SOUTH AFRICAN SUGAR INDUSTRY
AGRONOMISTS' ASSOCIATION

PROGRAMME FOR ANNUAL GENERAL MEETING 27 OCTOBER, 1977

10.00	Chairman's Report General	
10.15	Review papers 1. "Water use by sugarcane" 2. "Irrigation of sugarcane"	Dr Gerald Thompson
11.15	TEA	
11.35	"Rainfall use efficiency"	Murt Murdoch
12.00	"Moisture stress in relation to R.S.D., Smut and Variety Susceptibility	Doug Hellmann
12.30	LUNCH	
2.15	"Some controversial aspects of soil conservation"	Rob Paxton
2.45	"Practical experience in subsurface drainage"	Roger Stewart
3.15	"High volume sprinklers"	Mike Clemitson

1. Notice to Gyllenvion

2. Coldy Meyer - guard - targets
Roundup - Grand Jury

SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION

NOTES ON THE RATIO : YIELD/UNIT OF WATER

by M.G. Murdoch

These notes are an attempt to examine the ratio, pointing out some requirements and pitfalls, when using the measure as the criterion for efficiency and a yardstick for comparison.

The expression of yield and efficiency

Sugarcane, having a vegetative yield, and an indeterminate interval and time at which it is harvested presents a problem for the expression of a yield figure which can be used to make comparisons. About 10-12 years ago yield/unit time (tons/ha/month or annum) began to be used fairly generally and more recently yield/unit of water came into use.

Yield/unit of water is attractive for two reasons. Firstly a 'potential' figure has become available as a target yield. Secondly this measure makes an allowance for variation in conditions under which the crop is grown in terms of the major limiting factor which is not usually subject to control. In theory it becomes possible to compare yields from region to region, from one season to another, crops having had two summers growth versus those having experienced only one, etc.

For it to become really useful at a practical level it should gauge the yields of individual crops. It needs then, to be a fairly stable measure and not be subject to rather harge haphazard fluctuations (eg. showing a high value in a low rainfall season and vice versa). Both the measurement of yield and the measurement of water could be at fault in causing untoward variations.

The measurement of water

The ratio is obviously dependent on a reasonably good estimate of the water being available for the particular crop (sometimes this may not be possible and should be accepted).

In practice this will usually mean that rainfall data which are representative for the area under consideration should be available (if another source also contributes it would need to be estimable).

The question arises of how best to calculate an estimate of effective water, and whether an adequate approximation is obtainable in a sufficiently simple manner for it to be usable in practice. Many alternatives can be suggested and a few are listed below.

1. Use of the profit and loss type of moisture balance involving estimates of actual evapotranspiration and TAM values.

2. Total rainfall

3. Discarding certain categories of rainfall (eg. one which has been suggested is to discard rainfall in excess of 50 mm/day, 150 mm/week and 250 mm/4 weeks.)

4. Adjustment factors to be applied to total rainfall could be determined for various regional areas and published regularly by a central body.

A way of judging the various methods would be to compare them with the best available method using historical rainfall records. For example, if the profit and loss estimate is taken as the standard and total rainfall is to be tested then the two estimates are calculated for each year and the difference assessed for their consistency. An adequate method would be one with acceptably small variation in the deviations from the standard and if necessary it could be scaled to eliminate the average difference.

The Measurement of Yield

Several measures of yield could be appropriate. Usually yield has been expressed as t cane/ha when relating it to water. We could consider using sucrose or sugar yield, dry matter yield or Brix yield. It seems necessary to decide whether the efficiency ratio is to be indicative of growth only and to define what measure of growth to use, or to what extent quality criteria should be taken into account.

The use of t cane/ha can be criticized but it has the advantage of being traditional and convenient. It is variety dependent and varieties are normally chosen and certainly selected for their sucrose yield. Moisture content can vary and cane yield can be influenced by the amounts of trash, tops and other extraneous matter. Much the same criticism can be levelled at the use of dry matter yield and there is the disadvantage of it not being a familiar measure. Sucrose yield seems to be the logical choice since it to a large degree overcomes the previously mentioned criticisms and it is of course the objective of sugarcane agriculture. There is the point that sucrose yield is influenced by the time of year of the harvest or by other circumstances which may make the sucrose content low at an unavoidable harvest time. Brix yield would to an extent counter this objection but it would be more acceptable and amount to the same thing to adjust the sucrose yield to that at a standard purity.

MM/PMO
24th October, 1977

THE EFFECT OF MOISTURE STRESS AND R.S.D. ON VARIETAL PERFORMANCE AND THE INCIDENCE OF SMUT

by

D.B. Hellmann

INTRODUCTION

It has been common knowledge for a long time that R.S.D. can reduce the yield of sugarcane markedly under rainfed conditions. The irrigated areas of the S.A. Sugar Industry are relatively young and during the 1960's it was not really known what effect R.S.D. had on the yields of irrigated cane. It was suspected that these effects were not as great as those which occurred under rainfed conditions, but this had not been measured quantitatively.

In 1971 an experiment was established on the S.A.S.A. Pongola Field Station in an attempt to determine what effect R.S.D. had on the yield of 3 varieties, which were subjected to three different irrigation cycle times. It was hoped that these cycle times would create the three following moisture regimes: stressed, slightly stressed and conditions of adequate moisture.

The 3 varieties used were NCo 376, N53/216 and N55/805. Healthy seedcane of each variety was obtained from heat treated propagation plots, while the RSD infected seedcane was obtained from RSD demonstration plots and Mount Edgecombe.

The initial object of the trial, i.e. to determine the effects of RSD on the yield of cane under different moisture regimes, was carried out during the plant to 3rd ratoon crops of the trial. In the 4th and 5th ratoon crops, adequate water was applied to the whole trial in an attempt to see whether or not varieties (both healthy and R.S.D. infected), which had previously been stressed, could recover and produce yields similar to those obtained from a crop which had always received adequate water.

During the six crops of this trial, smut whip counts were recorded and this resulted in a third source of information, namely the effect of soil moisture stress and RSD on the intensity of smut infestation in susceptible varieties.

PRESENTATION OF DATA

The deep Makatini series soil on which the trial was established, has a TAM of ± 200 mm, and the interference of rainfall made it difficult to impose three distinctly different moisture regimes. An examination of the yield data indicated that the two wetter moisture regimes produced yields which were very similar. For the purposes of this presentation therefore, only two moisture regimes have been referred to; the dry (stressed) and the wet (the mean of the slightly stressed and adequate moisture) moisture regimes.

In order to obtain the overall effect of RSD and moisture stress on the tc/ha and ters/ha yields, and the ERS % C content, the mean yield results for the plant to 3rd ratoon crops (different moisture regimes) and for the 4th and 5th ratoon crops (same moisture regime) have been used for each variety.

RESULTS AND DISCUSSION

1. The effect of moisture stress and R.S.D. on the tc/ha yield.

The effect of moisture stress and R.S.D. on the tc/ha yields of the three varieties are presented in figure 1.

1.1 The effect of moisture stress on tc/ha yield

1.1.1 Healthy cane: Considering the yields obtained from the healthy cane it can be seen that NCo 376 gave the highest yield under wet conditions, while N53/216 and N55/805 gave similar yields. The stressed conditions reduced the yield of NCo 376 by 16%, N53/216 by 12% and that of N55/805 by 27%. It would therefore appear as if the healthy N55/805 is less tolerant to moisture stress than the other two varieties. In three out of four crops in an adjacent variety X irrigation trial, N55/805 tended to perform better, relative to the other varieties, under wetter conditions than under dry conditions.

