academicJournals

Vol. 7(3), pp. 29-37, March, 2015
DOI: 10.5897/IJWREE2014. 0556
Article Number: A557E9051547
ISSN 2141-6613

http://www.academicjournals.org/IJWREE

International Journal of Water Resources and Environmental Engineering

Review

Irrigation system in Israel: A review

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Received 11 December, 2014; Accepted 11 March 2015

The objective of this paper was to review the irrigation system of Israel and to identify the most common irrigation methods used for safe, efficient and sustainable agricultural production in arid and semi-arid regions of the world. Israel is one of the most densely populated countries in the world and characterized by desert and semi-desert climatic conditions. Major constraints of the country include: Frequent droughts, desertification of agricultural land, rapid urbanization, depleting resources: technological uncertainty and high cost of non-conventional sources, degradation of water quality and increased water scarcity. Among these constrains, water scarcity is the primary limiting factor in Israel agriculture while the country depends on irrigation. The main water source for agriculture is pressure drip irrigation systems. Drip irrigation has the highest water efficiency rate in agriculture, reaching a 70 to 80% rate, versus open irrigation, which achieves 40%. Recycled use of water, waste water, adding nutrients mixed in with the water and desalination are the recent new innovation used to solve problem of water scarcity in Israel. Therefore, technology currently innovated to alleviate problem of irrigation water resources by Israel should have to be adopted in arid and semi arid of the world to increase the productivity.

Key words: Water resource, types of irrigation, drip irrigation system in Israel.

INTRODUCTION

Israel is one of the most densely populated countries in the world, while yet only 20% of the land is arable and half of that has to be irrigated. More than half of Israel is arid or semi-arid, and the rest of the country is dominated by steep hillsides and forests (http://www.jewishvirtuallibrary.org/). Israel on a land area of 20,770 km^2 is divisible into three longitudinal strips running from north to south. The average annual rainfall varies from 600 to 700 mm in the north to 30 mm at the south. Israel's population is 6.0 million, of which 90% lives in urban areas and 10% in rural areas. The number of farming households is 25,000. Farm employment contributes 3.1%, of the total employment, equivalent to approximately 67,000 persons. Out of the total area, arable land amounts to 652,000 ha. The area actually irrigated is 230,000 ha or approximately 35% of the arable land. The land holding allotted to a farming unit in the collective and cooperative settlements vary in size,

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according to the soil and climatic conditions. The average holding is 7 ha (www.un.org/esa/agenda21/natlinfo/).

The State of Israel is characterized by desert and semi-desert climatic conditions. Israel relies on approximately 4 sporadically rainy months for the annual replenishment of all of the nation's natural water sources. This water is largely contained within three main aquifers, and the Sea of Galilee watershed (Rejwan, 2011). In Israel, where climatic conditions change from semi-arid in the north to arid in the south, agriculture is completely depended on irrigation. The amount of water utilized annually exceeds 90% of Israel's entire water potential (Elke, 1998).

Israel's agriculture is characterized by high technological level, pressure irrigation systems, automatic and controlled mechanization and high quality seeds and plants. Israel meets most of its food requirements through domestic production to produce over 5 million tons of field crops, 1.15 billion liters of milk, 1.6 billion eggs and 1.2 billion flowers for export (www.un.org/esa/agenda21/natlinfo/). While the major constraints include: increased water scarcity; depleting resources, frequent droughts; degradation of water quality; technological uncertainty and high cost of non-conventional sources; rapid urbanization, abandonment and desertification of agricultural land (www.un.org/esa/agenda21/natlinfo/). Water scarcity is the main limiting factor in Israeli agriculture and the country depends on irrigation to increase its crop yields; about 50% of the land is irrigated. Of the 1,129 million cubic meters (MCM) of water used by agriculture per year, some 30% of agricultural water is treated wastewater (TWW) for drip irrigation of orchards and non-food crops, while another 16% is saline water.

