SOUTH AFRICAN SUGAR INDUSTRY A(vii)

AGRONOMISTS' ASSOCIATION

TRIAL RESULTS

Cat. No.: 1848 CODE: MD S10/6/90/SW/IYSIS 'Zn'

TITLE: MOLE DRAINAGE IN A DUPLEX SOIL

1. PARTICULARS OF PROJECT

Site : Block S10/6

Region : Northern Irrigated (Swaziland)

Design : Observational Trial (See layout)

Soil Series : Zn/Zikane

	Texture (%)		
	Clay	Silt	Sand
0-20 cm	53.0	6.1	40.5
40-60cm	57.0	8.9	34.0

Irrigation : Furrow

Dates : 1/06/90-20/09/91

2. OBJECTIVES

2.1 To observe the performance of this technique in terms of discharge flow rate and effect on water EC and SAR.

2.2 To evaluate the installation of the drains in terms of shape and deformation of the mole channels and sealing of the tine leg slot.

3. MOTIVATION

In the poorly structured soils at Ricelands estate water-logging is a major limitation to sustainable sugarcane cropping. Sub-surface drainage is required to alleviate this problem. Conventional sub-surface drainage using PVC slotted pipes, however, becomes uneconomical at spacings below 20m. Hence, there is a need to assess mole drainage. If successful this technique could be used to supplement PVC drains. This would overcome the cost limitation of effectively draining areas with low hydraulic conductivity.

The installation of effective mole drains is technically a difficult operation, particularly under furrow irrigation. Some of the constraints in terms of soil texture, and timing which must be met for successful installation of mole drains under rainfed condition were discussed by Dewey, Meyer and George (1987). Under furrow irrigation an additional requirement for success is the need for effectively sealing the leg slot left by the tine connecting the mole bullet to the plough beam. This is particularly important to avoid inflow of surface irrigation water directly into the mole channels.

Prior to testing the effect of the viability of the technique against cane yield response it is necessary for the technicalities associated with the installation of the mole drains to be solved and the adequacy of the equipment to be tested. The success of the installation could be tested by monitoring the discharge flow rate after irrigation events to ascertain whether the drain works and by analysing the quality of the discharge water to determine whether the irrigation water enters the drains via the leg slot or via the soil. In addition a visual inspection, following excavation of selected drains at the end of the trial, could be conducted to confirm the interpretation of the flow and water quality data.

4. TRIAL LAY OUT

Seventy eight mole channels at 1.5 m spacing each 100 m long were drawn in-row at a depth of 0.9 m. The mole drains discharged in the gravel envelope of a specially constructed sub-surface collector drain (Fig.1). The collector could be accessed from a manhole.

Flow discharge and the quality of the discharge water in the collector were monitored from this manhole at regular intervals after an irrigation event.

Piezometers were installed above each mole drain at the point of interception with the sub-surface collector (Fig.2) allowing inspection of the individual mole drains.

Note on equipment

The mole plough was fitted with a wedge shaped attachment behind and above the mole bullet (Fig.3). The purpose of this attachment was to attempt sealing the leg slot by compaction.

5. RESULTS

5.1 Discharge flow and water quality in collector

Fig.4 shows typical patterns of discharge flow rates, EC and SAR observed in the collector after an irrigation event. The discharge flow rate is shown to increase dramatically within hours of commencement of irrigation. The flow rate peaked several times before abating +- 10 hours after the onset of irrigation. EC and SAR both followed inverse patterns to that of the flow rate i.e. when the flow rate peaked EC and SAR were at a minimum and vice versa. 24 hours later the discharge flow rate is seen to increase again but this time in a steadily manner. At 30 hours the flow rate appears to have reached a plateau. In apparent response to the increase in flow rate, EC decreased slightly.

SAR measurements on the other hand were found to be variable and no relation to flow rate was evident. It became apparent from examining the hydrographs that the flow rate pattern in the first 12 hours reflected the irrigation pattern. The succession of flow rate peaks *corresponded to the opening to irrigation of new* sets of furrows. It was clear, therefore, that irrigation water was flowing directly into the drains without transiting through the soil. This means that the leg slot had not been effectively sealed.

The pattern of discharge flow rate SAR and EC at the tail end of the hydrograph suggest that irrigation water transiting through the soil reached the collectors about 24 hours after the onset of irrigation.