1.1.2 Diseased cane: Under conditions of adequate moisture NCo 376 and N55/805 produced similar yields and N53/216 a lower yield. Stress conditions reduced the yield of NCo 376 by 32%, N53/216 by 27% and N55/805 by 23%, indicating that RSD infected NCo 376 appears to be less tolerant to moisture stress than N55/805.

1.2 The effect of R.S.D. on tc/ha yield

1.2.1 Stressed conditions: Under stressed conditions, R.S.D. reduced the yield of NCo 376 by 26% and N53/216 by 28% and increased the yield of N55/805 by 1%. Although the diseased N55/805 produced slightly higher yields than the other varieties, the reason for its different response pattern is partly the fact that the healthy N55/805 performed poorly under dry conditions.

1.2.2 Conditions of adequate moisture: Under conditions of adequate moisture, R.S.D. had a smaller effect on the tc/ha yields, the yield reductions being 9% for NCo 376, 13% for N53/216 and 5% for N55/805. This trial has therefore demonstrated that the effects of R.S.D. on tc/ha yields are less severe for irrigated cane than for dryland cane.

1.3 Recovery of previously stressed cane

1.3.1 Healthy cane: When adequate water was applied to the crop which was previously stressed, all the varieties showed the ability to recover in terms of tc/ha yield. The yield of the previously stressed cane was greater than that of the cane which had always received adequate water in the case of NCo 376 (7%) and N53/216 (20%), while it was slightly less in the case of N55/805 (3%). The yield obtained in the 5th ratoon crop from N53/216 which had always received adequate water, was lower than normal and this has exaggerated the difference between the two treatments.

1.3.2 Diseased cane: The diseased cane, which had previously been stressed, also recovered on receiving adequate water, the yields being 1% lower than the previously unstressed, RSD infected crop for NCo 376, 6% for N53/216 and 10% for N55/805.

1.3.3 Effect of R.S.D.: Where the crop had always received adequate water, R.S.D. reduced the yields by 8% (NCo 376), 12% (N53/216) and increased that of N55/805 by 2%, during the 4th and 5th ratoon crops. For the previously stressed crop, the R.S.D. reduced the yields of NCo 376 by 14%, N53/216 by 30% and N55/805 by 6%. It would therefore appear that when adequate water is applied to R.S.D. infected NCo 376 and N55/805, which had previously suffered moisture stress, the effects of the R.S.D. would be similar to those where the crop had always received adequate water.

2. The effect of R.S.D. on the ERS % C of 3 varieties subjected to different moisture regimes.

Table 1. The effect of R.S.D. on the ERS % C of NCo 376, N53/216 and N55/805 when subjected to different moisture regimes.

Variety	ERS % C: RSD - Healthy			
	Plant-3rd R		4th and 5th R	
	WO	W	WO	W
NCo 376	0,4	1,9	-0,2	0,9
N53/216	1,1	1,5	-0,6	0,4
N55/805	1,7	0,4	-0,2	0,9
Mean	1,1	1,3	-0,3	0,7

RSD tended to increase the ERS % C content of both the stressed and unstressed cane, the response appearing to be greatest for the unstressed NCo 376 and N53/216, and for the stressed N55/805. The relatively small response to R.S.D. for the unstressed N55/805 is partly the result of a very low ERS % C value recorded for the plant crop.

For the last two crops of the trial, the R.S.D. once again increased the ERS % C content of the unstressed crop, but depressed the ERS % C of the previously stressed crop. The reasons for this are not clear, but one reason could be that the crop was growing more actively in this case.

3. <u>The effect of R.S.D. on the ters/ha of 3 varieties subjected to different moisture regimes.</u>

Table 2. The effect of R.S.D. on the Ters/ha of NCo 376, N53/216 and N55/805 when subjected to different moisture regimes.

Variety	Ters/ha : RSD - Healthy			
	Plant-3rd R		4th and 5th R	
	WO	W	WO	W
NCo 376	-2,9	1,0	-2,5	0,2
N53/216	-1,6	-0,1	-4,9	-0,9
N55/805	1,7	0,1	-1,0	1,3
Mean	-1,0	0,3	-2,8	0,1

Under the stressed conditions, RSD appears to have depressed the ters/ha yields of NCo 376 and N53/216, but increased the yield of N55/805. In absolute terms, however, the yields obtained from the diseased, stressed, cane were similar for all varieties. Under conditions of adequate moisture, the yield of NCo 376 appears to have been increased when infected with R.S.D. Had it not been for the low plant crop ERS % C value for N55/805, a similar situation could possibly have exsisted for N55/805.

When adequate moisture was applied to the previously stressed crop, the R.S.D. reduced the yields of all varieties. The large reduction that occurred with N53/216 appears to be the result of the healthy crop recovering considerably more than the diseased crop from a tc/ha point of view. The response of the crop, which had received no stress, to the R.S.D. was slightly different to the response obtained for the Plant - 3rd ratoon crops, but there was still evidence of a positive response to R.S.D. for NCo 376 and N55/805.

4. <u>The effect of R.S.D. and moisture stress on the incidence of smut.</u>

Although the trial was not designed with the idea of studying the effects of moisture stress and R.S.D. on the incidence of smut, some useful data has been collected. As the plots are too small for this type of study, the data can only be used to establish trends.

4.1 The effect of moisture stress

Table 3. The effect of moisture stress on the incidence of smut (smut whips, 100/ha).

Variety	Treat.	Plant	1 st ratoon	2 nd ratoon	3 rd ratoon	4 th ratoon	5 th ratoon
NCo 376	WO W	0,0 0,0	0,0 0,3	0,0 4,0	1,3 19,1	0,0 1,0	0,0 0,7
N53/216	WO W	0,0 0,0	5,0 1,3	13,8 9,1	12,5 15,4	16,9 7,2	8,1 10,1
N55/805	WO W	0,0 0,0	14,4 3,1	38,2 10,1	201,8 40,1	136,6 56,9	63,3 65,5

The data shows that in N55/805 the most smut susceptible variety of the three, the incidence of smut was far greater in the stressed treatments. When adequate water was applied to the previously stressed treatments, the incidence of smut in these treatments was reduced. In the fifth ratoon crop, the second with adequate water, the incidence of smut was reduced to the same as that of the crop which had always received adequate water.

4.2 The effect of R.S.D.

Table 4. The effect of R.S.D. on the incidence of smut (smut whips, 100/ha)

Variety	Treatment	Plant	1st ratoon	2nd ratoon	3rd ratoon	4th ratoon	5th ratoon
NCo 376	Healthy R.S.D.	0,0 0,0	0,4 0,0	5,0 0,4	10,9 15,5	0,0 1,3	0,8 0,0
N53/216	Healthy R.S.D.	0,0 0,0	3,8 1,3	20,5 0,8	2,1 26,7	17,1 3,8	5,8 12,9
N55/805	Healthy R.S.D.	0,0 0,0	5,4 8,4	26,3 12,5	160,4 27,6	127,0 40,1	92,3 37,2

In the highly susceptible variety N55/805, the plots without R.S.D. consistently had a higher smut incidence than the R.S.D. infected plots.

CONCLUSIONS

1. N55/805 appears to be less tolerant, from a tc/ha point of view, than NCo 376 and N53/216 to moisture stress conditions.

2. It would appear that R.S.D. infected NCo 376 is less tolerant to moisture stress than R.S.D. infected N55/805.

3. Under moisture stress conditions, R.S.D. reduced the tc/ha yields of NCo 376 and N53/216 markedly, but had very little effect on the yield of N55/805.

4. R.S.D. had little effect on the tc/ha yields of all varieties under well irrigated conditions.

5. When adequate water was applied to healthy cane which had previously been stressed, all the varieties showed the ability to recover in terms of tc/ha yield.

6. When adequate water was applied to diseased cane which had previously been stressed, the yields obtained from all varieties were similar to those of the diseased cane which had always received adequate water.

