Development of Rain Gun Irrigation System for Large Scale Irrigation of FELDA Sugarcane Platation in Malaysia

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SUMMARY: Report on the equipment and management factors in adapting rain gun sprinkler system for irrigation in a 5,000ha FELDA sugarcane plantation in Malaysia. After the big gun sprinkler system was fully adopted, the total irrigated area was increased to 3,200ha in 1986.

INTRODUCTION

The 5,000ha sugarcane plantation was developed starting in 1968 by FELDA, the biggest land development agency in Malaysia. In recent years, improvement in the irrigation system has tremendously helped to increase the plantation yield.

SOIL CONDITION

The plantation is divided into many small plots. The size of each plot is not uniform because of the existence of hundreds of swamps, ravine and small streams. The field varies from being level to having a slope of slightly less than 10% (Mohamed, 1986).

The majority of the fields are sandy and root zone is shallow; mostly less than one and a half meters. To get a more detailed classification of the soils, the FELDA Agricultural Service Corporation was hired to make a detail soil study. Chemical and particles size analysis from 35 soil profiles spread over the sugarcane area were made. Nine soil series were identified in the plantation, with four series: Shallow Chuping, Lunas, Pokok Sena, and Nami are in about 70% of the area (Table I). The results of the particle size analysis, showed that the texture of these

TABLE I: PARTICLE SIZE DISTRIBUTION OF SOIL SERIES FOUND IN THE FELDA SUGARCANE PLANTATION

Soil Series (% of area)	Percentage of paticles; Sand	Silt	Clay	N Status
Chuping (25) (Shallow and deep)	70	10	20	Low
Lunas (15)	75	12	10	Low
Pokok Sena (15)	60	10	20	Low
Nami (15)	65	20	15	Low
Laka (8)	72	12	6	Low
Sembrin (8)	68	12	16	Low
Telaga (5)	26	35	32	Low
Padang Besar (5)	53	13	32	Moderate
Perak (3)	63	10	23	Low

soils ranges generally from sand, loamy sand to sandy clay loam.

With this type of soil texture, the water holding capacity of the soil is low and consequently the plants would often suffer from moisture deficit. A study carried out showed that seen days after a heavy rain, an average of 3.4cm moisture was lost from 30cm soil depth from two adjacent fields. Of this 3.4cm, 1.8cm (53%) was lost within the first two days after the rainfall (Mohamed et al., 1981)

Nitrogen status for the majority of the soils is also low. On the other hand, P, K, and Mg status varies widely between the soil series; from very low, low to moderate.

IRRIGATION

The sugarcane yield on the plantation had deteriorated from the initial 75 tones cane per hectare (TCH) in early 70's, when the plantation was newly established, to about 30 TCH in early 80's, about ten years later. The decrease in yield is mostly due to the effects of soil erosion and deterioration of jungle soils under continuous row crop cultivation. Erosion has depleted the soil of valuable nutrients, and eroded away the top soil. Without the humus and the top layer, the plantation soils, the majority of which are sandy textured (Table I) could not store moisture.

In order to improved the yield, since 1980 the plantation management had taken remedial action by implementing effective and conservation practices and improving irrigation.

The irrigation system at the plantation could be divided into two categories namely, irrigation for establishment of the sugarcane crops and irrigation for maintaining growth (Mohamed, 1984). Establishment irrigation is the water applied either during or soon after seed materials

are planted or immediately after rationing operation is completed. Many planting operations are carried out during the dry period, and they should be done together with establishment irrigation. Without establishment irrigation, the percentage of germination is very low and most of the time the fields have to be replanted. To supply the irrigation water, by 1986 the plantation constructed more than 150 surface water storage by bunting] of streams and digging of earth channels at the side of storage areas to act as the overflow channels (Mohamed, 1986).

After a lot of field studies and many modifications on the equipment and management of the irrigation system, and after fully adapting the big gun sprinkler system, the total area irrigated during crop establishment was increased from a total area of 200ha in 1982 to 3,200ha in 1986. There was also a corresponding increase in the average plantation yield from 33 TCH in 1982 to 62 TCH in 1986 (Mohamed, 1986).

IRRIGATION METHODS

Taking into account the various size of the fields which varies in the degree of the slope, the sandy texture of the soil, and the type of labour available, the plantation experimented with various kinds of irrigation methods: furrow method, small sprinklers, supplying water into furrows by water tanks with capacities of between 3.5 – 5.5 cubic meter pulled by tractors were experimented with (Mohamed, 1984).

