Irrigation water management in St. Vincent and the Grenadines

Viable or vulnerable?

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Abstract

Surface irrigation was only practiced sporadically in the past in St. Vincent on the private estates and plantations and was mainly used for cotton, sugarcane and bananas. Since 1998 more than 1000 acres of banana farms involving more than 500 farmers were brought under micro irrigation with the financial support of the European Union.

Run of the river schemes are used to supply the irrigation systems with an excellent quality of water. An advanced drip irrigation method is used which has the advantage of being very efficient in water application but requires very good filtration systems to prevent blockage of the emitters.

A small Irrigation Management Unit, established within the Central Water and Sewerage Authority (CWSA), does the management of the main infrastructure of the irrigation schemes. It involves the planning and implementation of the daily watering schedules beside the maintenance of the main water distribution network. The farmers are responsible for the maintenance of the equipment on their farm: the manifold and drip lines.

There are no Water User's Groups formed yet. Farmers seem reluctant to cooperate. Although the schemes function satisfactory the future will show how viable and sustainable these schemes are. It appears that the equipment is vulnerable to vandalism, adverse interference and fiddling with the valves and gauges. Some important lessons learnt so far will be presented.

St.Vincent has the advantage of the topography that favours gravity supplies but the multiple use of water by hydro-power stations may compel to use pumps. The implications for the management of operation and maintenance versus gravity schemes will be discussed further.

In St.Vincent as in most locations in the Caribbean, water is the limiting factor for irrigation. This implies that water, which is "granted" to one farmer, cannot be made available to another farmer. Similarly a farmer with 10 acres deprives 10 small holders with 1 acre from access to irrigation. The river basin development approach involves all potential users. It starts with an inventory of the dry season flow and its potential users in a certain river basin. This includes drinking water and hydro-power needs, recreation, fisheries, laundry use and a base flow for environmental reasons. Only after appropriate
allocation to these uses water that is 'left' can be used for irrigation. It is the prioritising of the water use, which is an important and challenging aspect of CWSA’s mission.

**Introduction**

Surface water abstraction schemes are the heart of the domestic and agricultural irrigation water supply in St. Vincent and the Grenadines. Modern drip irrigation techniques are used to supply more than 1000 acres (400 ha) of bananas during dry periods increasing yields with 10 tonnes per acre (25 t/ha). As bananas are the main export product, irrigation is vital for the national economy.

Although the average annual rainfall is more than 100" (2500mm) the intensity and temporal distribution of the rainfall combined with the fast runoff and limited waterholding capacity of the agricultural lands result in prolonged periods of water stress for the plants and water is a limiting factor for further development. The allocation of scarce river water between domestic water supply, hydro-power stations and agriculture and its sustainable management is therefore a challenging task for the Central Water and Sewerage Authority (CWSA).

The paper discusses these issues and the design characteristics of irrigation schemes (supply schemes) as compared to drinking water schemes (on-demand schemes) with the management implications. It ends with a number of problems experienced during the first 2 years of irrigation implementation and the solutions offered by CWSA in the attempt to make irrigation sustainable in St. Vincent.

**Impact of irrigation on agriculture**

The Windward Islands generate most of their income from Tourism and Agriculture. Both need water to be successful. It is of prime importance to manage the water resources and water usage in a sustainable way.

For agriculture to be successful good yields and good markets are essential. Yields are very much influenced by the availability of water to the plants. In fact water is one of the limiting factors for increased yields and quality in St. Vincent and the Grenadines. At first sight this may sound strange in a country with an average rainfall of over 100 inches (2,500 mm) a year. But for plants to grow well they need a medium to keep themselves upright, energy for photosynthesis, nutrients to form plant material and water to transport these nutrients, cool the plants and provide turgor.

An adequate water supply to the roots of the plants is often interrupted, either during the dry season or during the rainy season in between the rain showers. Some volcanic soils in St. Vincent are so permeable and have such small buffer or water holding capacity that 3 or 4 days after an abundant rain the plants suffer from water deficit in the root zone.

The supplementary supply of water, called here irrigation, is an effective technique to overcome these dry days/weeks. Figure 1 shows an example of the number of irrigation days for the largest irrigation project last year.
Presently banana is the single most important (legal) crop in St. Vincent and the Grenadines as in the other Windward Islands, so figures are derived from the banana productions.

The export volume of bananas during the last years coincide with the variation in rainfall. Similarly the quality of the bananas used to be above 80% only during the 4 rainy months September to December (Irricable 1998).

On farm level the impact of irrigation of farmers income is very clear, as shown in the Table 1. We completed recently a sensitivity analysis on the viability of banana production in St. Vincent based on field data from rainfed farmers and from within the irrigation project.