7. The depression in tc/ha yeilds caused by R.S.D. was similar for a crop which had always been well irrigated and a crop which had previously been stressed, but which was now well irrigated.

8. R.S.D. tended to increase the ERS % C of all varieties under both the stressed and well irrigated conditions. When adequate water is applied to a crop which has previously been stressed, however, the R.S.D. appears to cause a reduction in the ERS % C content.

9. R.S.D. appears to decrease the ters/ha yield of NCo 376 and N53/216, and increase that of N55/805 under stressed conditions.

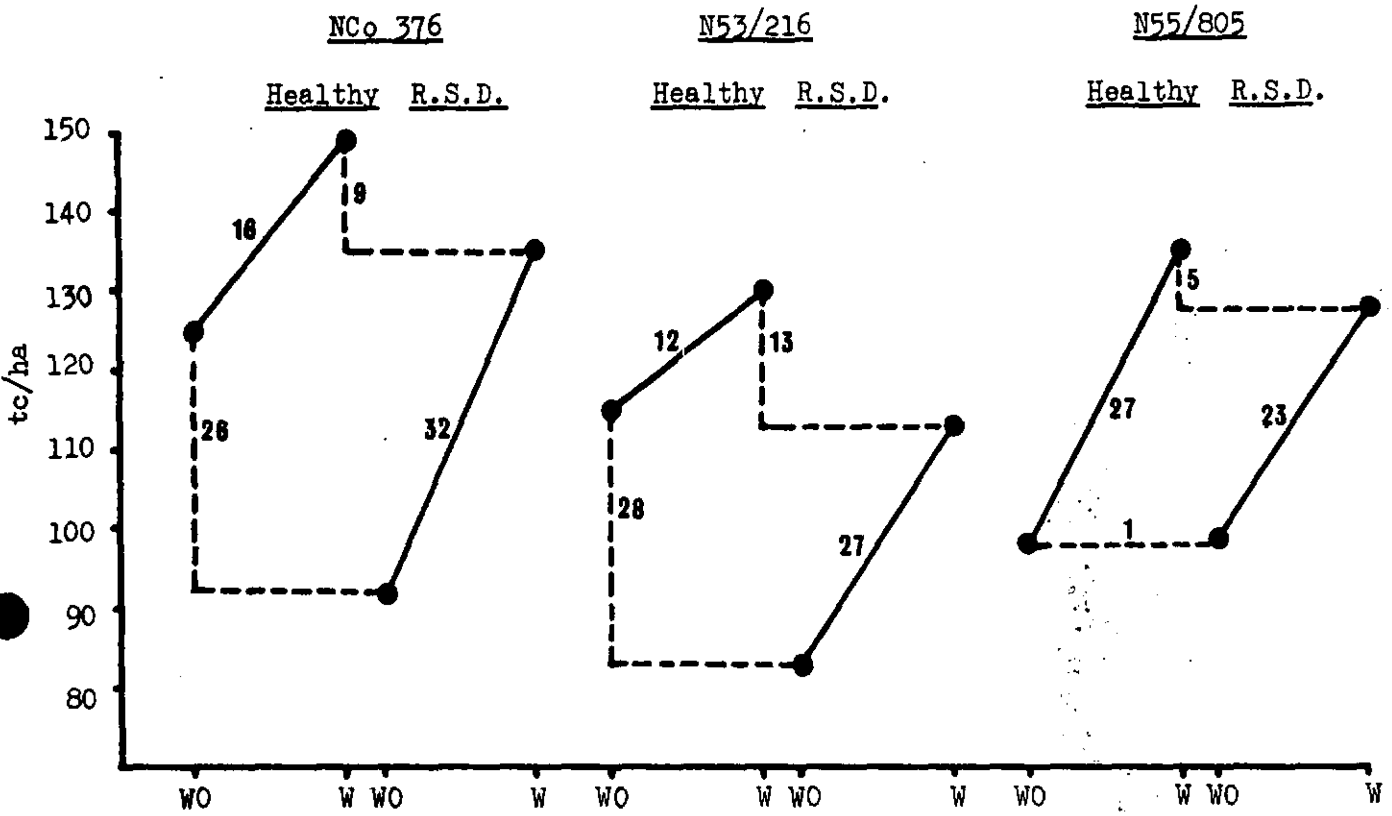
10. Under well irrigated conditions, R.S.D. appears to have a beneficial effect on the ters/ha yields of NCo 376 and N55/805.

11. Well irrigated cane appears to be more tolerant to smut infestation than stressed cane.

12. Cane grown from heat treated seed appears to be less tolerant to smut infestation than R.S.D. infected cane.

DBH/SN
17th October, 1977

1. Mean tc/ha yields for Plant to 3rd ratoon crops.



2. Mean tc/ha yields for 4th and 5th ratoon crops.

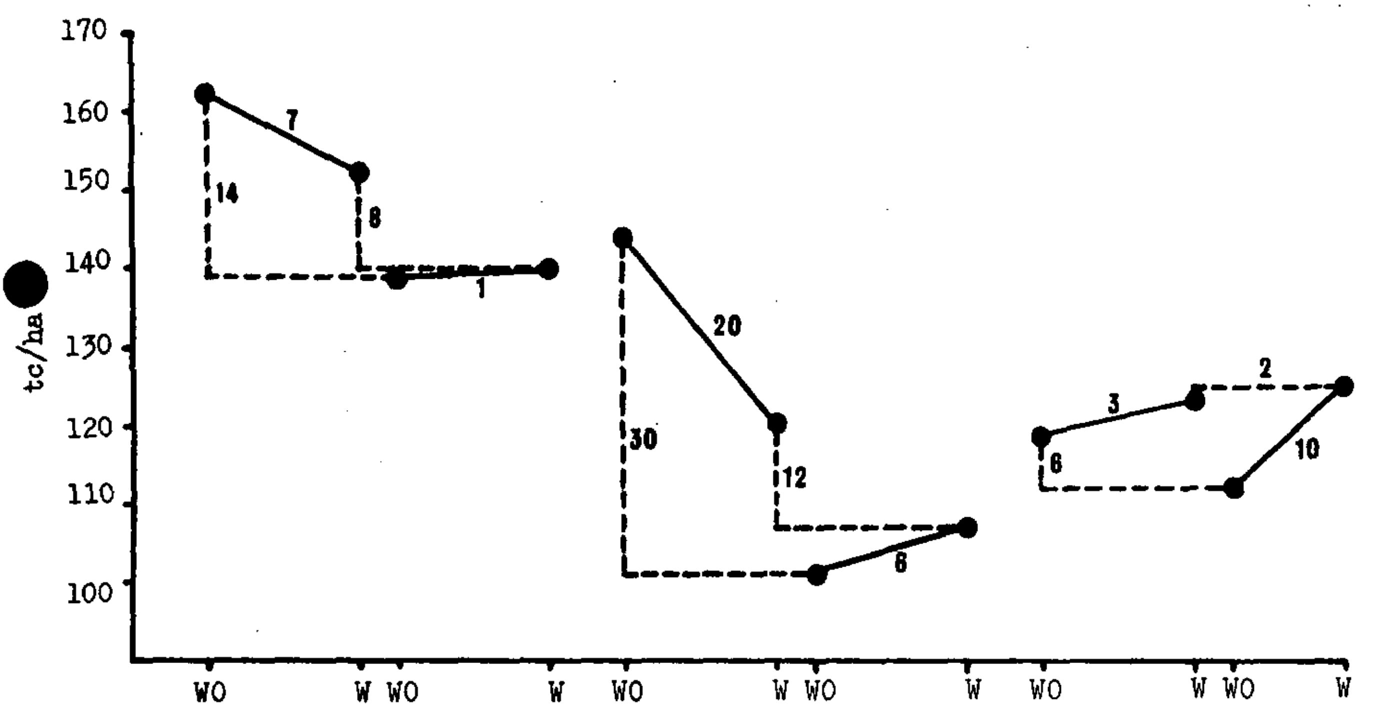


Figure 1. The Effect of Moisture stress and RSD on the tc/ha yield of 3 varieties.