Israel achievements in water resources development, agricultural production and irrigation technology are marked by the magnitude of the still facing problems of quantity, quality and cost of water for irrigation. Experience in water management is often considered unique, reflecting technological innovation, national commitment and ambitious development objectives. While there have been several mistakes along the way, the results of Israeli policies speak for themselves. During a sixty year history, the country's population has grown seven fold: from one to seven million residents. Orenstein (2004), Natural water resources have not increased but agricultural productivity has steadily increased and now is 1600% higher than it was in 1950! Automation of irrigation is one of the means to raise crop production per unit of water, through a strategy that aggressively utilizes waste water, drip irrigation and more recently desalinized sea water. Israelis enjoy a high quality of life which belies the remarkably low 300 m^3 per capita level of water (Tal, 2006). Therefore, the objective of this paper is to review the irrigation system of Israel and to identify the irrigation system that could be effective in arid and semi-arid region for efficient utilization of scares water resources in Israel.

LITERATURE REVIEW

Changes in agriculture over the last century have led to substantial increases in food security through higher and more stable food production. However, the way that water has been managed in agriculture has caused wide scale changes in land cover with watercourses, contributed to ecosystem degradation, and undermined the processes that support ecosystems and the provision of a wide range of ecosystem services essential for human well-being (Malin et al., 2007).

Global distribution of water resources

Among other natural resources, water resources have a unique position. Water is the main extensively distributed substance across the world. It contributes to a key role in the human life and surrounding environment. Fresh water is the most important among them, which is essential for human beings' life and activity. About 1.4 billion km^3 water is available on earth. Among them, approximately 35 million km^3 freshwater resources are present (nearly 2.5% of total volume), the distribution is shown in Figure 1 (UNEP, 2001).

On one hand, water resources are tends to depleting due to exceeding demand and consumption ratio. As a result of over pumping and demanding human activity, water quality is worsening in the sources. By considering worldwide population of 8 billion and with a raise of 2 billion dollars and as a common situation of business-as-usual, with enhance in water exploring of 22% over 1995 levels is predicted by 2025. It means irrigation demand raise up to 17%, including 20% demand for industrial water and 70% demand for municipalities' water (Rosegrant et al., 2002). On the other hand, Global warming further spells out such water shortage. Due to global warming, snow and ice in the Himalayas, which give huge quantity of water for agriculture in Asia, is estimated to reduce 20% by the year 2030 (UNDP, 2006). At present Irrigated agriculture contributes 40% worldwide food production. Irrigation increases crops yields from 100 to 400% but poor drainage and irrigation practices have led to water logging and salinization of about 10% of irrigated land over the world (http://www.actionaid.org/docs/gold_rush.pdf).

Major irrigation systems in the world

Irrigation systems are divided into 2 categories: gravity-fed systems and pressurized systems:

