

## **Appropriate Technologies and Systems in response to Climate Change**

### ***SOLAR POWERED AUTOMATED GREENHOUSE IRRIGATION SYSTEM INSTALLATION - LESSONS LEARNED***

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Over the last few years, particularly during this global recession, there have been cries for greater self-reliance from various interest groups and government. Food security has become a focal point for a number of small Caribbean states including Jamaica. The Ministry of Agriculture and Fisheries has been actively promoting a return to Agriculture with the inclusion of technological aids to improve efficiency. Improved productivity through application of greenhouse technology increases the sustainable production of high quality produce to meet the demands of the Jamaican market.

#### **Issues Affecting Agro Production**

##### **Water Management**

Farmers have relied heavily on rainwater, ground water and rivers for their irrigation needs. This has proven effective over the decades, as our weather patterns have been relatively predictable. The harnessing and storage of water to ensure continuous availability of this key component constitutes water management. As such, water management must be of primary concern to the agro production.

##### **Issues of Concern(Drought/Flood)**

- Over the last few years climate change has resulted in less predictable cycles – periods of extreme rainfall followed by periods of extreme drought.
- One can remember only 2 years ago when Jamaica was inundated by rain resulting in heavy losses for farmers, particularly open field farmers.
- Currently, the region is in a state of drought, which logically has again negatively impacted farmers and the irrigation needs.

##### **Labour**

Manual labour is employed to water the plants on a daily basis, apply fertilization and other things needed in the production process. Agro production costs are impacted by daily labour costs as well as costs associated with inefficiencies, which are not as easily quantified, but which

exist. The efficient application of water, fertilizer and the other things necessary for good yields comprises an important element in farming.

#### *Some Issues of Concern with Labour*

- Inconsistency in watering pattern where the plants may be over watered or under watered can result in wilting and failure of seed to germinate.
- The delivery of water to seedlings in trays using watering cans or hoses have resulted in dislodged seedlings from trays and thus low production
- Increased cost associated with weekend employment of labour.
- Non scientific application of soil and plant additives eg fertilizers

#### *Fertilizing*

Fertilizers have become an essential part of the technological drive in agriculture for the improvements in yields. Given their chemical nature, fertilizers require care and precision in their application in order to work optimally. Costs associated with fertilizers impact agro production and make efficient usage of this component critical

#### *Some Issues of Concern with Fertilizing*

- Increasing cost of fertilizer
- Inefficient application of fertilizers to plant
- Inconsistent application of fertilizer ie over or under-fertilization

#### *Product Standardization*

With increased competition from imported agricultural produce, issues like consistency in appearance, taste and quantity are paramount for agro production. Increasingly, the market demands certain standards to be met by the producers.

#### *Some Issues of Concern*

- Varying product size
- Non-standardized appearance
- Inconsistent supply

#### *Energy*

Improvements to efficiency have continued to be an issue facing the agro sector. Technological improvements to the production process have been achieved and thus provide the potential for efficiency gains. The automated system is not new to the landscape and provide an increased level of control of the farmers' inputs. These automated system consisting of pumps, timers, valves and storage tanks are largely powered from the main electricity grid. Energy, and its delivery continue to be an integral component in the technological drive for efficiency.

### Issues of Concern

- Inconsistency in power supply from the main. Long power outages (~8 hrs – scheduled or unscheduled) deprive plants of a day's watering. Shorter power outages (even briefly during a cycle) can cause the missing out of one of the day's watering periods.
- Cost of energy is affected in two ways.
  - Increasing US Dollar cost for oil – comprising the fuel cost in your bill
  - Exchange rate movements against the local currency.

### **Solar Technology in Agriculture**

Solar Irrigation provides a viable opportunity to match peak watering demands (between 7:30 am and 3:00 pm) with peak energy production (sunrise to sunset). This minimises the need for large battery banks for energy storage.

Automated, self-sustained systems, which provide clean, cheap and dependable solutions, are currently installed in a number of locations in Jamaica. These contribute to cost containment and standardisation of the production process.

### **Solar Powered Irrigation System Addresses Production Concerns**

#### Water Management

A Solar Powered Irrigation System provides efficient usage of the water with precise delivery of the required volumes of water through high pressure misting for the seedlings or lower pressure drip irrigation for more mature plants.

#### Labour

Solar Powered Automated Irrigation Systems provide consistency in watering pattern week over week.

The seedlings or plants receive requirements every day and on weekends and holidays as programmed in the timers, resulting in a reduction in wilting.

