Unfortunately, many pistachio growers in Iran are looking to deep-bore wells that are quite expensive and not very efficient. When coupled with flood and furrow irrigation—which is still used by many farmers in the Rafsanjan City area and increases soil salinity—the productivity of the pistachio plants is thwarted (Sedaghat 2008). Though older practices of irrigation are still used in Iran, the limited water resources and growing population have made people aware that efficient water application and usage is needed in order not only to become more sustainable, but to keep production shortages at bay (Keshavarz et. al. 2009). The most cost and water effective method in use right now is drip irrigation; whether it is in the fields, orchards, or greenhouses. In tomato cultivation experiments in recent years, it was found that drip irrigation in greenhouses saves, on average, 15 to 40 percent more water than outdoor drip irrigation (Emamzadei et. al. 2005).

Greenhouse growing is becoming more popular in Iran, with about 6,158 hectares of greenhouse growing space, mostly in southern and central regions. Vegetable crops are more popular to grow in greenhouses than horticultural crops, however, as they take up about 3,483 hectares of the total greenhouse space (Baniameri 2009).

Citrus cultivation in Iran incorporates both old methods and new methods. There are still three main, outdated citrus belts, where the trees are generally planted closer together than in the new groves and with more trees per grove. Only in the last two decades have citrus groves begun to be cultivated by machine instead of by hand, and since then chemicals and herbicides have been in use for weed control. Pruning and harvesting, however, are still done by hand. The spacing and lower number of the trees in the new citrus belts, which is approximately 4x8 meters apart and around 310 trees per hectare, appears not to relate to sustainability but more to pest and disease control (Ebrahimi, 2000).

Plant scientists of Iran have begun experimenting with growth regulators, such as NAA (naphthaleneacetic acid) and kinetin, on the saffron flower (*Crocus sativus*). These regulators have been found to increase the number of flower buds on the plants, an important discovery in increasing production of the popular culinary flavoring agent found in the saffron flower (Ebrahimzadeh et. al. 2004). The Association of Iranian Flower and Ornamental Plant Producers would like to see more genetic engineering by the country's plant cultivators, and is encouraging them to catch up to the rest of the world in production of genetically modified flowers. While genetic engineering has not yet fully caught on in Iran, it is likely that it will be a part of Iran's future. For the time being, however, Reza Mehrabani, of the Association of Iranian Flower and Ornamental Plant Producers, is proud that, "Iranian flower producers using the traditional greenhouses and methods were able to win three medals at the Osaka exhibition" (I.R. of Iran Embassy, 2007).

Table 4. Periods of Modernization in Iran and their Effect on the Environment

Information procured from Reaei-Moghaddam et. al.:

"*Conceptualizing Sustainable Agriculture: Iran as an Illustrative Case.*" 2005

and USGS Water Science for Schools website 2009

Period	Implementations	Effects	Sustainability
Pre-Modern: before 1960	qanat system, terracing, ploughing, reaping, threshing, winnowing by hand, flood and furrow irrigation	Generally low impact on the environment, though flood and furrow altered soil salinity and wasted water, and terracing contributed to soil erosion	relatively sustainable due to lack of chemicals and machinery
Period of Modernization: 1960s to 1980s	chemicals, machinery, corporations	These new technologies allowed growers to cultivate higher crop yields but contributed to pollution, chemical dependency, and a water crisis	not sustainable due to influx of technological and mechanical advancements and ensuing environmental problems
Period of Crisis in Development: 1980s to present	drip irrigation, experimentation, research	The effects of this period are similar to the previous period, though some slightly more sustainable methods, such as drip irrigation, are being implemented	somewhat sustainable due to efforts to become less dependent on chemicals etc, though not economically prepared to make drastic changes

VI. Integration of Historical and Current Production Practices: Ranked Strategies

As a result of the unforseen ecological damages that new technology brought to growers in Iran between the years 1960 and 1980, people have realized that there is a crisis in the agricultural and horticultural crop sector of Iran's industry and are trying to find new ways to reverse or stop the spread of damages to the environment and ultimately their crops (table 4).