5.2 Piezometer Measurements

Table 1 : Depth from soil surface to water (cm) in randomly selected piezometers

		Mole Pipe Number									
		16	18	22	28	35	39	46	59	66	74
	-1	90.0	90.0	90.0	90.0	90.0	90.0	90.0	61.0	69.0	58.0
	1	69.0	90.0	90.0	90.0	70.0	90.0	90.0	0.0	87.0	58.0
	2	78.0	90.0	90.0	79.0	76.0	90.0	83.0	60.0	66.0	39.0
No. of Days	3	90.0	90.0	90.0	80.0	77.0	90.0	85.0	62.0	69.0	49.0
Since	4	90.0	85.0	90.0	80.0	90.0	90.0	90.0	62.0	67.0	58.0
Last	5	90.0	90.0	90.0	90.0	90.0	90.0	87.0	62.0	67.0	56.0
Irrigation	6	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0
	7	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0
	8	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0

If a drain works properly, no water should be found in the piezometer, that is the distance measured in the piezometer should be 90 cm (depth at which the drains were installed). The data in Table 1 show that for most drains this was not the case. A day after irrigation, water at various depths was found in 70% of the piezometers, indicating that the flow of water in the majority of the drains was being obstructed. The magnitude of the obstruction was variable. It was slight where the water apparently drained within 48 hours (drains 16, 28, 35), heavy where it took a week (drains 59, 66) and permanent where drainage was never completed (drain 74).

There are two possible explanations for the slow flow of water in the drains. Firstly the Z set soils, being inherently high in Sodium content, have a tendency to disperse when irrigated with water of low electrolyte concentration. Thus, the fact that clean surface irrigation water flowed directly into the drains might have caused dispersion. The slurry of dispersed soil would have been washed into the gravel envelope blocking pores and or the channels themselves. The second possibility is that when the mole drains were pulled, soil was dragged across the gravel layer creating a local seal.

5.3 Excavation observations

Three drains were excavated after harvest by digging pits at various points along their length. The first point of excavation was sited at the interception between mole drains and the collector. The following observations were recorded:

* The end of all three mole channels were filled with slurry. In one case it was found that the whole channel had collapsed and filled with slurry. This slurry accounts for the slow flow of water in the drain and explains the piezometer observations.

* The shape of channels instead of a circular shape was of a rather distorted oval shape. Fig. 5 shows the approximate shape of the channel and the angle at which the mole plough must have travelled. This is a flaw in the drain installation and one that can cause the drain to fail.

After cleaning the slurry in the two intact channels discharge flow rates were observed. The first mole drain responded within 15-20 minutes of the furrow being irrigated. The water discharge rate was estimated at 1.0 l/s and remained at this level until irrigation had been cut off. This clearly confirmed that water flowed directly from the soil surface into the drain.

6. CONCLUSION

* Results of this trial revealed flaws in the method of mole drainage installation. These will have to be attended to before mole drainage can be contemplated at IYSIS.

* Patterns of water discharge flow rate showed that the slot leg was not properly sealed. This not only can reduce the efficiency of furrow irrigation but can lead to the dispersion of the soil in the mole channels. Dispersion results in blockage of both the collector envelope and the mole channels, slowing down the flow of water in the drains and ultimately can cause the collapse of the drain itself.

  Both these conditions were evidenced in this trial and it was estimated from piezometer observation that the problem affected +- 70% of the mole drains.

* Visual inspection of excavated mole channels showed that the mole plough travelled at an angle. This problem is likely to have compounded that of direct surface water inflow and contributed to the weakening of the channels' stability.

7. RECOMMENDATIONS

It is essential that the mole plough be modified. The following are the recommended modifications:

* Raise the wedge attachment so that the leg slot be sealed nearer the soil surface.

* Means of ensuring that when travelling the mole plough is levelled will have to be devised.

* Fit a small tine behind the expander to prevent smearing the collector envelopes with soil when pulling the mole plough.

8. REFERENCES

Dewey, F.J., Meyer, J.H. and George, J.A., 1987. An evaluation of the suitability of soils for mole drainage *in the South African Sugar Industry. Proc. S. Af. Tech. Ass.* 61, 133-138.