High pressure ultra fine misting of seed trays eliminates large droplets of water that can dislodge seeds prior to germination.

No overtime cost associated with weekend employment of labour are incurred.

The system is programmable, promoting scientific application of soil and plant additives eg fertilizers.

### Fertilizer

Solar Powered Automated Irrigation Systems provide efficient application of water soluble fertilizers to plant in precise quantities and frequencies using pump, timers and injectors.

### Product Standardization

Given the programmable nature of the system, all plants are subjected to the same irrigation and fertilization cycle. Therefore, the expectation is uniformity in product size and appearance and dependability in the supply

### Energy

Perhaps the most profound impact of the Solar Powered Automated System is in this area where the sun's energy is used to power the complete system. This is achieved through the use Photovoltaic Panels to convert the sun's energy to DC current to drive pump, valves, timer, zone control electronics and, with a battery, provide backup power. The results are:

- Consistent power supply with no power outages to deprive plants of a day's watering.
- Insulation of energy cost from
  - Increasing US Dollar cost for oil – comprising the fuel cost in your bill
  - Exchange rate movements against the local currency.

### **Case Study – FAO sponsored Solar Misting – Parish Nursery**

The Nursery is the source of seedling production for distribution to farmers in the Parish.

Critical considerations are:

- Producing consistently good quality seedlings
- Reducing spoilage due to inconsistent manual irrigation (over-watering/under-watering) as well as heavy dripping on the seed trays

Systems employed:

- Solar Automated Irrigation System
- Rainwater Harvesting System
- High Dome/Centrally vented greenhouse design



**Rainwater harvesting and solar powered system**

Using the solar irrigation system the delivery of water through high-pressure misters is automated. The electricity to power the timer, pump and valves is provided by an 80W solar panel. It also maintains a fully charged battery to provide backup energy if required.

The system comes on 3 times daily and provides an option for misting three zones within the house which contains twelve 20ft tables. This zone option allows the saving of water in the event that the house is only partially stocked with seedlings during the sowing process. The high-pressure anti-leak misters expel very fine droplets (130 microns), preventing droplet damage to the seeds in the trays prior to germination.

The roof is guttered for rainwater harvesting to fill a 1000 gallon tank thereby diversifying the water supply.



**Homogeneous seedling production**

The resulting output from the house is attractive homogeneous seedlings with significant reduction in spoilage through wilting (see picture to the right).

### **Case Study – Solar Drip Irrigation**

Three 50ft X 30ft Greenhouses used to rear Sweet Peppers and Scotch Bonnet Peppers.

Critical requirements are:

- Delivery of water and water soluble fertilizer in specific concentrations to the plants 4 times daily
- Drip Irrigating each plant
- Stand alone power system to run automation process

Systems employed:

- Solar Irrigation System
- High Dome/Centrally vented greenhouse design
- Rainwater Harvesting System
- Fertilizer Injectors



**Pump, Injectors and Valves in Solar Powered System**

Using the solar irrigation system the delivery of water and water-soluble fertilizer through low-pressure drippers is automated. The electricity to power the timer, pump and valves is provided by an 80W solar panel.

The system comes on 4 times daily and drip irrigates each house sequentially with water twice per day and one of two fertilizers in the morning with the second being applied in the afternoon. The ability of the system to run various combinations of water and fertilizers is through a series of electrically operated valves configured for this specific need. Depending on the needs of the client, the system can be configured to achieve the desired results.



**Plant-specific drip irrigation**

The water-soluble fertilizer is stored in sunken covered barrels and accessed by the solar powered pump through the valves.

The three roofs are all guttered for rainwater harvesting to fill two 1000 gallon tanks per house.

### **Cost /Benefits of the Solution**

Clearly, there is a cost associated with this improvement in efficiency. Typically, the solar powered automated irrigation systems cost less than US\$6,000.00. This cost containment is achievable through the DC current system design that removes the cost for AC current conversion ie no inverter, and reduces the need for large battery banks as the system is energy balanced, meaning the peak demand corresponds to the peak supply.

Additionally, the irrigation system is modular, allowing easy cost effective expansion to additional houses without the need for the purchase of the substantive parts of the system, namely the pump, controllers and panels.

The Solar Powered Automated Irrigation System provides an economically viable alternative for farmers to consider.

### **Conclusion**

Increased use of solar irrigation will bring to the industry technological improvements that will result in efficiency gains. The long-term view is that more applications, not limited to greenhouse irrigation only, will incorporate the use of solar technology, which has become more

cost effective and which inherently uses more of our natural resources as we move towards energy independence.



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