Two points became clear from the analysis.

a) The farmer's banana yield under rainfed conditions varies, depending on his agronomic and management skills, from 3 to 10 tonnes per acre (7 to 25 t/ha). However if the yield drops below 7 tonnes/ acre or the farm gate price drops below 33 cents/lb he will work for less than the daily labour rate

b) Point 2 - The irrigated farmer's yield ranges from 13 to 23 tonnes/acre (37 to 57 t/ha). Pump schemes are less attractive due to the pump costs involved.

Irrigation of bananas seems therefore crucial for the survival or sustainability of the banana industry or in other words for the entire agriculture industry.
### Table 1 Crop budget comparison rainfed and irrigated farm

<table>
<thead>
<tr>
<th></th>
<th>Rainfed</th>
<th>Irrigated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Banana yield (t/acre)</td>
<td>7</td>
<td>20</td>
</tr>
<tr>
<td>Farm gate price (cts/lb)</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Gross income/acre</td>
<td>5100</td>
<td>14500</td>
</tr>
<tr>
<td>Cost</td>
<td>&lt; acre income Gross&gt;</td>
<td></td>
</tr>
<tr>
<td>Agricultural inputs</td>
<td>3000</td>
<td>3000</td>
</tr>
<tr>
<td>Irrigation</td>
<td></td>
<td>1400</td>
</tr>
<tr>
<td>Labour</td>
<td>2500</td>
<td>6000</td>
</tr>
<tr>
<td>General</td>
<td>700</td>
<td>1200</td>
</tr>
<tr>
<td>Net income / acre</td>
<td>(-)100</td>
<td>2700</td>
</tr>
</tbody>
</table>

Source: ICWSA-MU 2000

### Allocation of scarce water resources

Water for irrigation is scarce in St. Vincent and the Grenadines, as in other Windward Islands. The available water resources are surface water and ground water. Unfortunately, the seawater is saline and can not be used as desalinisation would make it too costly for agriculture.

The surface or river sources are reasonably well known in St. Vincent and the Grenadines, however the ground water resources have never been investigated. A national water study is planned for next year which would set up a hydrological monitoring network both for surface water and ground water.

Presently St. Vincent relies on river water only. The topography of the island does not favour construction of reservoirs, so all schemes have to be run-of-the-river schemes.

These are the following water users and probably in the order of priority:

- People
- Animals
- Industry
- Hydro-power
- Fishing
- Irrigation for agriculture

The Figure 2 gives an impression of the volume of water that is utilised by the various users in St. Vincent and the Grenadines at present.
Although the ten main rivers have a reasonable flow, with a typical average rainy season flows between 2 and 20 mgd (400 and 3600 m3/hr) and in the dry season from 0.5 to 5 mgd (100 to 900 m3/hr) they dwindle to small streams or dry up completely in the dry season.

In other words, water is scarce in St. Vincent and the Grenadines or to speak in terminology of the Rio Conference 1998 'Water is a scarce commodity'.

It is within the mandate of CWSA to allocate this limited and scarce resource among the users, according to an Act in 1991. An important parameter in the allocation of the scarce surface water is "How efficiently and how effectively is the water utilised?"

With regard to irrigation in St. Vincent we can state the following:

Efficiency: From each 1000 m3 water diverted from the river 750 m3 reaches the root zone of the plants. This is achieved by the installation of a piped water distribution network and the use of pressure compensated emitters along the plant rows.

Effectivity: Each 1000 m3 of water generates an additional 12 tonnes of bananas. At a farm gate price of 40 cents per lb, this is $1 per m3 or $4.5 per 1000 gln return to the farmer.

Similar scenarios for other crops could be done, however they are academic as there is not yet a developed market for any sizable volume agricultural product. Obviously there is a large multiplier effect for the national economy.

**Irrigation management practices**

It was only in the 60-ies that pump irrigation of sugar cane was introduced on the larger estates like Rabacca Farms. A small weir was constructed in the river to convey water through concrete ditches by gravity and subsequently pumped through sprinklers. The aluminum lateral sprinkler pipes had to be moved manually after each irrigation supply.
The irrigation was done in dry season once per two to three weeks. The Manager, when asked was not convinced of the great benefits of this irrigation. When diesel fuel prices doubled in the 70-ies the irrigation was stopped altogether.

Years later in the early 90-ies there was an enterprising farmer who introduced the highly sophisticated drip irrigation system (see photo 1) for his bananas. This was an immediate success, due to three reasons:

(1) The system requires very little labour as the drip lines are laid down permanently for the duration of the crop.

(2) The irrigation water supply can be done frequently and in small quantities, to keep the plants optimally provided with moisture without any leaching below the roots.

(3) In case of pump schemes the power requirement for drip irrigation is less than for ordinary sprinklers.

Photo 1 Drip lines along the bananas, are spaced 8' (2.4 m) with a dripper each 2’ (0.6 m).