(Numbers in body of figure are percentage differences).

SOUTH AFRICAN SUGAR INDUSTRY

AGRONOMISTS' ASSOCIATION

SOME CONTROVERSIAL ASPECTS OF SOIL CONSERVATION

by

R.H. Paxton

INTRODUCTION

1. It was about 12 years ago that a close examination of soil conservation measures for sugarcane lands was initiated. We must remember that the conditions, paritcularly topographic, under which cane is grown are unique, and therefore no formulae were available on which to base recommendations for field layout for sugarcane. Existing formula had to be adapted without any research being done and the value of the crop itself as a means of preventing erosion had to be estimated.

2. During this 12 year period we all have had an opportunity of examining the recommendations critically and a number of issues have developed which need to be discussed.

3. The implementation of the recommendations provided by the Experiment Station in the 'Interim recommendations for Land Use Planning' has provided a very sound basis for the conservation of our soils, and it is the adaptions or compromises to these recommendations that may be controversial.

POLICY

4. It is accepted that erosion commences when water increases in volume and velocity, some soils being more susceptible to erosion than others, because they are less cohesive. Thus the first principle in erosion prevention must be to reduce run-off volume and velocity to a degree that will not result in soil movement. There is no compromise in this respect and any adaptions to the recommendations must take this first principle into account.

5. The policy of moving run-off water from a crest to a natural or artificial waterway evolves from this. It is a universal method of field planning and its adaption to our Industry took place during this period some decade ago. This means dividing a slope into sections or panels, at the bottom of which the velocity and volume of water are beginning to reach erosive levels. This flow is then reduced or cut-off by a graded channel which moves the run-off water to a prepared or natural discharge area.

6. The rate or velocity at which the water moves down the slope will depend on the degree of slope, and the distance between the graded channels is altered to allow for changes in slope. We could ask ourselves if we are satisfied that the intervals between the channels are adequate to prevent erosion. This is not as simple as it may sound, as some erosion is acceptable. Even to establish what degree of erosion is acceptable is no easy task. Suffice to say at this meeting that the Experiment Station is in the process of examining these standards. It does appear that on flatter slopes our recommendations are acceptable but on the steeper areas we need to reduce the intervals between structures.

7. I have said that we are dealing with unique circumstances in so far as the slopes are concerned. We must add that we are also dealing with a unique crop as far as soil conservation measures are concerned.

8. The fundamental cause of erosion is that rain acts upon the soil, and the study of erosion can be divided into how it (the soil) will be effected by different kinds of rain, and how it will vary with different types of soil. The amount of erosion is therefore going to depend upon the combination of the power of rain to cause erosion and the ability of the soil to withstand the effects of the rain. In mathematical terms erosion is a function of erosivety (of the rain) and erodibility (of the soil). The erodibility of the soil will depend to a large degree on the management of that soil, i.e. the land management and crop management, and it is this factor of crop management that possibly provide us with the greatest area for compromise.

9. Research workers in the mid 40's first realised how important was the effect of raindrop splash in the process of erosion. It was shown that the raindrop was a complete erosive factor within itself, and that little or no erosion occurred when the ground surface was protected by ample cover. The principle effect of raindrops is to detach soil, while the principle effect of surface flow is the transportation of that soil. The cane crop with its canopy of broad leaves and high plant population and the trash layer, can obviously be used to considerable effect in preventing erosion. Thus if our cane lands were under crop continuously then erosion would be reduced to something negligible and acceptable. However, we have to burn, cut, extract and re-establish the crop, and it is here that our problems arise.

PRACTICE

10. We have recently examined some 50 farms throughout the rainfed areas of our Industry in an attempt to confirm our existing terrace spacing criteria, and on most of these farms, though the layout design was according to accepted principles, there was insufficient or no channel capacity in the terraces and run-off water was flowing across the terrace into the panel below. We know that there are many growers who do this on principle, but I suspect some of the examples we saw were simply due to bad construction or maintenance.

11. Through the desire to avoid the concentration of water in a prepared waterway, the principal of a spill-over terrace has evolved. On close examination this system does not appear by any means to be a completely satisfactory means of preventing erosion, though in combination with good crop management and land preparation and for storms of low intensity and short duration soil loss is probably within acceptable limits.

12. Bearing in mind the basic principle of reduction of volume and velocity, neither of these is fully achieved by the spill-over system though some reductions can be made if the system is correctly implemented. To do this there must be no concentration of water either in the terrace itself or in the panels between terraces. In other words the terrace channel and bank must be level and free of low spots into which run-off will drain from all directions, and within the panel minor drainage

lines must be levelled out to avoid water concentration, both demands difficult to achieve in practice. However, we must accept that under certain conditions a certain amount of success has been achieved, though perhaps not as much as growers imagine.

13. It could be argued of course that to prepare a satisfactory discharge outlet for graded terraces <u>can</u> be achieved, and this of course is being done, but it does require careful preparation.

14. Much of the antagonism to the concentration of water in waterways arises because run-off has been discharged into poorly grassed unstable and badly prepared waterways. We do of course recommend that run-off is not discharged into a waterway until stability has been achieved but this is not always practical. A possible way out is to lay out a graded system in the normal way, but give the terraces no channel capacity until the discharge area is stable, and then return with an implement and shape the channel. In our recent farm examination, the waterways with few exceptions, were totally inadequate to accept the discharge from the catchments draining into them.

15. We are aware that the most limiting factor to optimum cane production in the dryland areas of our Industry is rainfall, and therefore the management of this vital resource is of particular importance, and we should perhaps be more heedful of the distribution of surface water over our fields.

16. We have for long advocated the masterline system, as a means of row alignment for distributing water evenly over the panels between conservation structures. This must be done in combination with land levelling or smoothing. Close examination of fields shows that with methods of land preparation now being practised that the cane row itself in many instances is lower than the interrow and often, particularly on soils of low permeability, this has resulted in waterlogging and consequent mortality of germinating plant crops. To be fully effective the implementation of the masterline system must be supplemented by a broad flat channel in the interrow with the cane row itself on a flat ridge. In flat valley bottom areas direction of flow of the interrow channels must be adapted to the change of slope that occurs in the valley bottom, to achieve even distribution of water and to avoid concentration of water and waterlogging. A system of conservation structures is in itself a means of promoting better distribution of surface water.

17. We have also become aware of the need to increase efficiency in the use of machines on our lands, and some adaptions to conventional layouts are being made to reduce machine down time to a minimum. We are all aware of what is going on at La Mercy and there is no need to go into further detail here.

CONCLUSION

18. In conclusion I would suggest that, bearing in mind the fact that one of the most important agents in the erosion process is the tearing loose of the soil particles by the energy of the falling rain, we are not making full use of the crop itself in our efforts to prevent soil movement.

19. The first effort should be directed at reducing the amount of land ploughed each year. At present the Industry re-establishes something like 10% of its crop annually. With costs of re-establishment at about R560/ha, the profitability of the plant crop is negligible. With good land preparation, the use of disease free seed, high plant populations, correct fertilization adequate weed control and effective drainage, the amount of land ploughed out and therefore laid bare to the effects of storms can be reduced considerably and profitability increased.

20. The implementation of strip-cropping becomes imperative and the retention of the trash blanket equally so. In addition the period when soils are most vulnerable to storms should be confined to the winter when storms of high intensity are less likely.