This is not easy, however, because practices like pesticide application have a circular effect—farmers are having to use more pesticides than ever to fight pests and diseases that are becoming increasingly resistant to the chemicals used by the farmers (Reaei-Moghaddam et. al. 2005). In order to become more sustainable and ecologically responsible, Iranian crop producers must find a way to incorporate older, less technologically advanced but ultimately more environmentally sound techniques into their modern ways of crop production. Some have already accomplished the integration of new and old methods, such as the almond growers who have found that they can grow trees in areas where the only irrigation is rainwater, the people who use the qanat aqueduct system and drip irrigation, or those who have incorporated machinery for efficiency but still realize the importance of manual labor and care in the successful production of their crop, like the citrus growers. Unfortunately, few Iranian growers can afford to implement agents such as yellow sticky tape for pests and advanced nutrient management—most can only afford to keep using the pesticides and chemicals that they've been using since introduced in the 1960s (Baniameri 2009).

It is not easy for a civilization to introduce a technology, realize the detrimental effects that the technology has, and be able to return to old methods of production. This would require a complete shift in the way that the plants are produced, and this shift would be neither economical nor practical. The modern world is advancing much too quickly for Iran, a developing country, to turn back to old, slow methods of production—even if those methods were more sustainable. The change in production pace would be devastating on Iran's economy, no matter how much better off the environment would be (Reaei-Moghaddam et. al. 2005).

The best solution would be to find a way to produce crops in a more sustainable way while still keeping production rates high. While many Iranian horticultural farmers realize this, they have little monetary means or motivation to make a big change in their production practices. The best way to begin to make Iran's horticultural crop sector more sustainable would be to implement economically attainable, sustainable crop production practices on a select few economically important crops. As stated earlier in the paper, two of the most important horticultural crops produced in Iran are pistachios and saffron. Though the pistachio tree is somewhat drought tolerant, the economic and crop yield productivity of this crop still rely heavily on irrigation methods (Sedaghat 2008), while the economic sustainability of saffron relies heavily on international trading and marketing strategies (Ghorbani 2008). As this is a paper about horticultural crop production, I will focus on the strategies that can be implemented on crop productivity, though economic sustainability is just as important to a developing country such as Iran. Therefore, I will be focusing my ranked strategies on the pistachio. The strategies that I will develop toward sustainability for this crop have to do with field irrigation—as the majority, if not all, of the pistachio crop is grown outdoors in arid land. These strategies, which include eliminating wasteful use of groundwater supplies, rainwater collection, and watershed management, should be feasible for the general public of farmers in Iran, both economically and horticulturally. Some agricultural experts are skeptical of ideas promoting sustainability, considering them to be a means of halting the advancement of developing countries, while others simply view sustainability as an idealistic goal that Iranian growers cannot afford to reach (Reaei-Moghaddam et. al. 2005). Hopefully these ranked strategies will prove that sustainability is attainable, and that it will further, rather than halt, the advancement of a developing country such as Iran.

VII. Finalized Sustainable Development Strategy

Since water shortages are a very pressing matter in Iranian horticultural crop production, each ranked strategy developed in this paper will have to do with water conservation and protection (Table 5). Though there are other matters in Iran's horticultural sector relating to sustainability, such as overuse of pesticides and machines resulting in resistant pests, soil degradation, erosion and more, I think that introducing sustainability into this developing country should be done at a more manageable level. A direct focus on one important aspect of the irrigation situation would be more successful than introducing too many strategies at once.

The first strategy that I have developed to help Iran combat water shortages would be a plan to conserve the groundwater that is already existent. As mentioned earlier, many Iranian farmers still use flood and furrow irrigation, a method that alters the salinity of the soil and is not a very efficient use of water. Also mentioned was the qanat underground water system, which uses gravity to pull water from the top of aquifers located in mountainous regions to areas in need. This system is quite sustainable because gravity will not bore into the aquifers—it will only take what is available at the top of the underground reserve. And finally, I mentioned that drip irrigation has been found to be a more sustainable practice than flooding methods, and though it has been found that greenhouse drip irrigation is more effective than outdoor drip irrigation (Emamzadei et. al. 2005), indoor production of pistachio trees is not practical. Implementing laws and restrictions on the use of groundwater in Iran could help remedy the problem of wasteful water management by farmers (Sedaghat 2008). These laws should be placing restrictions on how deep the personal wells into groundwater systems could be bored and restrictions on the use of flood and furrow irrigation. They should reward those who begin to use the water supply more sustainably, like those who use qanat or drip irrigation, while setting higher costs to those who do not adhere to the new restrictions. Research and cost analysis would need to be done to figure out the logistics of the newly implemented rules, as well as research on what levels are safe to bore into aquifers so that the correct standards can be set. This strategy does have some setbacks, however, one being the involvement of law enforcement and the government to both set and enforce these restrictions and laws. This means that there would be additional efforts made by the government, and these efforts may not be appreciated by the farmers who would have this strategy implemented upon them. It could also, at least for the short term, cost both the farmers and the government more money: to set up new systems and adhere to new rules for the farmers, and to pass, implement, and retain the integrity of the laws passed by the government and law enforcement. I have deemed this strategy toward sustainability quite feasible.