Gravity systems

(i) Irrigation pond: Water is provided in the form of a

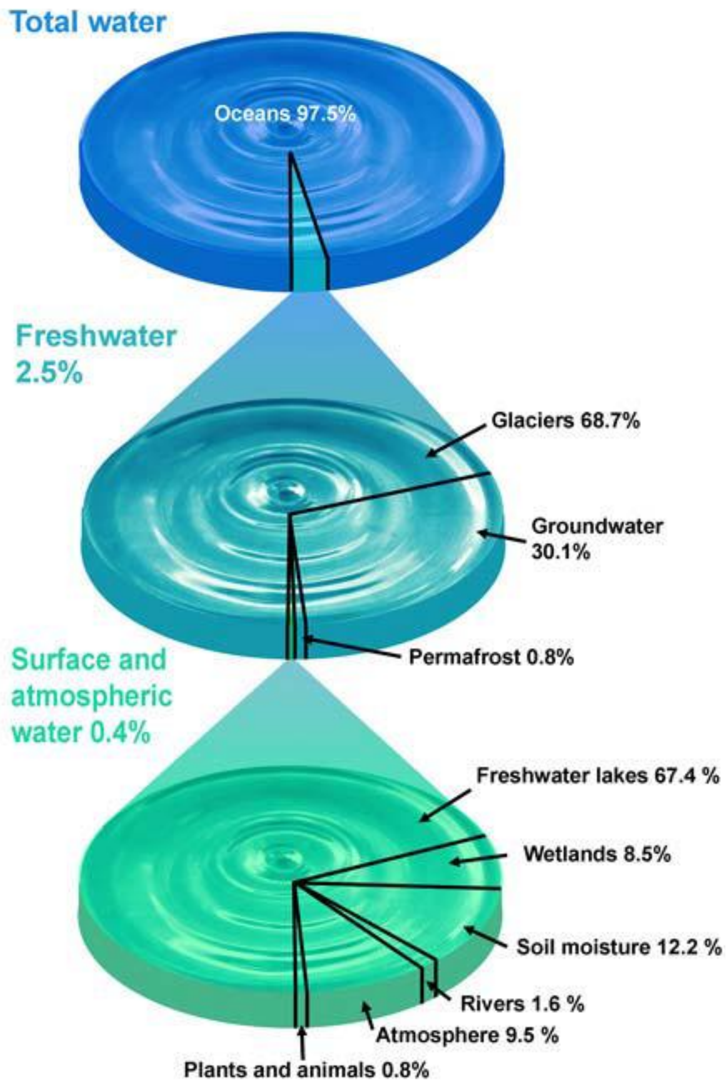

Figure 1. Global distribution of water resource. Source: UNESCO, the United Nations World Water Development Report 2, UNDP, 2006.

tablecloth in a basin (which can be partitioned) built on a leveled ground (slope of 0.1 to 1%);

(ii) Irrigation skate: water is made by runoff in separate paths from a distance of 0.6 m to 1.25 m; soil is leveled (slope of 0.2 to 3%);

(ii) Irrigation siphon or bordered ramps: water is beamed down by siphons or railed ramps to allow a reduction of head erosion, better flow control and consistency of water distribution (http:// www. mospi.nic.in/Mospi_New/...IRRIGATION).

Pressurized systems

(1) Sprinkler irrigation: distributing the water as rain with regulation and uniformity of the dosage given; only possible on the condition that the area does not suffer under wind with speeds over 4 m/s; systems sprinkler irrigation are either fixed or mobile;

(2) Localized irrigation: water circulates in flexible, small diameter pipes, arranged on the surface and fitted with emitting devices providing water at the plant's foot; the most prevailing localized irrigation systems are drip-irrigation (targeted at domestic audience) and micro-jet (targeted at sylviculture-market) (http:// www. mospi.nic.in/Mospi_New/...IRRIGATION).

Pressurized irrigation systems create, on average, a water savings of 30 to 60% compared to gravity-fed systems. Localized irrigation systems, in turn, can lead to water saving up to 50% compared to the sprinkler systems (limit maximum evaporation and percolation because water is delivered in un-humidified, low dosage on a fraction of the soil). Drip irrigation system is the best solution for environmentally safe, efficient and sustainable agricultural productivity for arid and semi-arid regions of the world to use scarce water resource when compared other existing methods.

Types of irrigation techniques

Objective of irrigation technique

Although various types of irrigation techniques differ in how the water obtained from the source is distributed within the field, generally, the ultimate goal is to supply the entire field uniformly with water, so that each plant has the right amount of water it needs, neither too much nor too little (Andreas and Karen, 2002).

Surface irrigation

In surface irrigation systems, water moves over and across the land through simple gravity flow in order to wet and to infiltrate into the soil. Surface irrigation can be subdivided into furrow, border strip or basin irrigation. It is often called flood irrigation when the irrigation results in flooding or near flooding of the cultivated land.

Localized irrigation

Localized irrigation is a system where water is distributed under low pressure through a piped network, in a predetermined pattern, and applied as a small discharge to each plant or adjacent to it. The method can be further categorized as drip irrigation, spray or micro-sprinkler irrigation.