21. Mechanical cultivation for weed control on steep slopes where there is no trash blanket should be avoided in an effort to reduce soil disturbance. Minimum tillage provides a promising technique for the future.

22. Our dilemma is to what extent we can use the crop without a framework of protective structures. If run-off is to be concentrated can it be effectively controlled. There are instances where systems involving of strip-cropping only have been introduced with a trash blanket and are claimed to be effective. I believe that a great deal <u>can</u> be done using the crop itself to prevent erosion but it requires careful management and planning to do this, and we are still faced with the period of complete vulnerability at ploughout. Remember we need an effective system of roads to provide a means of extracting our crop, and if not effectively planned and maintained these can themselves become sources of serious erosion.

I also believe that there are many growers who hope and expect the crop to do all the protective work without any planning, and that unacceptable levels of erosion are occurring in their lands.

23. The system of land planning introduced in the mid-sixties has stood the test satisfactorily but we must be prepared to adapt and modify with experience, but at the same time not be prepared to accept any increase in soil loss. We must also regard the conservation of our soil as a part of the whole process of water management which is so vital to the production of our rainfed crop.

Ref. 'Soil Conservation' Norman Hudson.

RHP/SN
24th October, 1977

SUBSURFACE DRAINAGE IN CANE FIELDS

by R.E. Stewart

Sugarcane is an incredibly tough crop which is able to withstand a wide range of climatic conditions and abuse by farmers. However, excess soil water, which is a problem for relatively short periods during the year, is lowering the resilience of sugarcane in the South African Sugar Industry. Insufficient drainage is probably one of the most important factors limiting the attainment of potential yields.

WHY ARE DRAINS NECESSARY?

(1) Short intervals of soil saturation, particularly when soil temperatures are high, cause sugarcane root damage and in extreme cases the death of the stool. This leads to the inefficient uptake of available soil water during peak growing conditions and a decreased resistance to drought.

(2) When soils are saturated the oxygen between the soil particles is displaced from the profile which upsets the development of soil organisms.

(3) It has been found that nitrogenous fertilizers are reduced in very wet soils which results in the unavailability of this vital nutrient and thus the wastage of this expensive resource.

(4) The capacity of soils to carry machinery falls steadily as the soil moisture content increases and at moisture levels above field capacity soils can only bear very light loads without being damaged. It is significant to note that the Australian Sugar Industry, since it has become fully mechanised, is experiencing a decline in yield because of soil compaction which is aggravated by bad drainage.

(5) Sugarcane that is suffering stress from waterlogged conditions is more susceptible to herbicide damage.

(6) Drainage is necessary in some irrigated areas of the Industry to remove excess salts from saline or potentially saline soils.

A strong case for drainage of some of the soils of the Industry emerges from the reasons listed above. The increase in mechanization militates against the extensive use of open ditch drains so that the remarks in this paper will apply to underground drainage systems which lead into major canals or natural streams.

HOW MUCH DRAINAGE IS NECESSARY?

Underground drainage removes gravitational water from the soil profile leaving capillary water which is available to the plant root and hygroscopic water which is not available to the plant. It is important to stress that gravitational soil water, because it excludes air from the soil profile, damages the plant. Furthermore since drainage cannot remove capillary water SOILS CANNOT BE OVERDRAINED.

Therefore the extent of drainage is only determined by economic factors.

The decision of how extensively to drain a field to obtain an optimum response is complex because of the variability of soiltype and topography makes it difficult to estimate a general benefit which can be expected for different levels of drainage. Appendix 1 shows a partial economic analysis of the benefits of drainage. The figures used in this exercise are conservative which supports the view that there are considerable advantages to be gained from drainage. This particularly applies to miller-cum-planter cane growers who have milling profits to add to their marginal profits. A longer plough-out cycle appears to be an added benefit from drainage.

PRACTICAL DRAINAGE

Drainage must be viewed on the Industry's coastal lowlands as an art rather than a science because of the variability of soil, topography and aspect from field to field. Therefore the following remarks are based upon current drainage practices on New Guelderland Sugar Estates which may not apply to other farms or areas.

(1) Tile pipes are now being used in preference to plastic pipes for the following reasons:

  (a) Flexible corrugated PVC is difficult to lay flat because of the "springiness" of the pipe caused by it being delivered in rolls.

  (b) Roots appear to be a bigger problem in plastic pipes.

  (c) The detrimental effects of "red ochre" or "iron bacteria" which appear to be blocking the holes of the plastic pipe.

(2) Terram 70, a filter membrane, is used as a wrap around the joints of the tile pipes.

(3) When a field that is drained is ploughed-out, some 15 years after the original drainage scheme was laid, a new drainage system is considered necessary and advisable. The tile pipes from the old drainage system are dug up and re-utilized. These pipes are generally in good condition, are relatively cheap (the cost of digging them out to the cost of new pipes is very favourable) and the quality of the pipes is superior to those obtainable at present.

(4) Draiange depth is at least 1 metre with the requirement that the pipe is laid in the impermeable soil layer.

CONCLUSION

The Sugar Industry, particularly that region on the shallow coastal soils can benefit from very extensive drainage. This is a long term capital investment by the sugar farmer which provides a good return.

APPENDIX I WHAT SUGARCANE YIELD INCREASE IS REQUIRED TO JUSTIFY THE IMPLEMENTATION OF A DRAINAGE SCHEME?

Assumption

- (i) Cost of drainage = R600/ha.
- (ii) Cane is harvested every 18 months.
- (iii) Cane field produces a plant crop and 6 ratoons.
- (iv) Marginal profit per ton of cane on increased yield after harvesting is R9/ton at time (t) = 0.
- (v) Inflation of cane marginal profit is 10% per annum.
- (vi) Discount rate (return required on investment) is taken at 15% per annum.
- (vii) Fallow time is 6 months (taken here as the period between drainage and planting).
- (viii) Let y = yield increase required to justify investment.

Operation	DRAINAGE	PLANT	HARVEST						
			P2	1R	2R	3R	4R	5R	6R
Time (Years after drainage) t	0	½	2	3½	5	6½	8	9½	11
Marginal profit/ton (R9/ton at t = 0)			$9(1,1)^{2}$	$9(1,1)^{3,5}$	$9(1,1)^{5}$	$9(1,1)^{6,5}$	$9(1,1)^{8}$	$9(1,1)^{9,5}$	$9(1,1)^{11}$
			10,89	12,56	14,49	16,72	19,29	22,26	25,68
Present Value (PV) at t = 0 of Marginal profit/ton (discount rate 15%)			8,23	7,70	7,21	6,74	6,31	5,90	5,52

Now the Sum of the PV of Margin Profit/ton x y = Cost of drainage/ha

$\therefore$ 47,61 y = 600

y = 12,60 tons cane/ha/18 month cycle or 8,4 t/ha/annum.

SOUTH AFRICAN SUGAR INDUSTRY AGRONOMISTS' ASSOCIATION

THE USE OF HIGH CAPACITY SPRINKLERS FOR THE OVERHEAD IRRIGATION OF SUGARCANE

by M.J. Clemitson

Many growers of irrigated sugarcane in southern Africa have experienced increasing difficulty in hiring labour for the onorous task of moving in-field sprinkler irrigation equipment. The first solutions which found some favour involved "dragline" and semi-solid set layouts which reduced the amount of portable equipment, but still required some in-field equipment movement. More recently, due to aggravated labour shortages, travelling irrigators have found some acceptance.

This equipment usually consists of a large bore or "big gun" sprinkler which is winched through the field along a prepared path at a regular rate. These sprinklers discharge 30-120m^3 per hour at pressures up to 800 kPa. Stationary "big-guns" have been used for sugarcane irrigation and their problems are well known. In fact they have been discarded by many growers because of their drawbacks and it might appear initially that the re-introduction of such equipment is a retrogressive step. However, there is limited information on the effects of motion on the two main disadvantages of the "big gun", namely, severe distortion of the distribution pattern and high precipitation rates.