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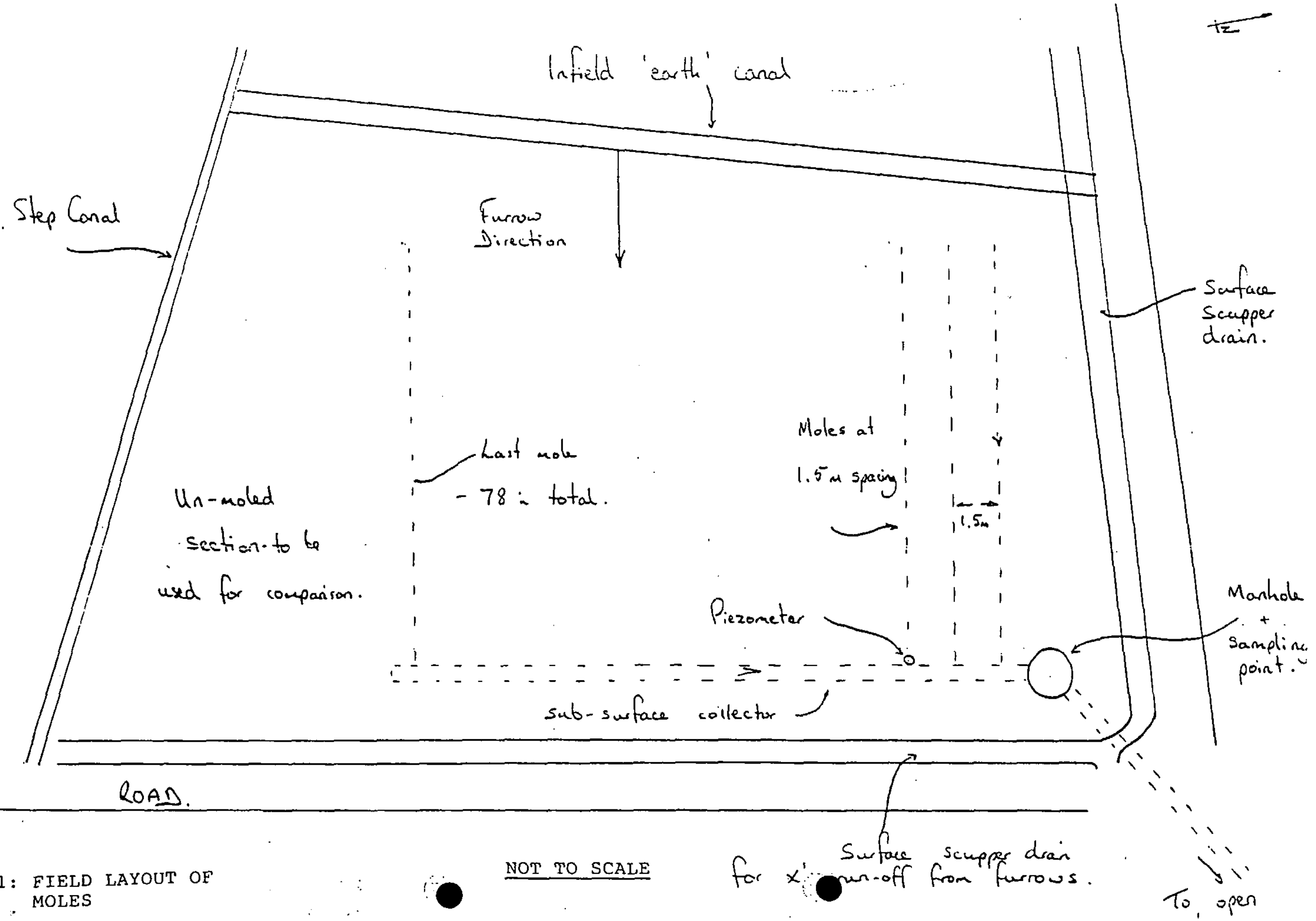