Drip irrigation

Drip irrigation, also known as trickle irrigation, functions as its name suggests. Water is delivered at or near the root zone of plants, drop by drop. This method can be the most water efficient method of irrigation, if managed properly, since evaporation and runoff are minimized. In modern agriculture, drip irrigation is often combined with plastic mulch, further reducing evaporation, and is also the means of delivery of fertilizer.

Sprinkler irrigation

In sprinkler or overhead irrigation, water is piped to one or more central locations within the field and distributed by overhead high-pressure sprinklers or guns. A system utilizing sprinklers, sprays, or guns mounted overhead on permanently installed risers is often referred to as a solid-set irrigation system. Higher pressure sprinklers that rotate are called rotors and are driven by a ball drive, gear drive, or impact mechanism. Guns are used not only for irrigation, but also for industrial applications such as dust suppression and logging. Sprinklers can also be mounted on moving platforms connected to the water source by a hose. Automatically moving wheeled systems known as traveling sprinklers may irrigate areas such as small farms, sports fields, parks, pastures, and cemeteries unattended.

Sub-surface drip irrigation

Sub-surface drip irrigation (SDI), also termed seepage irrigation, has been used for many years in field crops in areas with high water tables. It is a method of artificially raising the water table to allow the soil to be moistened from below the plants' root zone. Often those systems are located on permanent grasslands in lowlands or river valleys and combined with drainage infrastructure. A system of pumping stations, canals, weirs and gates allows it to increase or decrease the water level in a network of ditches and thereby control the water table. Sub-irrigation is also used in commercial greenhouse production, usually for potted plants. Water is delivered from below, absorbed upwards, and the excess collected for recycling.

Drip irrigation has the potential to use scarce water resources most efficiently to produce vegetables (Locascio, 2005). The major benefits of drip irrigation are the ability to apply low volumes of water to plant roots, reduce evaporation losses, and improve irrigation uniformity (Schwankl et al., 1996). Compared to surface irrigation (flood and furrow), Sub surface drip irrigation reduce water loss to evaporation, deep percolation, and completely eliminate surface runoff (Phene, 1990), it also increase crop marketable yield and quality (Ayers et al., 1999). Use of DI can result in high nutrient use efficiency (Thompson et al., 2002). Saline irrigation water can be used with DI, while maintaining yields and improving water use efficiency compared to surface irrigation (Cahn and Ajwa, 2005; Tingwu et al., 2003). On the other hand subsurface drip irrigation applies water below the soil surface, using buried drip tapes. It has many benefits over conventional drip irrigation (Singh and Rajput, 2007). The biophysical advantages are the lower canopy humidity and fewer diseases and weeds as drip irrigation (Camp and Lamm, 2003).

Advantages and disadvantages of drip irrigation

Experimental evidences of SDI advantages over other irrigation methods, specifically drip irrigation, are vast. Some advantages and drawbacks of this method, compiled by Lamm (2002) and Payero (2005) are shown below.

Advantages of drip irrigation

The efficiency of water use is high since soil evaporation, surface runoff, and deep percolation are greatly reduced or eliminated. In addition, the risk of aquifer contamination is decreased since the movement of fertilizers and other chemical compounds by deep percolation is reduced. The use of degraded water. Subsurface wastewater application can reduce pathogen drift and reduce human and animal contact with such waters.

The efficiency in water application is improved since fertilizers and pesticides can be applied with accuracy. In widely spaced crops, a smaller fraction of the soil volume can be wetted, thus further reducing unnecessary irrigation water losses. Reductions in weed germination and weed growth often occur in drier regions.

Hand laborers benefit from drier soils by having reduced manual exertion and injuries. Likewise, double cropping opportunities are improved. Crop timing may be enhanced since the system need not be removed at harvesting nor reinstalled prior to planting the second crop. On the other hand, laterals and submains can experience less damage and the potential for vandalism is also reduced. Operating pressures are often less than in drip irrigation, thus, reducing energy costs.