Ubombo Ranches Limited of Big Bend, Swaziland, have recently purchased travelling irrigators. With their co-operation and assistance it was possible to test the machines under field conditions.

Two fields were selected in a representative area where the sprinkler travel lanes would be at right angles to one another to provide a wide variety of wind direction recordings. Two lanes in each field were tested with opposite directions of travel. The schematic layout is shown in Figure 1.

Precipitation was collected in metal cans, supported above crop level, spaced 6m apart in a rectangular grid pattern of 100 cans. Once the sprinkler had moved out of range of the grid the volume of water caught in each can was measured and converted to precipitation depths.

Three recording rain gauges were erected in each grid to gather data on precipitation rates. They also provided information on total precipitation time and gave a check on the total application recorded in the cans. An anemometer was mounted in the centre of the test area to record wind speed and direction during precipitation in each grid.

Data from each test were analysed by a calculated overlapping of patterns giving an overlapped total precipitation at various lane spacings. It was then possible to derive a mean application and coefficient of uniformity for each lane spacing under given conditions.

The coefficient of uniformity, (Cu) was calculated from Christiansen's formula, the most widely accepted method of comparing sprinkler performance. Cu values greater than 0,85 are usually considered acceptable.

Application uniformity

Wind speed and direction had a considerable effect on the precipitation pattern. Initial analysis of overlapped precipitation suggested a grouping into two categories of wind speed and three categories of wind direction. Wind speeds up to 7,5 kph were termed "LOW" and those in excess of 7,5 kph were termed "HIGH". The highest wind speed recorded during the trial was 13,2 kph. The wind direction was termed right angular oblique or parallel according to the octant in which it was recorded during each sprinkler run. Figures 2, 3 and 4 provides comparison of high and low wind speeds in the three categories of wind direction. Figure 5 shows the average application and coefficient of uniformity in the two fields for all conditions.

Precipitation rates

The average precipitation rate, recorded by three intensity rain gauges, was found to vary considerably with wind conditions and distance from the travelling irrigator. High precipitation rates were recorded near the travel lane in low wind conditions, particularly down-wind from the sprinkler. Generally high rates in the range of 10 to 22 mm per hour were recorded under conditions of right angular and oblique wind. Excessive rates, in the range of 20 to 34 mm per hour were recorded when the wind direction was parallel to the travel lane.

It is apparent that, as with all large capacity sprinklers, wind does impair uniformity of application. However, by virtue of its motion, the travelling irrigator largely overcomes the effect of winds which are right angular or oblique to the direction of travel. Under conditions of parallel wind, uniformity will be poor. It is clearly important therefore, that the prevailing wind direction should influence field layouts where travelling irrigators are to be installed.

The precipitation rates recorded were very high, ranging from 10 to 33 mm per hour. The more common soils in the irrigated sugarcane growing areas have infiltration rates much lower than this, usually 5 to 7 mm per hour and runoff could be considerable. Ideally, the terrain should be flat enough to prevent excessive runoff and applications should be small to limit evaporation from the surface, which may lead to crystallization of salts in the soil.

The results showed that it is possible to achieve excellent precipitation uniformity with the travelling irrigator provided its limitations are recognised. The machines were reasonably reliable, only two of 28 tests being lost due to malfunctions. Labour costs are probably similar to those for hand moved sprinklers for, although fewer units are required, the degree of skill needed is much higher.

MJC/MH
20 October, 1977.

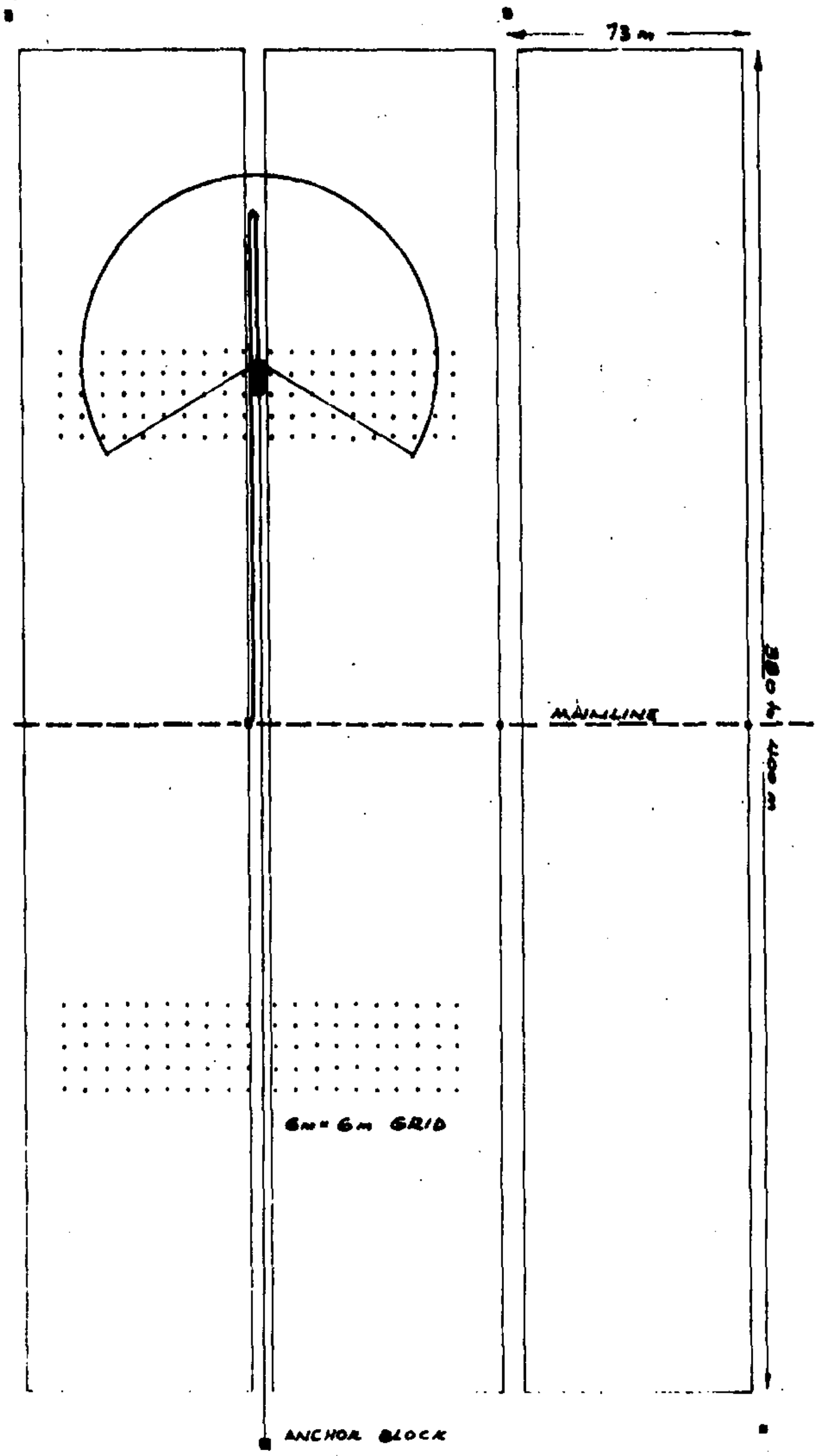


FIG. 1. SAMPLING GRID LAYOUT.