The plantation had even made preliminary studies on the possibilities of travelling irrigator, drip irrigation, and centre pivot systems. Two foreign companies came up with proposals of drip and pivot system: Their proposals was based on technical data provided by the plantation. The proposals were rejected.

SEMI PORTABLE BIG GUN SPRINKLER SYSTEM

In the field, the big sprinkler irrigation system was first implemented on a permanent basis for 200ha using a semi portable system. There are three parallel main lines for the system, at a distance of about 300m each, and are buried at a depth of 1.8m to avoid from being destroyed by field implements during field operation. Several fields were also irrigated using small sprinklers, and furrow systems.

The irrigation system used water from an excavated 1,500ha-cm storage pond. Water was pumped into the three buried mainlines, and could be tapped from hydrants submerged on the field. On the fields, furrow system, small sprinkler system, water tank irrigation system (Mohamed, 1984), and big gun irrigation system were also implemented initially.

After some time, the big gun system was fully adopted for the field, because the system was much easier to operate compared to other irrigation methods. With big gun system irrigated the field, at operation: it was easier to handle. A general specifications for the systems as stated in Table II.

Two models of big gun sprinkler were tested, and later some adapta-

TABLE II: THE FIRST 200ha AREA UNDER SEMIPORTABLE BIG SPRINKLES SYSTEM: GENERAL SPECIFICATION

1. Irrigated area: 200ha
2. Maximum storage of the irrigation water: 1,920ha-cm
3. Primary piple line:
   Three lines of 25.4cm dia. AC pipe buried
   Average distance between main lines: 300m.
4. Secondary pipe line:
   176pcs of 12.7cm dia. Aluminium pipes
5. Distance between hydrants: 21.8 cm
6. Maximum difference in elevation: 100m
7. Pumps: permanent multistage (4 stage)
   Number of pumps: 2 units
   Maximum total head (each): 120m
   Operating flow rate (each): 56.81ps
8. Big gun sprinkler:
   Total number of sets for the area:8
   No. of unit in operation at one time: 2
   Working pressure at sprinkler: 6 bar
   Flow rate at each sprinkler: about 551ps.

tions they were found to be suitable for the fields: RAIN BIRD model 204G power nozzle (34.8mm diameter), and BAUER R50 wide range sprinkler (Appendix I). In order to reduce the flow from the nozzle to coincide with the capacity of the pump, the nozzle diameter of the R50 was reduced to 42.1mm.

Even though the big gun was suitable for the field, and was found to be more practical compared to other irrigation methods, the initial investment for the semi portable system was very expensive. It cost $370,000 just to bury the 25.4cm diameter main lines at the depth of 1.5 meters. Since the land surface is undulating, high total head at the pump was also required. It was very costly to have the two multistage pumps that could produce 120m total head and a flow rate of 571ps each, permanently stationed for an area of only 200ha: less than one twenty-fifth of the plantation area.

PORTABLE SYSTEM

Since the crucial part of irrigation in this plantation is to establish the crop, what the plantation really needs is just a practical portable system that could easily be transferred to another planting area once irrigation for the field had been completed for two or three rounds.

The sprinkler heads came without the supports. Various designs for the support of the sprinkler head were produced and tested, before an acceptable design was accepted. The support should be stable and able to withstand the thrust of the jet of water, but has to be light and simple enough so that it could easily be moved to the next irrigation point through wet and muddy area, and also to another field to be irrigated.

Adjustments to the nozzle size itself had to be made. BAUER R50 comes with six standard nozzle sizes (diameter): 33.2mm, 36mm, 39.7mm, 42.5mm, 46.0mm and 48.7mm. With the supplied nozzle sizes, the system curves were not compatible with the pump curve. The 39.7mm nozzle was too small. On the other hand the 42.5mm nozzle tended to produc-

ed too much flow and cause the pump to become overheated. It was not an easy task to identify that the problem on the multistage turbo pumps was due to the nozzle size, and many trials had to be conducted before the plantation decided to replace the supplied nozzles with their own 42.1mm diameter nozzle.

Usually five to ten fields were irrigated simultaneously. These fields vary in size and could be kilometers apart, and each field requires a different number of pipes. Initially the plantation had four types of pipes: 101mm and 127 mm diameter pipes made of PVC and Aluminum. After having difficulty in the relocation of the different types of pipes, only one size: 127mm diameter 12mm length Aluminum pipe, together with quick couplings were found to be suitable.

Many sizes and makes of pumps were used initially. After having problem in obtaining spare parts, and of different capacities and different operation procedures that tend to confuse field workers, only two kinds of pumps were suggested and are now used widely. One is a particular 22Kw model pump placed on a set of tires which allow it to be pulled by tractors, and the other is PTO pump.