Drawbacks of drip irrigation

Water applications may be largely unseen, and it is more difficult to evaluate system operation and water application uniformity. System mismanagement can lead to under irrigation, less crop yield quality reductions, and over irrigation. The last may result in poor soil aeration and deep percolation problems.

If emitter discharge exceeds soil infiltration, a soil overpressure develops around emitter outlet, enhancing surfacing and causing undesirable wet spots in the field. Timely and consistent maintenance and repairs are a requirement. Leaks caused by rodents can be more difficult to locate and repair, particularly for deeper SDI systems.

The History of drip irrigation and success

Drip irrigation has been used since ancient times. Fan Sheng-Chih Shu, written in China during the first century BCE, describes the use of buried, unglazed clay pots filled with water as a means of irrigation (http://www.brc.tamus.edu/). Modern drip irrigation began its development in Germany in 1860 when researchers began experimenting with subsurface irrigation using clay pipe to create combination irrigation and drainage systems (http://www.infoplease.com/). Research was later expanded in the 1920s to include the application of perforated pipe systems (http://www.ers.usda.gov/. The usage of plastic to hold and distribute water in drip irrigation was later developed in Australia (http://www.epa.gov/).

Usage of a plastic emitter in drip irrigation was developed in the 1930s in Israel by a water engineer Simcha Blass. He was visiting a friend in the desert when he noticed a line of trees with one member that was noticeable taller and more robust looking than the others. He did a little digging, literally, and noticed that a household water line running along the tree line had spring a small leak in the area of that one tree and as feeding it with a steady drip of water. The wet spot on the surface didn't seem like much, but down below was a large onion-shaped area of juicy soil and modified by his son Yeshayahu (http://www.infoplease.com/). Instead of releasing water through tiny holes, which are blocked easily by tiny particles, water was released through larger and longer passageways by using velocity to slow water inside a plastic emitter. The first experimental system of this type was established in 1959 by Blass who partnered later (1964) with Kibbutz Hatzerim to create an irrigation company called Netafim. Together they developed and patented the first practical surface drip irrigation emitter (http://www.ers.usda.gov/; http://timelinks.merlin.mb.ca/). The modern development of drip irrigation started in Great Britain during World War II and continued in Israel and other countries (Camp, 1998).

Drip irrigation

Drip irrigation is the most energy and water efficient of all the irrigation systems. Water savings of up to 50% compared to sprinkler irrigation are common (Lamont et al., 2002). Ideally, water is applied in the proper amount to the root ball of the plant, minimizing water leaching from the root zone and minimizing evaporation of water since the water isn't sprayed into the air (Shock, 2006; Lamont et al., 2002; Haman and Smajstria, 2010; Schultheis, 2005). The water can be emitted at uniform distances along a pipe or a tube with an emitter that directs water to one plant volume of soil.

The drip hose can be placed above ground or buried in the ground, which is called sub-surface drip irrigation (Lamm et al., 2003). Sub-surface irrigation has the advantage of nearly zero evaporation, but it is difficult to diagnose if an emitter becomes plugged or damaged. Drip irrigation operates at low pressures, 10 to 20 psi at the emitter. The system pressure will need to be higher to overcome pressure loss in filters, valves, backflow preventers, pressure regulator and tubing. Typically, about 40 psi is needed at the pump outlet. Drip irrigation can be designed to fit any situation or field. It can also reduce disease problems, because it doesn't get the plant wet. It does require some experience to learn how much water to apply, but a soil water sensor in the row or next to the plant can provide feedback to aid in determining the correct amount of water. Drip irrigation requires understanding of the system to assure good management and maintenance.

Drip method of irrigation helps to reduce the over-exploitation of groundwater that partly occurs because of inefficient use of water under surface method of irrigation. Environmental problems associated with the surface method of irrigation like waterlogging and salinity are also completely absent under drip method of irrigation (Narayanamoorthy, 1997). Drip method helps in achieving saving in irrigation water, increased water-use efficiency, decreased tillage requirement, higher quality products, increased crop yields and higher fertilizer-use efficiency (Qureshi et al., 2001; Sivanappan, 2002; Namara et al., 2005).