In fact these farmers showed that, in particular for bananas, they dramatically increased their production, both in quality and quantity. During the dry season they kept their bananas productive and made them more resistant to wind damage. Furthermore they did not have to replant (most part) of their field after the dry season.

These pioneer farmers increased their annual yields per acre with 10 tonnes and sold more than 20 tonnes of bananas from each acre (50t/ha)!

This attracted the European Union in providing Stabex funds to introduce irrigation on a large scale to boost the bananas export of St. Vincent.
From 1998 to date, 1100 acres have been equipped with drip irrigation systems. See map. They are spread over 7 schemes varying in size from 15 to 500 acres. Most of the schemes have been built on the old estates that have been re-allocated to the workers. The new farmers lease lands in sizes from 1 - 5 acres (.4 - 2 ha).

The European Union has made CWSA the project implementation unit for the irrigation project. They had already an efficient organisation for providing potable water. To fully understand the management requirements of the irrigation systems in SVG the design characteristics will be discussed first.

**Design characteristics of a drip irrigation system**

St. Vincent has a few conditions that make a drip irrigation system very attractive, namely soil, slope and (lack of) mechanisation.

- **Soil**: The majority of the land reform areas where the irrigation is concentrated have light to very light volcanic soils with a high permeability and a very low water holding capacity. In practical terms: after each heavy shower the soils drain rapidly and after 3 - 4 days plants experience moisture deficit and are prone to drought stress.

- **Slopes**: Lands on slopes which normally would be left to natural vegetation have been brought under cultivation in St. Vincent and the Grenadines. All kinds of crops - coconuts, arrowroot, rootcrops (dasheen, tannia, cassava, ……) and bananas are grown on slopes up to 60% In fact there is virtually no flat land available.

- **The cutlass is the universal tool for most farm practices. There are no 4 wheel tractors nor 2 wheel tractors used. The produce is hauled by (wo)man power to the nearest farm access road where it is further transported by a small truck.**

In contrast to a potable water system a drip irrigation system is a supply system where as a drink water system is an on-demand system.

In an on-demand system the user can open the tap any time he/she wishes for as long as he/she wishes. The number of open taps or size of pipe determine the flow. In a supply system, as most irrigation systems, each user (farmer) has a defined period during the day or week that he/she gets water. This difference in design makes the management much different.

A normal flow to a consumer would be 3 gpm (0.8 m³/hr) while a farmer gets a flow of 90 gpm (25 m³/hr) or 30 times more. These large flows would lead to exorbitant pipe sizes and render it not financially feasible, if the irrigation systems would be designed on-demand.

The supply system requires a strict operation schedule to ensure that each field gets the appropriate irrigation water supply. This varies with the daily rainfall. The system is closed down for respectively 1, 2 or 3 days after 10, 20 or more than 25 mm daily rainfall.

The pipe network system have been designed that approximately 20% of the farms can get water at the same time. This means there are 5 watering cycles per day. CWSA
employs System Operators to implement this irrigation operation schedule. The present schedule is: twice an irrigation supply for two hours to each farm, providing 6 mm of water.

This implies that the System Operator has to make his round through the scheme five times in the day time and five times at night time. To reduce the work load of the System Operators, gradually the water control heads at the farms are being automated. The task of the System Operators will gradually be reduced to (preventative) maintenance and sporadic checking.

![Photo 2 The blue and red control head regulates the irrigation water to this banana farm in Langley Park, St.Vincent, during dry season 1999. Each farm receives twice per day 2 hours water, in total 6mm per day.](image)

Problems experienced

There are four levels of problems that are experienced in these new schemes,

The first is the institutional level. Irrigation is a capital intensive and is being provided to the farmers on credit. There need to be a procedure which ensures that the money invested is being repaid. The farmers are given a grace period of two and a half years to bring their farms into full production. The repayment would therefore be made under the conditions of increase production. A contract is made between three parties: the farmer, the CWSA as project implementation unit and the BGA, the Banana Growers' Association, the vehicle to collect the repayments through a deduction on the price paid for the sale of bananas.

The payments comprise the cost for replacing the drip lines drip lines after 8 years, and an annual charge towards the capital cost of the main pipe distribution network and for the O&M and a contribution to the central Irrigation Management Unit running costs. A total of 3.2 cents per lb bananas is being deducted for this purpose. In the present setup
the farmers cannot sustain the costs of maintaining a central Irrigation Management Unit

The farmer is the person who has a title to the land. Problems arise when the person cultivating the land is not the same as the one that holds the title. This can have a variety of reasons such as land is shared cropped, land has been sold without changing the lease, a relative is cultivating the land, etc.

However administratively the titleholder is the only legal signatory, and can be time-consuming or can cause much confusion before it is sorted out. For instance, in the project are still 35 cases pending after two years out of 500.