NOT TO SCALE

FIG.1: FIELD LAYOUT OF MOLES

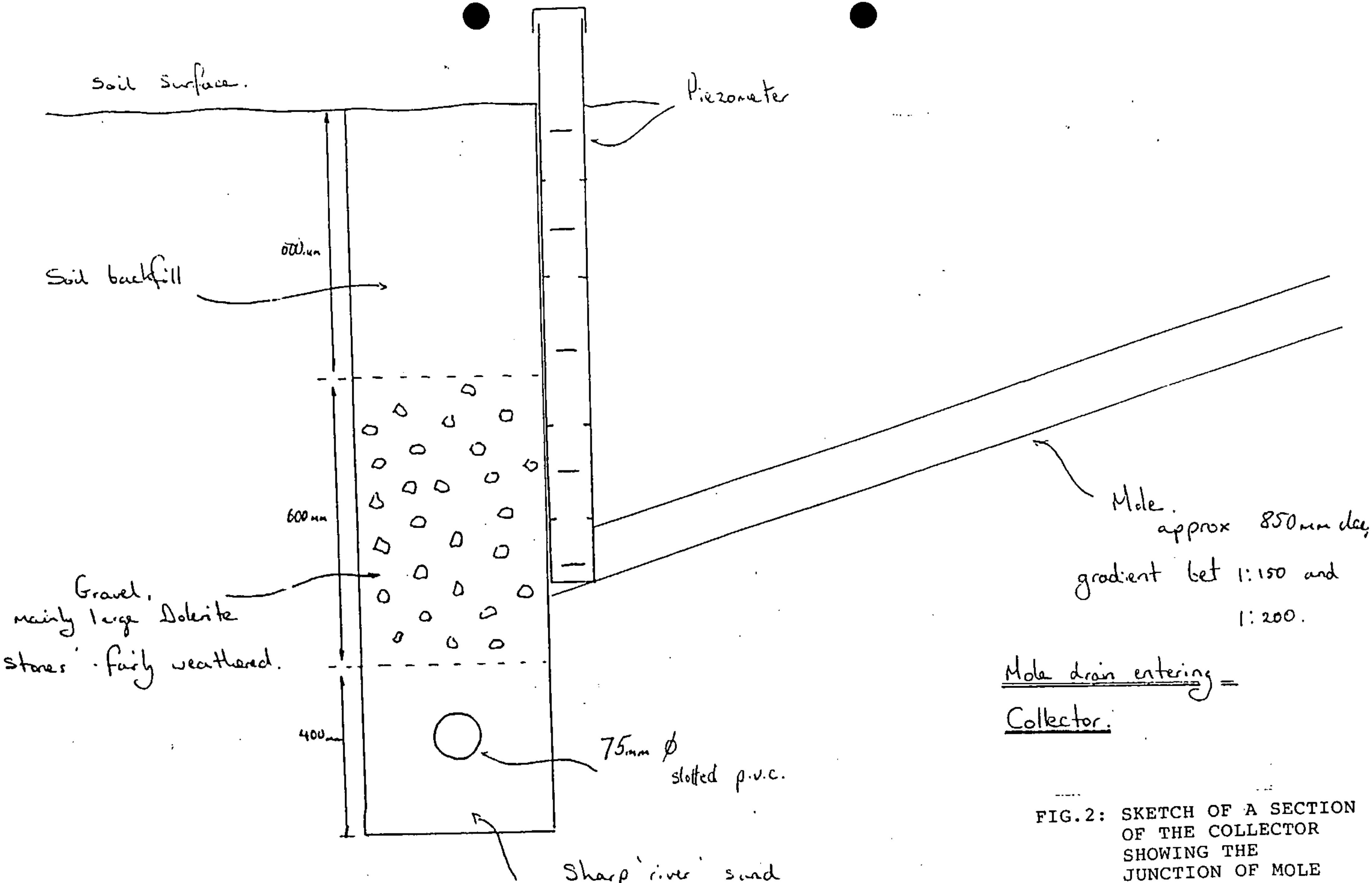

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FIG.2: SKETCH OF A SECTION OF THE COLLECTOR SHOWING THE JUNCTION OF MOLE CHANNELS WITH THE GRAVEL ENVELOPE AND LOCATION OF THE PIEZOMETER