Drip Irrigation for arid soils

The classical 'leaching requirement' approach for salinity management does not work well with subsurface drip irrigation (SDI), because irrigation with SDI results in no leaching above the depth of the drip tape, and salts will accumulate throughout the growing season. Irrigation with SDI can maintain suitable root-zone salinity, but surface salt accumulation will occur unless there is adequate leaching due to rainfall or supplemental surface irrigation. Facilitating crop establishment with SDI will help to improve the long-term economic sustainability of SDI (Thomas et al., 2010).

Accumulation of salts in concentrations detrimental to plant growth is a constant threat in irrigated crop production. With surface irrigation, leaching adequate amounts of water through the soil profile (e.g. the 'leaching requirement') is the desired method for maintaining suitable soil salinity (Dasberg and Or, 1999; Hanson and Bendixen, 1995; Oron et al., 1999). By applying saline water with appropriate irrigation management techniques, long-term sustainability in agricultural systems can be achieved (Rhoades et al., 1992). One such irrigation technique is drip-irrigation, which has been successfully used in combination with saline waters (Shalhevet, 1994).

Surface drip irrigation

Wastewater recycling provides solutions for multiple problems. By recycling used water, fresh water is "freed up" for domestic needs, which is less expensive than developing new water resources. Additionally, water recycling solves waste disposal problems and reduces fertilizer requirements (Radke, 2006).

Sustainable development and reducing environmental hazards through subsurface drip irrigation (SDI) is more suitable for treated wastewater and results in even more efficient water use and crop growth than surface drip irrigation methods. However, continued research is required to ensure the success of recycled water in agricultural production.

Water management is undoubtedly the foundation of Israel's success in agriculture in arid, semiarid and dry sub-humid zones. The most conspicuous technology in this regard is the ubiquitous surface drip irrigation developed in Israel during the 1960s that enabled farmers to increase crop yield and quality while using less water and fertilizers. This result in even higher levels of water use efficiency through reduced runoff, evaporation and other parameters, and provides nutrients to plants while maintaining a dry soil surface. Drip emitters in SDI systems are positioned within the soil in attempts to conserve water, control weeds, minimize runoff and evaporation, increase longevity of laterals and emitters, permit heavy equipment to move easier in the field, and prevent human contact with low-quality water. Additional motivation for SDI comes in the form of savings of the extensive labor involved with seasonal installation and collection of surface drip system laterals (Mekala et al., 2008).

Wastewater reuse (untreated) is a common practice in developing countries of Asia and Africa and wastewater (treated) recycling is common in water scarce regions of the developed countries such as the Australia, Middle East, south west of US, and in regions with severe restrictions on disposal of treated wastewater effluents, such as Florida, coastal or inland areas of France and Italy, and densely populated European countries such as England and Germany (Marsalek et al., 2002). Utilization of SDI systems is particularly beneficial when using recycled wastewater systems, making them particularly relevant to Israeli agriculture in drylands. Whether for simple soilbased waste disposal or for agricultural utilization, regulated flow and prevention of surface exposure are extremely important when irrigation systems rely on effluents. SDI is a potential tool for alleviating problems of health hazards, odor, contamination of groundwater, and runoff into surface water. SDI particularly augments opportunities for treated wastewater in landscape and ground cover as well as in edible crops. SDI presents a unique opportunity to manipulate root distribution and soil conditions in drylands in order to better manage environmental variables including nutrients, salinity, oxygen and temperature.

The widening gap between supply and demand is often made up with marginal resources, especially reclaimed municipal wastewater, which is becoming an increasingly important source of water for agricultural in water-short countries like Israel (25% of the total agricultural water in

2000, and projected to be 37% in 2010, and 46% in 2020). The land area in Israel irrigated with treated wastewater is rising continuously- 5,100 ha in 1975, 16,300 ha in 1985, and 36,300 ha in 1994 (Dobrowolski, 2008).