The second strategy that I have developed is surface water collection. This is not a new idea, but implemented on a large scale and in an arid climate, it could be a very successful strategy toward water conservation. Farmers, citizens, and corporations around the country could partake in this idea. Rainwater and runoff from roofs, roads, and paved areas should be collected in anything from barrels to holding tanks to reservoirs, filtered, then transported to the horticultural areas in need of irrigation (NSF 2004). This solution is not without drawbacks. Finding rainwater and runoff collection implements for a low price could be difficult, and many farmers would find it a risk to spend extra money on a new supplemental irrigation system when they already have irrigation means. There is also a contaminant factor. Rainwater and runoff water that is collected needs to be properly treated before it is applied to the crop, especially if people want to be using it for drinking and household water as well, which is a possibility that needs to be accounted for. I rated the feasibility of this strategy as very feasible, because even if it is only implemented by some growers, it will still have a beneficial impact on their well and qanat water savings. Coupled with the conservation of groundwater strategy and drip irrigation methods, rainwater and runoff water collection, whether it is on a small scale or cooperatively implemented by hundreds or thousands of growers, is a feasible option in gearing Iran toward more sustainable water consumption in regards to horticultural crop production.

The third strategy that I have ranked is the application of watershed management programs. These would include goals, standards, and plans set by a governing group, whether it be the government or a cooperative of horticulturists, that pertain to the protection and advancement of watersheds in Iran. These watersheds would help add integrity to the soil; natural watersheds help prevent erosion, decrease contaminants found in runoff and airborne pollution, and can even create natural floods that could replenish the soil more sustainably than flood and furrow irrigation (US Environmental Protection Agency, 2008). Some drawbacks to implementing watershed management programs in a developing country such as Iran have to do with community participation and low rainfall levels that would make the watersheds less productive, at least in the short term (Sedaghat 2008). According to R. Sedaghat, "it is expected that farmers don't show any interest to participate in such projects individually against a possibility of groups participation," which is why cooperative efforts would have to be made in order for any watershed management program to be successful. Also, the aridity and low rainfall levels of the regions that the pistachio crop is grown in would make watershed rehabilitation a very long process that would be sustainable at some point, but not in the near future. These reasons are why I have deemed the watershed management program strategy only somewhat feasible.

Table 5. Ranked Strategies based on implementations, benefits, drawbacks, and feasibility for sustainable irrigation purposes in Iran, specifically pistachio production

Ranked Strategy	Implementations	Benefits	Drawbacks	Feasibility
Conservation of Groundwater	Laws/restrictions set on groundwater usage the use of qanat system instead of deep bore wells elimination of flood and furrow system replaced by drip irrigation	More responsible usage of groundwater as a result of laws/restrictions qanat usage is quite sustainable drip irrigation will reduce wasteful water usage	Law enforcement will be needed to see that the restrictions are adhered to laws take time to be processed new irrigation implementations (drip irrigation, qanat usage) can be costly to farmers who do not already have them	Quite feasible, though it could take years to pass and begin to implement laws
Collection of Surface Water	an impermeable area with no crops (Roofs, pavement, roadways) rainwater runoff control (Gutters, downspouts, piping) a filtering device for debris, a collection system (tanks, barrels, ponds) a means of distributing the water (trucks, hoses	An increase in usable rain-based irrigation water less need for farmers to overdraw from the water table less contaminants enter large waterway systems and lakes	surface water collection implements may be expensive contaminant removal needs to be thorough large-scale success of this strategy would only work if nearly all farmers cooperated	Very feasible, at least on a small scale. Cooperation between farmers could lead to a larger scale turnaround in water shortages for horticultural practices

Ranked Strategy	Implementations	Benefits	Drawbacks	Feasibility
Watershed Management Programs	Goals, standards, and programs set by a governing board to: reduce impermeable areas (pavement) outline environmental issues, and create and restore healthy watersheds	If both the farmers and the government participate, the programs implemented will be successful Decreased surface water and contaminant runoff Decreased erosion levels	Citizen/Farmer Participation Levels may be low There are many climates in Iran, therefore many types of watershed Governmental participation is needed research is expensive yet needed	Somewhat feasible; this strategy would take the most time, effort, and cooperation on the part of the government, communities, researchers, and horticulturists

