COMPONENT 4

SETTING UP AND OPERATION OF A PILOT CENTRE PIVOT IRRIGATION SCHEME AMONG CONTIGUOUS SMALL CANE FARMING HOLDINGS

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INTRODUCTION

Jamaica's sugar cane is grown in distinct ecological zones characterised by varying soil types and moisture regimes. While most of the cane is grown under rain-fed conditions, about a third of the cane area falls in a southern arid zone in which natural rainfall is by itself inadequate to produce an economic crop. Soils are however fertile and the terrain relative flat permitting the mechanised agriculture associated with large scale cane growing. The 30-year mean rainfall for this zone is however less than 1000 mm/annum, though in some years totals may actually double this mean as in 2005 when passage of hurricanes resulted in an annual rainfall of 1844 mm. By 2006 however, rainfall returned to more normal levels with an average of 898 mm recorded necessitating heavy reliance on supplemental irrigation.

A fairly well developed irrigation infrastructure is developed and maintained by the Government agency - National Irrigation Commission - which provides water at subsidised rates to farmers in this area. Nonetheless, many cane growers find irrigation costs increasingly prohibitive and made worse by their use of inefficient furrow irrigation methods. Estimates suggest that traditional irrigation methods are less than 40% efficient. Largely as a consequence, growers were found to be going out of production at fairly rapid rates in recent years. The CFC project allowed for the introduction to farmers of modern, more efficient irrigation systems, such as centre pivot and drip irrigation schemes. Such technology, if successfully adopted, should result in higher yields, increased farm income and thus increase farm viability and sustainability. Component 4 of the CFC Project included the installation of a centre pivot irrigation scheme in one area and setting up of 8 small drip irrigation plots at several locations within the irrigated zone.

1. CENTRE PIVOT

General Activities

The process of installing a centre pivot scheme, Fig 1, to serve a group of contiguous cane farms in Content, Clarendon, started in 2004 with the tendering, evaluation of bids and awarding of contract. Installation and commissioning was achieved by August 2005. Natural rainfall immediately following commissioning was so great that the pivot was hardly used and therefore had little influence on the crop reaped in 2006. The first harvest for which water would have been largely supplied by the pivot was therefore that of 2007.

Initially, the scheme was deemed to be serving 18 farms covering 60.8 ha. Remapping of the area by the PEA with use of hand held GPS units and the application of local knowledge of the various field boundaries by some farmers revealed that there were indeed 16 farms as a consequence of merger and acquisition of small holdings. Actual farm land totalled 55.34 ha but total area under the pivot, including intervals and gullies, was 60.8 ha.

Management

This being a totally new technology and one requiring a more sophisticated level of management, one of the first tasks undertaken by the PEA was to organise the growers so that they would acquire a level of understanding commensurate with managing the system. Thus a Water User Group, comprised of the growers served by the system was set up in the first year. It appointed its leadership and, met on several occasions to devise strategies for functioning. Such meetings were used by the PEA to address various issues such as the occasional bogging down of the pivot, protection against cane fires,

possible vandalism, preparations for hurricanes, production costs, operation and maintenance, irrigation scheduling, the importance of team work, training, proper sugar cane agronomy, etc.

At the inception of the project fields were in a general rundown state and so much effort was directed to upgrade standards of cultivation during the life of the project. This necessitated supplying to fill gaps to ensure adequate field populations and in some instances blocks too rundown for resuscitation were replanted. Fertilizer was applied based on recommendations by SIRI following soil and foliar analyses. Routine weed control and inter-row cultivation work was carried out over the area. Two rundown field blocks, totalling 3.5 ha were replanted and two totalling 3.32 ha were planted in double row formation using the reduced tillage method.

Fig. 1: Centre Pivot in Content, Clarendon

Track Maintenance

Maintaining wheel tracks in a state permitting free movement of the pivot proved particularly challenging. With the clay soil structure the weight of the pivot soon created a groove along the wheel tracks in which irrigation water and rain water collected and tended to be constantly soggy, bogging down the pivot from time to time. This was addressed by trucking aggregates to the site and manual distribution to fill soft patches. When the pivot got bogged down and was not swiftly freed, growers tended to become impatient and revert to use of the old furrow irrigation method. This in turn created further soggy field conditions, compounding the difficulty in keeping the pivot moving. Much effort then had to be expended educating the farmers as to the disadvantage of resorting to this practice. Sometimes stoppages resulted from an overflowing main canal operated by the NIC. Such stoppages were usually brought to the attention of the NIC which then needed to carry out repairs to their canal embankments. By the end of 2007, most trouble spots along tracks were rock filled. An alternative proposal to build up these tracks through moulding in the form of cambered beds was not executed as the brief window of opportunity to do this after harvesting was spoiled by un-seasonal rains.