Drip irrigation system components

Drip irrigation is a method of watering plants through devices called emitters. The drip emitters are usually industrially made tapes with very small outlets. Single drops of water come out at a time to wet the soil around the plants roots, hence the name 'drip irrigation'. Low head drip irrigation uses scarce water most efficiently to produce vegetables and other crops during drought periods (Alin, 2004):

1. The power unit supplies the electrical power to operate the pump if the water is coming from a well or surface water source, exclude municipal water sources.
2. Pumps are used to bring well water or surface water into the irrigation system.
3. Shutoff valves can be opened or closed to allow or prevent the flow of water into the system. Valves can be operated manually or by an electronic controller to automate irrigation.
4. Backflow preventers are one-way valves that keep contaminated water in a drip system from flowing back into the water source in the case of a sudden loss of pressure. This is particularly important if water is sourced from a well or municipal water supply.

Check with government building department or water provider to determine what backflow prevention is required locally.

5. Fertilizer injectors insert nutrients directly into irrigation water, allowing the placement of nutrients directly in the plant root zone.
6. Filters are used to remove sand and large organic particles from source water that might plug irrigation emitters. The larger the filter's mesh count, the smaller the filter screen openings. For example, a screen with a mesh count of 200 would filter out smaller particles than would a screen with a mesh size of 150. For most irrigation systems a mesh size of 15–200 is adequate.
7. Pressure regulators maintain water pressures entering the system at levels appropriate for the drip irrigation equipment. Typically, drip irrigation systems are designed around water pressures that are less than that of standard residential water pressures. Low-pressure gravity systems may not need a regulator.
8. Distribution lines carry water from the source to emitters. These can be garden hoses, UV-resistant PVC pipes or a softer material that is designed to have holes punched into it as needed.
9. Emitters and microsprayers are basic small irrigation devices used to deliver a regulated amount of water to a specific location or plant.
10. Controls are available to help automate irrigation systems. The most beneficial control device is a timer, which assists in working out of how much to water and when.

Typical timer options include AC electric timers that require access to power; DC battery timers; windup timers that require no power source; battery timers that must be manually started; and zero-pressure battery timers for gravity-fed irrigation systems.

11. Monitoring equipment should be used to assess the soil moisture levels after irrigation to ensure that sufficient but not excessive soil moisture levels are achieved. A tensiometer or similar device can be used to obtain sufficient estimates of soil moisture levels and is especially useful in situations where mulch or row cover is present (www.uaf.edu/ces or1-877-520-5211) (Figure 2).

Challenges and constraints of drip irrigation

Agricultural planning from an environmental perspective must take account of the sustainable use of non-renewable production factors which are in short supply in Israel water and soil. Land availability in the center of the country will depend on how much agricultural land is converted to residential, commercial and industrial development. Fresh water is already in short supply today both in terms of quality and quantity. Since Israel's freshwater potential will be allocated to the growing urban sector in the future, development of marginal water sources and treated wastewater will be essential to supply agricultural needs in the long term. While wastewater can and should be used in agriculture throughout the country, its quality must be upgraded and adapted to each specific use.

Wastewater and sludge utilization in agriculture must be based on the potential risks to humans, soil, crops and water sources. Israel achievements in water resources development, agricultural production and irrigation technology Israel achievements in water resources development, agricultural production and irrigation technology are still facing problems of quantity, quality and cost of water for irrigation. The system requires regular maintenance. Emitters and microsprayers can become clogged, clean water, a filtration system and regular inspection of distribution lines and emitters are essential for success. Proper emitter spacing is a must to ensure proper root development and reduce moisture stress on plants. Plants need a minimum of one emitter. Determining the duration and frequency of irrigation can be a challenge. Contamination of water sources from back siphoning can occur, and a backflow preventing device should be installed at the beginning of the system (www.uaf.edu/ces or1-877-520-5211