By 1988, the plantation has 112 units of big sprinklers and 3324 pieces of 127mm diameter Aluminum pipes (Table III). The number of pumps is relatively small because for fields that are to be irrigated by irrigation contractors, the contractors have to use their own pumps.

TABLE III: MAJOR IRRIGATION EQUIPMENTS FOR RAIN GUN IRRIGATION AVAILABLE IN FELDA CHUPING PLANTATION (1988)

1.	Big sprinkler: 112 pcs @ ($2,500 + $300)	M$313,600
2.	Aluminium pipes (127mm 0): 3324 pcs @ $235	M$781,140
3.	PTO pumps: 40 units @ $3,500	M$140,000
4.	Mobile pumps: 8 units @ $13,000	M$104,000

OPERATIONS AND SUPERVISORY REQUIREMENT

To actually irrigate the field is a very big task. To run 50 big guns at ten different locations, kilometers apart, at the same time is very difficult to manage. The labourers are the settlers of the plantation. They are the shareholders of the plantation, so they cannot be fired or replaced; this could work both ways for the efficiency of the irrigation operations.

To control the depth of irrigation, and the irrigation uniformity was difficult. The initial moisture status, difference in elevation, and wind speed varies greatly between fields to be irrigated, so to set the depth of irrigation through setting the hours of operation could be misleading. By monitoring the depth of drops by simple can technique, the amount of irrigation could practically be controlled.

The get a continuous, effective and consistent supervision at field

level, the field staff at field assistant, supervisor, and section manager levels were given in-house training on technical aspects of irrigation, especially big gun irrigation.

But the first big problem was to convince the administrators that what the plantation needed was a practical irrigation system that was suitable for the plantation, which need not necessarily be expensive and impressive system as were suggested by visiting "irrigation experts".

CONCLUSION

Chuping sugarcane irrigation was the first big scale field crop irrigation in the country. Couple with the low water holding capacity of the soil, various sizes and slope of the fields, and water source for irrigation were not developed earlier, to design and operate a practical irrigation system for the plantation was a very challenging job. With big gun irrigation system the task could be simplified to some extent. After various modifications to the big gun supporting assemblies, nozzle sizes, using portable systems with a one size aluminum pipes and couplings, and deciding on operating procedures at field levels, the big gun irrigation was found to be very practical for the FELDA plantation

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Appendix A: Technical data for the two types of big gun used.

Rate of flow and spray range for 39.7mm and 42.5mm diameters ring orifice R50 BAUER Circular Sprinkler (BAUER Publication).

Pressure at sprinkler; bar	Nozzle diameter; mm			
	39.7		42.5	
	Q; ha-cm/h	Range; m	Q; ha-cm/h	Range; m
4.0	0.90	57.6	1.07	60.5
4.5	0.96	59.4	1.14	62.3
5.0	1.01	60.9	1.12	64.0
5.5	1.06	62.4	1.25	65.5
6.0	1.10	63.8	1.31	67.0
6.5	1.15	65.1	1.37	68.3
7.0	1.19	66.3	1.42	69.6
7.5	1.23	67.5	1.47	70.8
8.0	1.27	68.6	1.51	72.0
8.5	1.31	69.6	1.56	73.1
9.0	1.35	70.6	1.61	74.1

Note: At the plantation the nozzle diameter was reduced to 42.1mm.

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RAIN BIRD power nozzle performance for 204G-23 degrees trajectory (RAIN BIRD publication).

Elbow gage pressure; bar	34.8mm diameter nozzle	
	Q; ha-cm/h	Spray range; m
5.0	1.07	63.8
6.0	1.18	68.4
7.0	1.28	71.6
8.0	1.37	74.0
9.0	1.45	76.6

REFERENCES

Mohamed Daud, Muktar Che Ali, Adnan Salleh (1981), Preliminary Study on Soil and Water Relationship at Yunit Tebu FELDA Chuping Perlis; Practical Training Report FKP UPM.

Mohamed Daud (1984); An Analysis of Irrigation Operation in FELDA Sugarcane Project at chuping; Land Development Digest, 6(1) 39)49.

Mohamed Daud (1986); Development of Surface Water Storage for Irrigation at FELDA Sugarcane Plantation in Malaysia; Conf. on Ag. Engine; Adelaide 24-28 Aug. 86, pp49-51.

Mohamed Daud (1987); Development of Surface Water Storages for Irrigation at FELDA Sugarcane Plantation and its effect on Yield; Land Development Digest 8(2) Jun 87, pp18-27.