Several main drains and gully crossings that impeded rotation of the pivot were also targeted for remedial work. By the first half of 2006, culverts were established consisting of ribbed polyethylene (P.E) reinforced pipes and concreted outlets/inlets installed to facilitate smooth passage of the pivot wheels across gullies, Fig.2. These P.E pipes, although quite sturdy, served the intended purposes initially but collapsed under the heat of pre-harvest burning. They were subsequently re-

Fig. 2: Ribbed Polyethylene Pipe used for Culvert Crossings

placed with more sturdy and fire resistant reinforced concrete culvert pipes.

Hurricane Protection

Secured anchors comprised of buried reinforced concrete at approximately 1.5 m depths along the parking interval were constructed during the first half of 2006. In preparation for hurricane, steel cables were affixed to these anchors and looped over the pivot to hold it in position These constituted precautionary measures to safeguard the system against excessive damage, Figs 3A & 3B.

The hurricane straps endured their first rigorous test during hurricane Dean in August 2007. All stakeholders were relieved to discover that no damage was incurred. This was at least partly due to the effort made to properly secure the Pivot in advance of the hurricane.

Fig. 3A Centre Pivot Steel Anchor

Fig. 3B Steel Cable used for Hurricane Straps

Water Supply

The pivot was designed to deliver water at a flow rate of over 800 gpm. On several occasions a flow of only some 50% of design capacity was detected using a DCT 1088 Ultrasonic Flow Meter for measuring ultrasonic signal strength. This prompted investigations into the main causes of such wide deviations. It was found that the filter system was frequently clogged with debris and aquatic growth from the open canal water source being used. This filter, Fig. 4, had to be routinely flushed to restore signal strengths of over 95%. As an added safeguard, an extra pair of filters was acquired. This has since reduced the pivot downtimes occasioned by the routine cleaning of the filter.

Irrigation Scheduling

Farmers were taught how to obtain a rough estimate of soil moisture content from the feel of a sample taken rolled in the palm of the hand as a pragmatic means of determining when to irrigate. This was supported by a more scientific approach in determining the irrigation schedules from evapo-transpiration and rainfall data from instruments set up and read regularly at the site.

During 2006 the pivot was operated for approximately 18 days, delivering some 110 540 cubic meters of water. This was equivalent to 181 mm. of rainfall. At the same time, rainfall totalling 683 mm was also recorded. Total water delivered (rainfall + irrigation) for 2006 was therefore 864 mm or 525 312 cubic meter over the 60.8 ha. Irrigation totalling 4 8726 cubic meters, the equivalent of 88 mm was applied during the growing phase between April 2006 and March 2007. This volume (Rainfall + Irrigation) resulted in a total of 1094 mm and represented a significant shortfall of 406 mm for a well balanced Irrigation Schedule. The deficits of 197 and 238 mm for February and April respectively were largely by design

Fig. 4 Screen Filter System

due to drying off plans for harvesting, fig 5.

IMPACT

Given their initial state, although farms under the pivot have shown improvement and were, for the most part, noticeably more productive than neighbouring farms, there was still much room for improvement. Much more progress would have been made had growers shown the requisite application in maintaining a satisfactory standard of husbandry. Yields under the system varied with the degree of attention to farming by the respective growers. Some plots were owned by absentee operators who displayed little interest in cane farming. Although farms were hit by the various hurricanes of recent years, this would not account for the low productivity on some farms which suffered more from failure to replant, lack of timely application of weed control, fertilizing, and a need for ensuring adequate cane population density. Yields varied from a high of 109 tc/ha in a well established field to a low of 31.75 tc/ha in one that was badly in need of replanting. To be truly profitable growers need to be producing in the region of 100 tc/ha.