Major constraints among others include: Increased

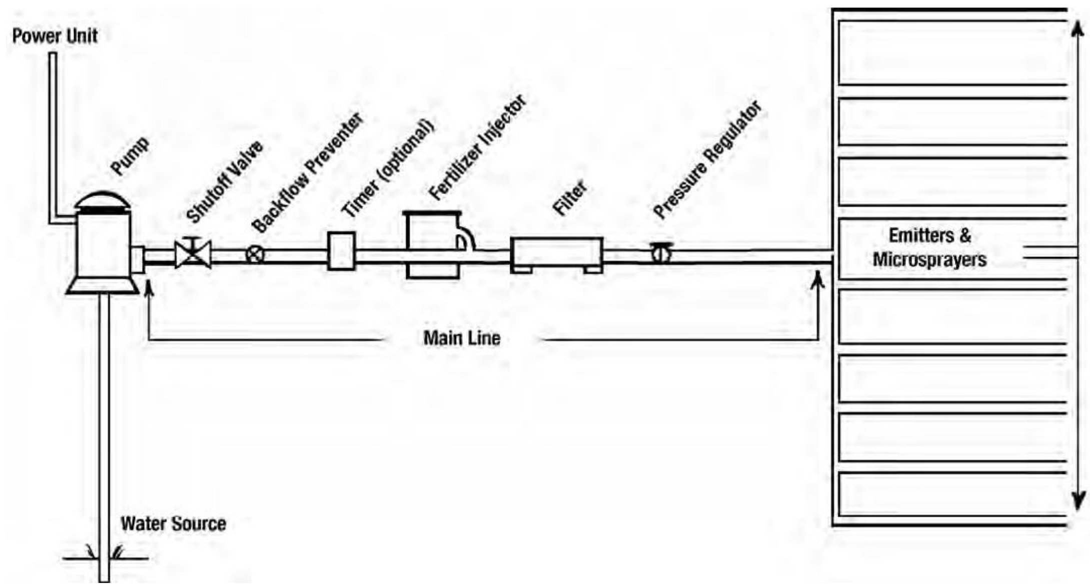

Figure 2. A schematic of lay-out and assembly order for typical drip irrigation components. Source: University of Alaska Fairbanks, 2013.

water scarcity; depleting resources, frequent droughts; degradation of water quality; technological uncertainty and high cost of non-conventional sources; rapid urbanization, abandonment and desertification of agricultural land (www.un.org/esa/agenda21/natlinfo/).

SUMMARY AND CONCLUSION

In the 1960s, drink water were used for irrigation in Israel. Recently, recycled use of waste water and nutrients fertigation have been started by mixing with water. Subsurface drip irrigation is a valuable irrigation method in arid and semi-arid regions. Drip irrigation has the highest water efficiency rate in agriculture, reaching a 70 to 80% rate, versus open irrigation, which achieves 40%. However, limited research has been conducted in the area of evaluating effects of salinity on establishment of crops with SDI in successive seasons. There is a potential for saline-water irrigation of crops in water scarce areas.

In order to achieve sustainability when irrigating with saline water, management strategies must aim to achieve two things: to minimize soil evaporation from the surface and to apply enough water to the field to ensure leaching of excess salt ions from the root-zone. Low-cost drip irrigation is suitable to use for irrigation with saline water, since it minimizes salt accumulation in the soil. As such, leaves are not subject to leaf burn, and peaks in salt concentrations are avoided. The practice of Israel drip irrigation system is the best solution for environmentally safe, efficient and sustainable agricultural productivity for arid and semi-arid regions of the world to use scarce water resource when compared other existing methods. Further research should be conducted associated with hazards to the environment and sustainable use of scarce noun renewable resources. Therefore, technology currently innovated to alleviate problem of irrigation water resources by Israel is strongly recommended to be adopted in arid and semi arid of the world to increase the productivity. Compared to other methods of irrigation system, drip irrigation has high irrigation water use efficiency. Reduced stomatal conductance and water loss formed high water use efficiency.

Conflict of Interest

The authors have not declared any conflict of interest.

ACKNOWLEDGEMENT

All the authors of this study are duly acknowledged.

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