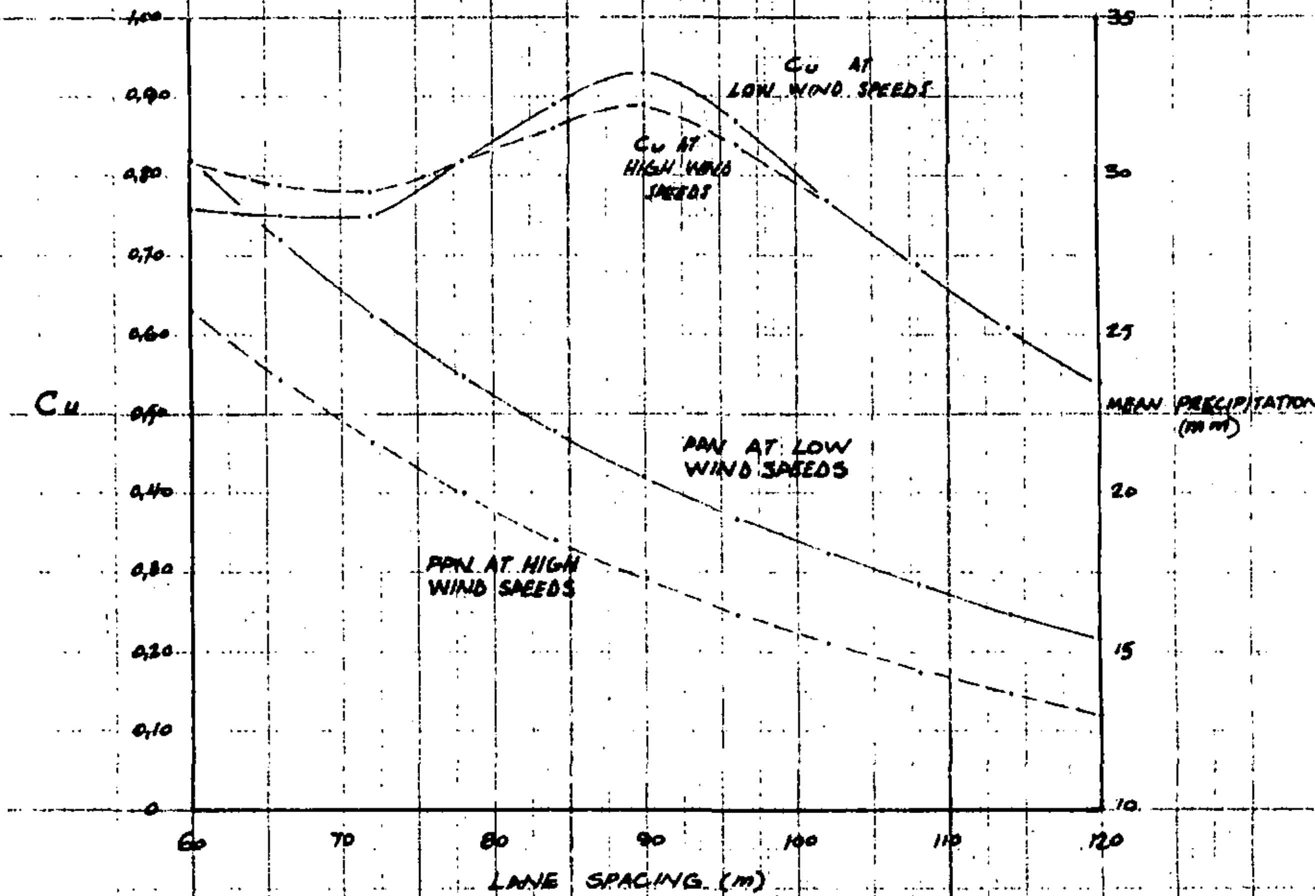


FIG. 2. SPRINKLER PERFORMANCE IN RIGHT ANGULAR WIND.

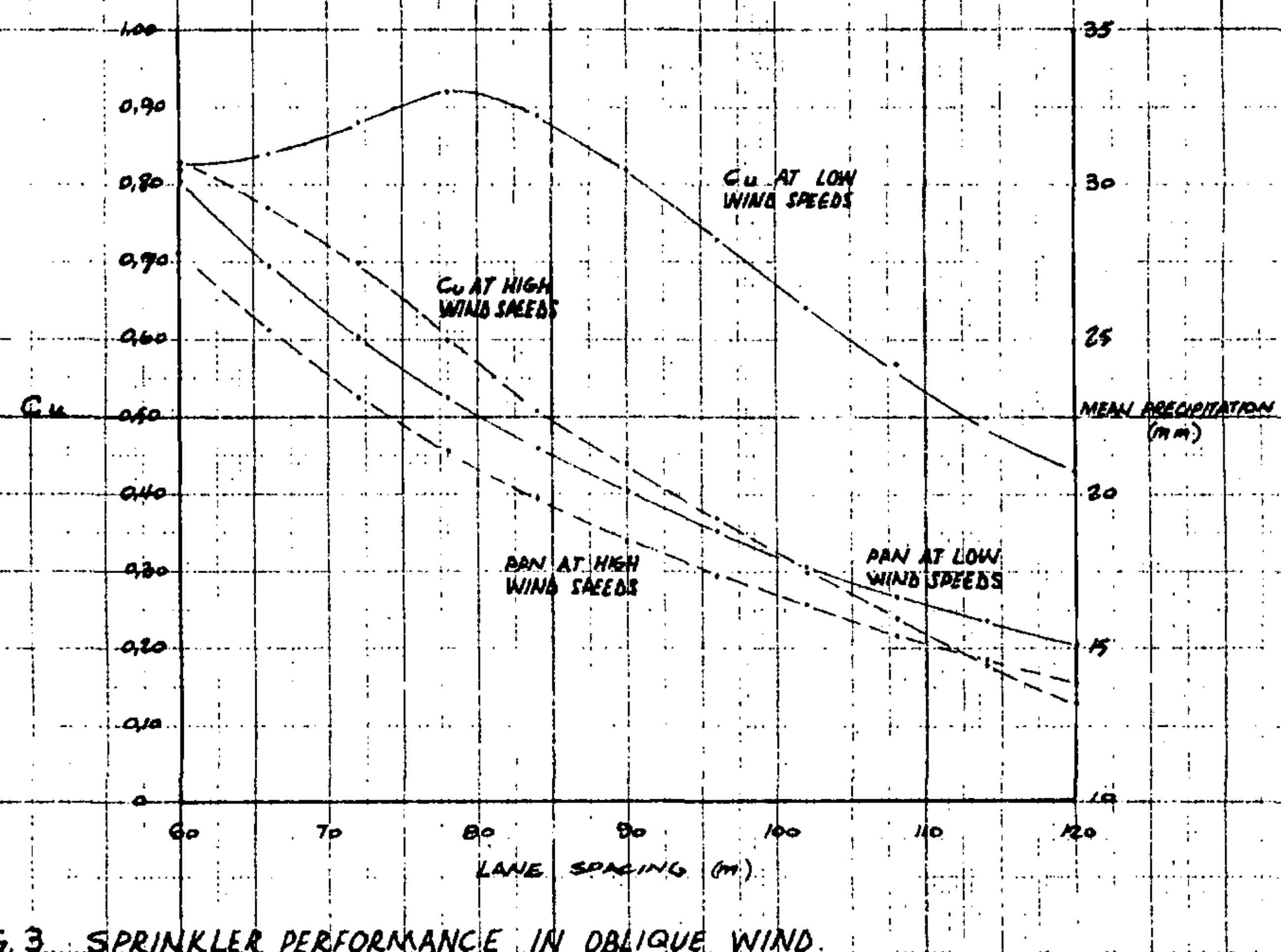


FIG. 3 SPRINKLER PERFORMANCE IN OBLIQUE WIND.