Economic Consideration

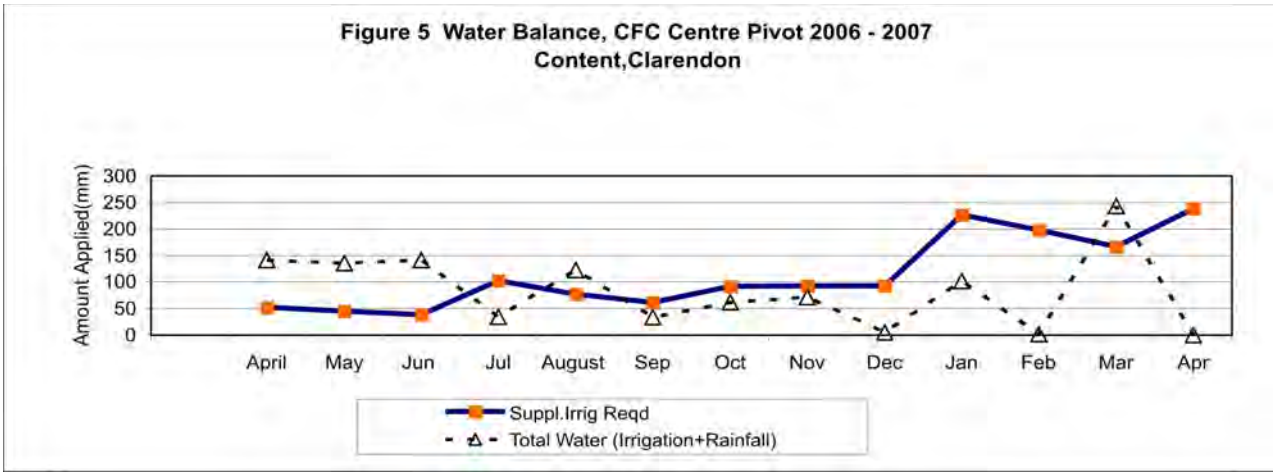
Equipment and Installation cost, Land Preparation, Planting, Cultivation, Irrigation, field infrastructure etc amounted to some J$333 888 per hectare. Given capital and operational costs, an average break even yield of 101 tc/ha at a predetermined bank interest rate of 9% was calculated. The actual yield was a disappointing 47 tc/ha.

Sustainability

From the outset of this centre pivot project, there were efforts to put in place mechanisms to ensure its continuity beyond the life of the CFC project:

1. The Water User group would see to its day to day management
2. With the consent of members of the Group, a bank account was established into which funds were deposited from two sources - (a) an agreed cess withdrawn from the sale of each tonne of cane produced and sold to the factory and (b) a recovery of funds "loaned" to farmers (at no interest) for field development work. These funds would be for the continued operation and maintenance of the system.

Figure 5 Water Balance, CFC Centre Pivot 2006 - 2007 Content,Clarendon



Public Launch

In June, 2006 there was a formal launch of the centre pivot scheme to which a wide cross section of cane growers was invited along with the local press, representatives of Government and the hierarchy of the Sugar Industry. Special guests were the representatives of the CFC, Miss Eltha Brown, and the International Sugar Organisation, Mr Lindsay Jolly. Miss Brown carried out the symbolic switching on of the system, while Mr Jolly addressed the gathering on the significance of such a project in the context of a changing market environment for sugar and co-products. The occasion was also used to showcase drip irrigation and other plots, described elsewhere in this report.