Other problems arise from the social level. Farmers by nature are very individualistic. They are not quick to form co-operatives, water user groups or other communal entities. The result may sometimes be that farmers tamper with system to get water at their own time, thereby disrupting the supply to other farm. Beside the farmers there are other people (children, passers-by) who interfere with the equipment, mostly the control heads.

People try to get water for a drink, to mix chemicals for spraying bananas or to wash their car. Thus parts get broken or get missing. In short, vandalism is a problem. In St. Vincent we work on two strategies to overcome this (a) Education of farmers and visiting school children and (b) To build a protective shed around each control head and to take off all handles from the valves

A social problem is also the farmer, or his labourers, are not used to having irrigation drip lines in his field. It requires special care NOT to cut them when weeding by cutlass! If cut the farmer's tendency is to turn to the government or CWSA for help instead of doing these simple repairs by themselves.

The third set of problems arises from the technical level. First and foremost is the high sediment load of the river water. The major critical point of drip irrigation technology is the need to have clean water that will not block the emitters. For this purpose an appropriate number of media filters are built in the system.

However as the schemes are run-of-the-river, the water carries momentarily a dramatically increased amount of silt, sand, gravel and even rocks and trees that swamp the intake structure. One or two days of tedious manual labour are needed to excavate the sediment and free the intake opening. after each heavy rainfall

The system functions generally satisfactorily. When it malfunctions it can mostly be traced back to sediment entering the system and small grains of sand blocking the tubes of the pressure regulators or sticking in the membranes of the automatic valves. Frequent flushing of the filters is an important maintenance activity

Last but not the least important problem is the issue of management. Although the trend worldwide is to eventually pass the management of the irrigation schemes to the farmers in an effort to reduce the overhead cost this is not the case (yet) in SVG as due to the
large number of small size farms (average 2-3 acres) there are no existing management models in the Caribbean for St. Vincent to benefit from.

The irrigation schemes in St. Vincent vary from 15 to 500 acres (6-200 ha) and are all centrally actively managed by an Irrigation Management Unit. It requires one System Operator for each 100 - 200 acres depending on the size of the scheme. An Irrigation Technician can supervise up to 10 System Operators.

Education level of the System Operators is primary education only, and the Irrigation Technicians have beside secondary school advanced training in either technical subjects or agronomy. After evaluation of two years operation it seems that primary education of the System Operators is not sufficient. There are problems with reading, writing and interpreting field maps, which need to be upgraded for effective duty. The Irrigation Technicians are properly equipped with a technical advance education to diploma level.

It is a management challenge to maximise the effectivity of the System Operators who are the core of the Operations and Maintenance of the schemes.

One approach is the issue of daily work order each morning and the other approach is to give them weekly tasks such as responsibility for the intake structure, or the routine preventive maintenance on all automatic valves, or stand by for emergencies.

Presently farmers tend to report problem (the most frequent one: "My field does not wet").) in person to the nearest System Operator, and wants him to attend to his problem without delay. This jeopardises any planning.

Recently we have introduced the voicemail system. The Project Office has a phone with voicemail (a facility of Carib &Wireless, that records any message). The Project Supervisor checks the voicemail twice a day. He enters the call, with problem and data, in a Service Logbook and enters later the date when the problem has been solved. Thus he is able to plan the work for his System Operators more effectively The Service Logbook becomes an excellent monitoring tool for intensity and frequency of certain problems occurring.

By frequent analysis of the monitored data CWSA trusts that it can continuously improve the operation and maintenance and the overall management of the irrigation schemes.

**Farmer's participation**

Presently, farmer participation in irrigation is limited to the on-farm operations. Taking into account that there is little experience for further involving farmers, IMU undertakes to explore the scope and possible modalities for increase farmer involvement. The irrigation project plans for the input of a farmer trainer expert to interact with farmers on the irrigation schemes and their associated marketing and service providers to create sustainable management models in the irrigation areas.

The management responsibilities that may be vested in a Water Users Association or individuals or companies, who may contract others to carry out the tasks comprise activities, such as: operation and maintenance of water control systems,
· water scheduling,
· collection of water fees
· marketing and input supply or equipment sharing and
· farmer representation

While there may be potential for handing over substantial responsibilities to such associations (and by doing so making the system more responsive to farmers needs and less costly to Government), this needs careful and realistic exploration; initially at a modest scale. The existing legislative framework may have to be reviewed and amended to accommodate the proposed systems.

Conclusion

The results so far indicate that the irrigation project is successful in substantially increasing the production and quality of bananas in St. Vincent and the Grenadines. It has reversed the trend of the traditional fall in production at the end of the dry season. The success in St. Vincent and the Grenadines has fueled the development of the irrigation programmes in the other Windward Islands.

Ultimately, the major agricultural production in St. Vincent and the Grenadines is expected to come from the irrigated zones