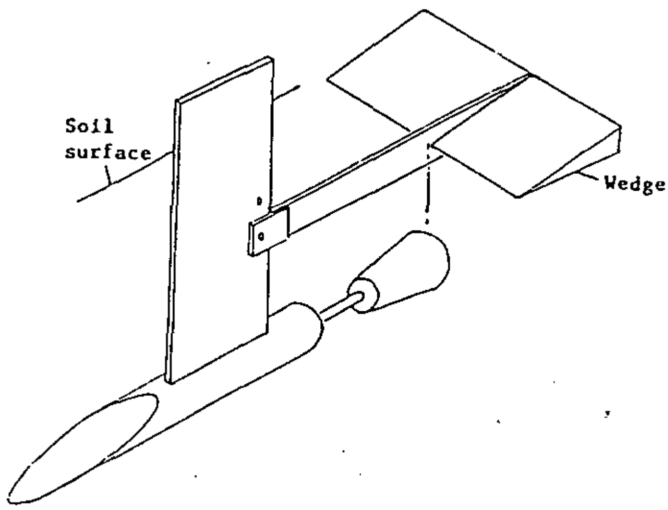

FIG.3 : MOLE PLOUGH WEDGE FOR DISRUPTING
LEG SLOT AND FISSURES

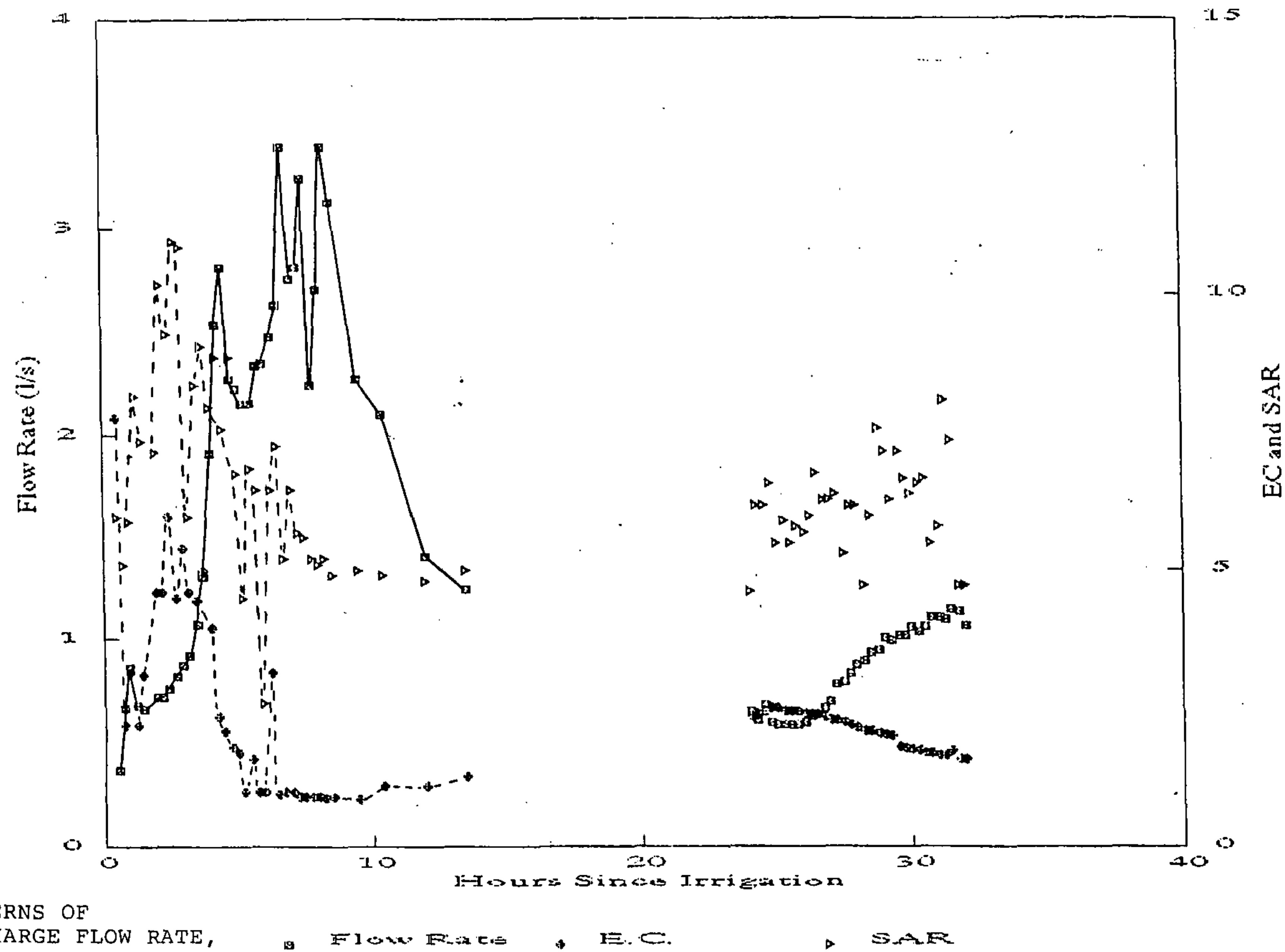

FIG.4: PATTERNS OF DISCHARGE FLOW RATE, EC AND SAR OBSERVED AT THE COLLECTOR AFTER AN IRRIGATION EVENT.

FIG.5: SHOWING CONSEQUENCES OF AN INCORRECTLY ANGLED MOLE PLOUGH ON CHANNEL SHAPE