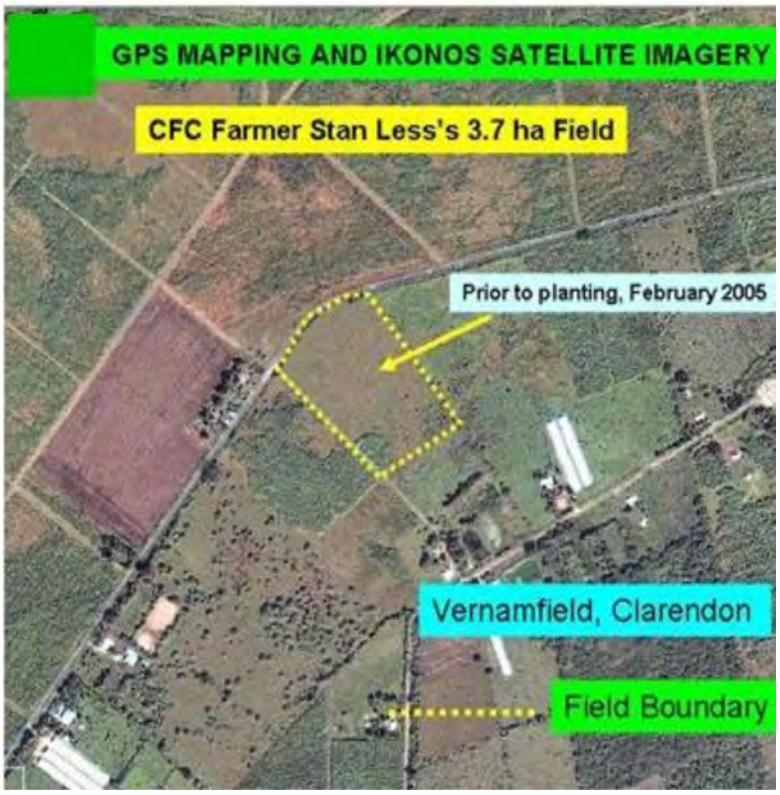


Fig. 6 GPS Mapping and IKONOS Satellite Imagery, Vernamfield

PROJECT STATUS AND FUTURE ACTIVITIES

Further financial and economic evaluation of this project will be necessary as steps are taken to achieve desired yields. Work must therefore continue to bring all fields in the zone to acceptable agronomic standards. Training and dissemination will continue with emphasis on operating and maintenance of the system. The water balance approach will continue as the most appropriate irrigation schedule. Efforts will be made to achieve block reaping so that there is uniformity of cane age under the system. Once block reaping is achieved, the system will be further adapted to deliver fertilizer (by a method called fertigation) and the whole area may be treated with sucrose enhancers by aircraft to boost sugar content before harvest.

2. DRIP IRRIGATION

Eight drip irrigation plots totalling 23 ha were laid down and planted to sugar cane in 2005 within the traditional irrigated zone on the southern coastal plains. In 2006, a further two plots were added, bringing the total area to 30 ha. Meanwhile, under the Crop Diversification component of the Project, a total of 3 ha of drip irrigation was established for 8 former sugar cane growers who were being guided in crop diversification where a factory was earmarked for closure in the parish of Trelawny in a relatively arid zone on Jamaica's north coast.

Sugar Cane: Mapping and design of field layout on the holdings of farmers selected for drip irrigation installation were carried out with the aid of GPS hand held instruments and IKONOS Satellite imagery, Fig 6 . The contractor who won the award for supplying equipment also supervised installation, while SIRI, along with the farmers concerned, undertook site preparation and drip tube layout, Fig 7. SIRI provided the tractor and tube laying implement.

IMPACT

All but one of 10 drip irrigation plots established to sugar cane exhibited impressive growth. The single failure was due to a stolen portion of irrigation main and illicit fire which together crippled operation on that particular plot.

Most of the plots were not been harvested and sold to the factory as mature cane in the first year. Vigorously growing plant canes, as produced in these plots, are usually in high demand for use as seed cane, Fig 8. The fact that they were all elite varieties made them even more attractive to potential purchasers. Several of the plots were therefore harvested within 5-7 months and material sold as commercial seed cane to other growers. Seed cane sale is usually more profitable than mature cane sold to the factory as price per tonne is competitive and it is feasible to complete two harvests of seed cane in