VIII. Design for a Future, Sustainable Production Facility

Designing a sustainable production facility for Iran, a developing country, is not a clear-cut task. It would involve not only sustainable practice and product implementation, but careful consideration on the time and budget restraints of the Iranian horticultural farmers. I have chosen a horticultural crop that holds much importance both in Iran and as an export, the pistachio (*Pistacia vera L.*), but the strategies tested at this production facility must be feasible for the majority of growers in Iran, no matter what crop they're producing, to implement at some point. I have also chosen a few strategies that would help overcome the irrigation water crisis prevalent in Iran today. Based off of these choices, the future sustainable production facility experiment would be placed in the south-eastern part of the Kerman Province, the area of Iran where pistachio trees originated (Pistachio 2009). This province is located in the south-eastern region of Iran. Within this province, the facility would be located near the city of Baghein because of its close proximity to the Hashu-eieh qanat system (Boustani 2008). There would be no greenhouse structure for the facility because it would not be economically or environmentally sustainable to erect a greenhouse or high tunnels for the pistachio crop—there has been no research showing that pistachio trees would fare better in a controlled environment condition versus outdoors, as it has been cultivated for thousands of years. The production facility would, however, include different stations for different experiments. It would be at least 20 hectares to begin with, because at some point the facility should be used to make actual profits after the experimentation is over. The trees would be planted in rows 0.4 kilometers in length 19 meters apart, each tree planted 18 meters apart. This spacing would ensure that the trees will not begin to crowd until at least 15 years in the future, when pruning will be manageable and the trees will be mature enough to handle the pruning, and the length of the rows would make it easier for equipment to move through. The pistachio tree takes a long time to mature, so this experiment would not be done quickly. It would take five to six years for the trees to develop enough to produce the first crop (Kallsen et. al. 2008), so during those six years my research team would implement test strategies for qanat and drip irrigation systems, rainwater collection systems, and begin petitioning for watershed management programs and laws and restrictions on groundwater usage. The hectares would be split between four treatments—drip irrigation from the qanat system, collected surface and rainwater application, a combination of drip irrigation from the qanat system and collected surface and rainwater, and a control treatment that only includes rainfall.

In the five hectare section that would be solely irrigated with drip irrigation from the qanat system, the trees would be watered with a drip irrigation system using only a regulated amount of water from the qanat for a minimum of five years. This experiment would show how reliable the qanat system is for many years in a row. Throughout the facility there would be several types of holding tanks, ranging from simple used barrels to high-tech holding tanks to runoff ponds. These would be used to collect rainwater and surface water for use on the five hectares devoted to the rainwater and runoff collection treatment. This water would be filtered through a purification system and applied to the crops. This experiment would apply the collected water in coordination with regular rainfall to measure how much more impact the added rainwater could have on the crop's productivity. The area where the combination of the drip irrigation and rainwater and surface water collection irrigation would be allotted a portion of each experiment's means of irrigation, and would be used to see if both systems in place together would be more effective than one or the other. The final experimental station would use the remaining five hectares to apply no type of irrigation to—this station would be completely reliant on the water that is rained upon it as its sole source of irrigation. There would also be a cost analysis of each treatment and its corresponding equipment, energy, and labor consumption to determine how cost effective each system would be over the course of several years. When the trees start to produce, we would be able to compare the crop yield for each treatment and make an assessment of which sustainable irrigation system would be the most effective. After the tree fruits for its first year, the experiment would be conducted at least four more growing seasons to ensure a timeline of both tree growth (the five years prior to pistachio production) and crop yield (the five years during pistachio production).

The answers obtained from this project would be attained slowly. The project would take at least a decade to complete, but within a few years would produce theories as to which methods will be the best to implement in a generally arid region of the world such as Iran. This proposed production facility would allow Iranian pistachio farmers to explore the idea of sustainable irrigation practices before committing to them or being pressured into them, as it would be open to the horticultural public and would contain written records, translated into the persian language, of all information regarding to the experimentation with the sustainability strategies. They would be able to use our figures to devise their own cost and benefit analysis for their production facilities around the country. It would be possible for the Iranian pistachio farmers to conclude that, even though they are producing a demanding crop in a developing country, some level of sustainability is achievable. By selecting just one aspect of sustainability to focus on at a time—in this case irrigation and water usage reforms—the feasibility of a more sustainable pistachio industry in Iran could be within reach.

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