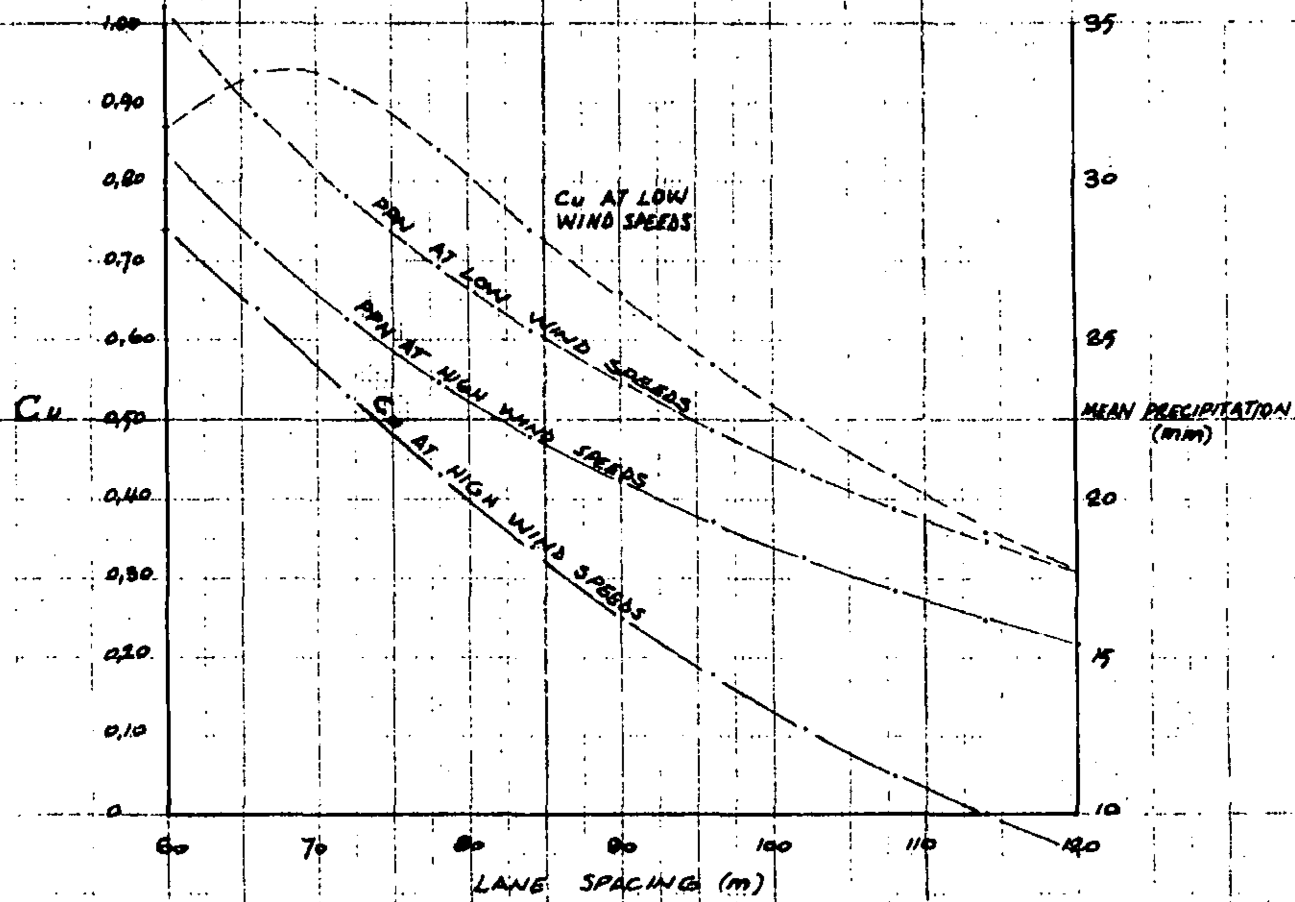


FIG. 4 SPRINKLER PERFORMANCE IN PARALLEL WIND.

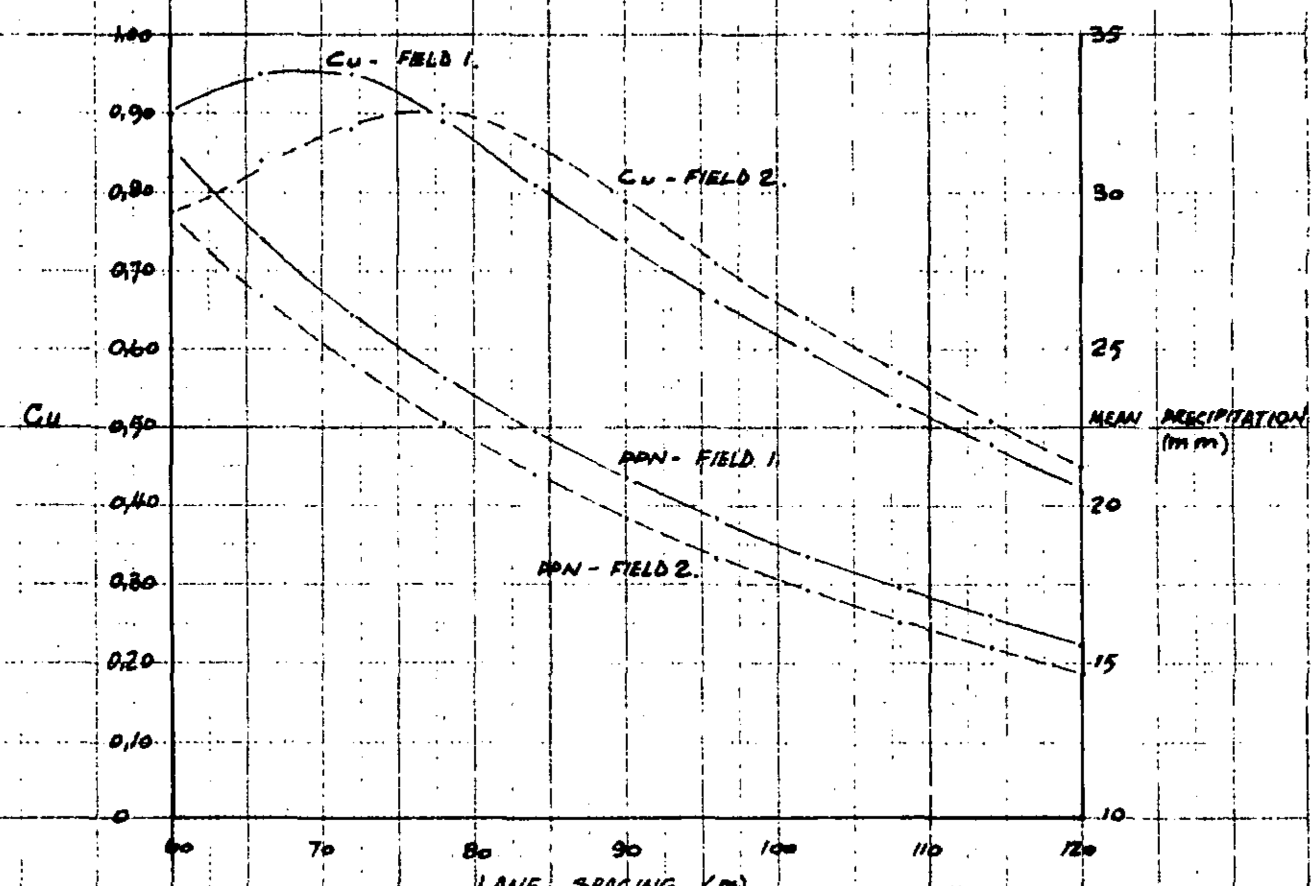


FIG. 5. AVERAGE SPRINKLER PERFORMANCE