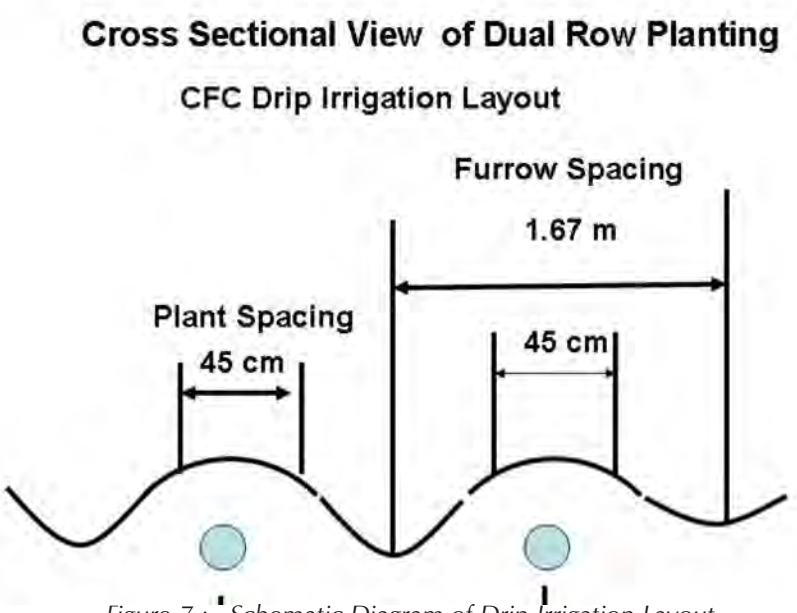


Figure 7 : Schematic Diagram of Drip Irrigation Layout

the 12 months it takes for a crop to mature for factory processing (when price may be depressed because of poor quality). As the purchaser also absorbs some of harvesting and transportation cost, the seed cane vendor therefore retains more of the proceeds than the person selling mature cane.

The quantity of cane sold as seed cane is usually estimated based on well established industry practices whereby a full bite with the mechanical grab loader is estimated to be of a certain weight. By counting the number of such bites, a rough estimate of yield may therefore be made. Using this method, yields from the drip irrigated plots have been outstanding, ranging from 110 to 148 tc/ha, Table 1, compared with average yield of less than 60 tc/ha from fields grown under commercial practice within the irrigated belt in 2006. For 2007, the water delivered (Irrigation + Rainfall) has been adequate for Nugent's and Morrison's that received 1692 and 1677 mm respectively, table1. Most of the other farms with the exception of Morgan's have so far received adequate water supply.

Economic Consideration

The total establishment cost of each system (Irrigation Equipment + Crop establishment) varied from $447 270 per hectare at Evans' farm in Rhymesbury to $187 498 per ha for Fearon's Farm, Cow Park, Bernard Lodge. The low cost at Fearon's farm was due mainly to an innovative approach to the Drip system design and layout and low cost of planting. The high cost at Evans' farm was due primarily to having to do repeat supplying before proper field establishment was achieved. With preparation of several sites being disrupted by rainfall in 2005, necessitating redoing of some operations, establishment cost varied from J$187 498.22 to $447 270 /ha. Given such variations, break even yields ranging between 84 and 112 tc/ha were projected at a bank interest rate of 9%. In the case of Fearon's project, harvesting accounted for over 33% of a 6 year average projected, production costs. This was followed by Irrigation at 20%, figure 9.

Fig. 8 Dual Row Drip Irrigated Field, Nugent's Farm

With most of the Drip Irrigated plots being used for seed canes, it was only possible to obtain the actual amount that was delivered to the factory in the cases of Morrison and Fearon during 2007. Plant cane yield of 100 tc/ha and corresponding quality measured in terms of Jamaica recoverable Cane Sugar (JRCS) of 10 were quite satisfactory results for Fearon's farm. However, at Morrison's farm, where the cane was grown for use as seed but was eventually sold to the factory, a very high yield of 154 tc/ha was obtained but the quality was poor - JRCS of only 7.5.

Crop Diversification

Up until recently, there were two government-owned sugar factories in operation in the parish of Trelawny. One, Hampden, closed a few years ago and the other, Long Pond, was also slated for closure. This jeopardised the livelihoods of farmers associated

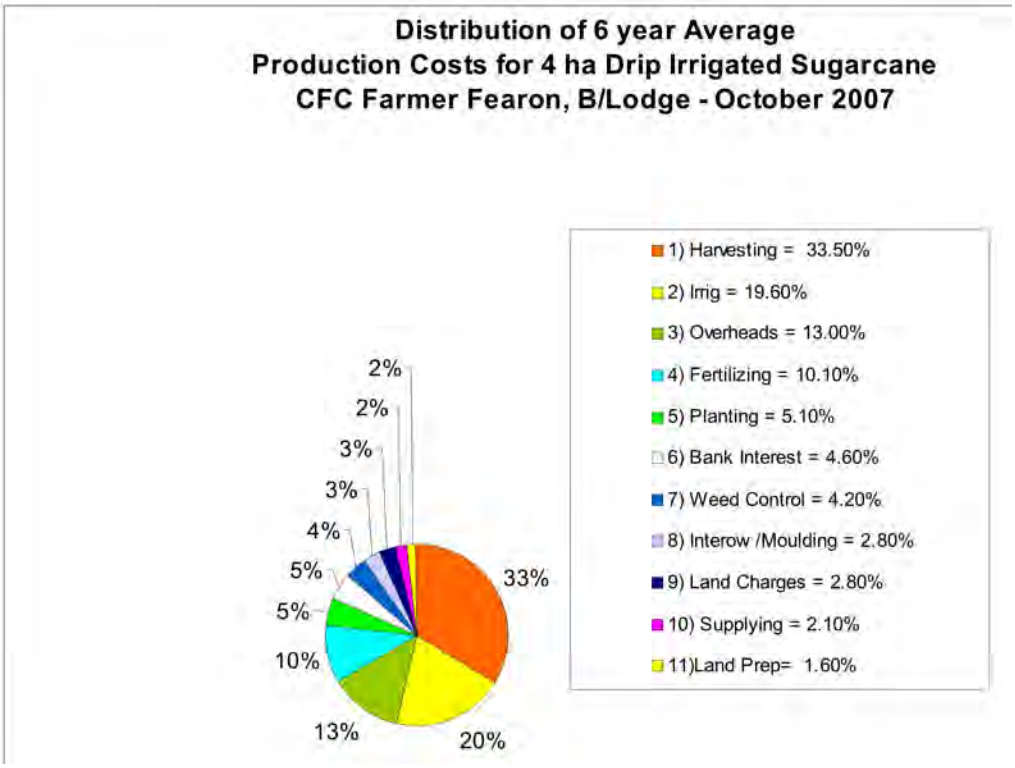


Fig. 9 Distribution of 6 year's Production Costs, Farmer Fearon's Project

with these factories. Such farmers, it was thought, would be prime candidates for the proposed Crop Diversification project.

With the assistance of SIRI's Extension staff, a number of potential participants was identified in a cane growing district at Braco, Trelawny, and invited to explore growing of alternate crops for which there were assured markets. Their farms had access to reliable pressurized irrigation water supply passing nearby. On volunteer farmers' holdings, eight small plots were laid out with surface placed drip tubes with a single tube per bank in most cases and with double lines occasionally. Plot size ranged from 0.2-0.4 ha. Mapping and design work was accomplished through use of GPS handheld instruments, figure10. Land preparation began in June, 2006.

Under the guidance of the project leader responsible for the Crop Diversification component of the project, plots were eventually planted to crops such as carrot, escallion, cantaloupe, Caribbean red pepper, Scotch Bonnet pepper, figure 11.

Fig 10 Mapping using Garmin Hand Held GPS Unit

Reflecting the demography of the Jamaican cane grower, half the plots were operated by women.

CONCLUSIONS AND RECOMMENDATIONS

The implementation of this project was generally successful amidst the challenges of extreme unseasonal weather conditions and a shortage of land preparation equipment. These challenges should be taken into account during future project designs. The poor cooperation among some farmers under the Centre Pivot scheme should be addressed by a strong focus on training in the areas of teamwork and group dynamics.

Special attention should be taken to avoid high costs of replanting while rectifying poor establishment occasioned by unfavourable weather.

The direct involvement and supervision by some farmers that resulted in improvement in production and productivity especially under the drip irrigation scheme is perceived as one aspect of

Fig 11 : Drip irrigated plot of Scotch Bonnet Pepper, Braco, Trelawny

the best practices that are worthy of replication throughout the wider industry.

An absence of regional drains especially in the irrigated plains was identified as a major constraint to the development of a drainage network. This problem may be resolved through a multi-agency approach involving the National Works Agency, the Water Resources Authority and both National Water and Irrigation Commissions.

Further financial and economic evaluation of this project will be necessary as steps are taken to achieve desired yields on a cost effective basis. This should facilitate attractive R.O.I as well as favourable NPV and IRR based on more direct links to Jamaica's macro economic environment.

Finally, training and dissemination will continue with emphasis on efficient operating and maintenance of all systems. ✯