PHASE TWO OF THE SMALL CATCHMENT PROJECT AT LA MERCY

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Abstract

The different management systems of the four catchments at La Mercy are described. The methods used to monitor soil and water losses and results from 1984 to 1988 are given. The effect the crop and management systems have had on runoff and soil loss is discussed. The problems with measuring devices in heavy storms are described.

Introduction

The La Mercy small catchment project is situated on 20 ha of land north of the Umdloti river. The area is divided into four separate catchments which were maintained as bare fallow until September 1984. The first phase of the project (Platford[1]) concerned soil loss and runoff under bare fallow conditions. This, the second phase, concerns the effect of the crop and different management systems on soil loss and runoff.

With each catchment being subjected to a different management practice and soil conservation layout, actual runoff and soil losses can be assessed at different stages of crop cover and compared.

Physical Features

The project area is made up of four small catchments which have been numbered from south to north, 101 being the southernmost catchment and 104 the northernmost catchment. Details of the catchments are given in Table 1.

Table 1

Surface Properties of The La Mercy Catchments

Catchment No	101	102	103	104
Area (ha)	2,7	4,7	4,4	6,6
Average slope %	29	21	12	17
Waterway slope %	21	16	8	23

Topography: Slopes vary from 5% to 35% and valleys and drainage lines are well defined. Catchment 101 is the steepest while 103 is the flattest. The average area of the catchments is about 5 ha.

Soils: The dominant soil form is Arcadia (72% of the area). Followed by Swartland (25%) and Hutton (3%). The Swartland form has an orthic topsoil and is shallow while the Arcadia form has a vertic topsoil. There are outcrops of shale in areas of the Swartland form. Both forms have a high clay content.

Well defined cracks, that close up quickly after rain are found in the Arcadia soils. This results in a low infiltration rate and runoff occurs soon after soaking rains. The Swartland soils do not crack as much as the Arcadia soils, and also have a low infiltration rate. Soil depths vary from 300 mm to 900 mm in the Arcadia and from 100 mm to 600 mm in the Swartland. The small area of Hutton form soil found in catchment 104 exceeds 1000 mm in depth. There were drainage problems in the valley bottoms, but these were solved with sub-surface pipe drains.

Measuring Equipment

The measuring equipment is made up of 1,37 m H flumes with 6 m approach channels, which were designed to record flows up to 2.36 m^3/s. There are holes in the wall of the side sheet which allow water to enter a measuring well. A Negretti and Zambra recorder is situated adjacent to the wall with a pressure plate in the base of the wall. Pressure on the plate activates the pen arm which records on a rotating clock chart.

Soil loss is measured by splitters at the entrance of the flume. A splitter removes a 5% sample and channels the sample through a second splitter, which removes another 5% sample and channels it to the collecting tanks. The sample deposited into the collecting tanks is thus 1/400 of the original flow. This collecting tank holds 400 l (A bin) and once filled, the overflow spills onto a 800 mm Coshocton wheel which extracts a 1/100 sample into a 200 l (B bin) tank.

After each storm samples are removed from the tanks in 1 l jars, sent to the laboratory and the sediment loads determined. Rainfall is recorded by a rainfall intensity gauge. This is made up of a clock driven rotating drum and can record up to 350 mm of rain. This gauge was placed centrally between all four catchments.

Catchment Layout and Management Practices

The first phase of the project dealt with runoff and soil loss under bare fallow conditions with no conservation works. The second phase concerns the effect conservation structures and management practices have on runoff and soil loss. The field layouts and management practices on the four catchments are as follows (Fig 1):

Catchment 101: The conservation layout is made up of spillover roads and a flat-based waterway. The spillover roads were constructed at a gradient of 1:150, and a vertical interval of 9 m. Alternate panels were harvested and the minimum tillage system of replanting was introduced.

Catchment 102: The conventional system of conservation layout was used, ie water carrying terraces at a gradient of 1:150 discharging into grassed waterways. Cane was burnt before harvest, and when replanting is required the cane will be ploughed out. No strip cropping or minimum tillage was practised.

Catchment 103: No structures were made; cane was planted over the entire area including the natural depression, which would normally require a waterway. Cane was burnt before harvest, and when replanting is required the cane will be ploughed out.

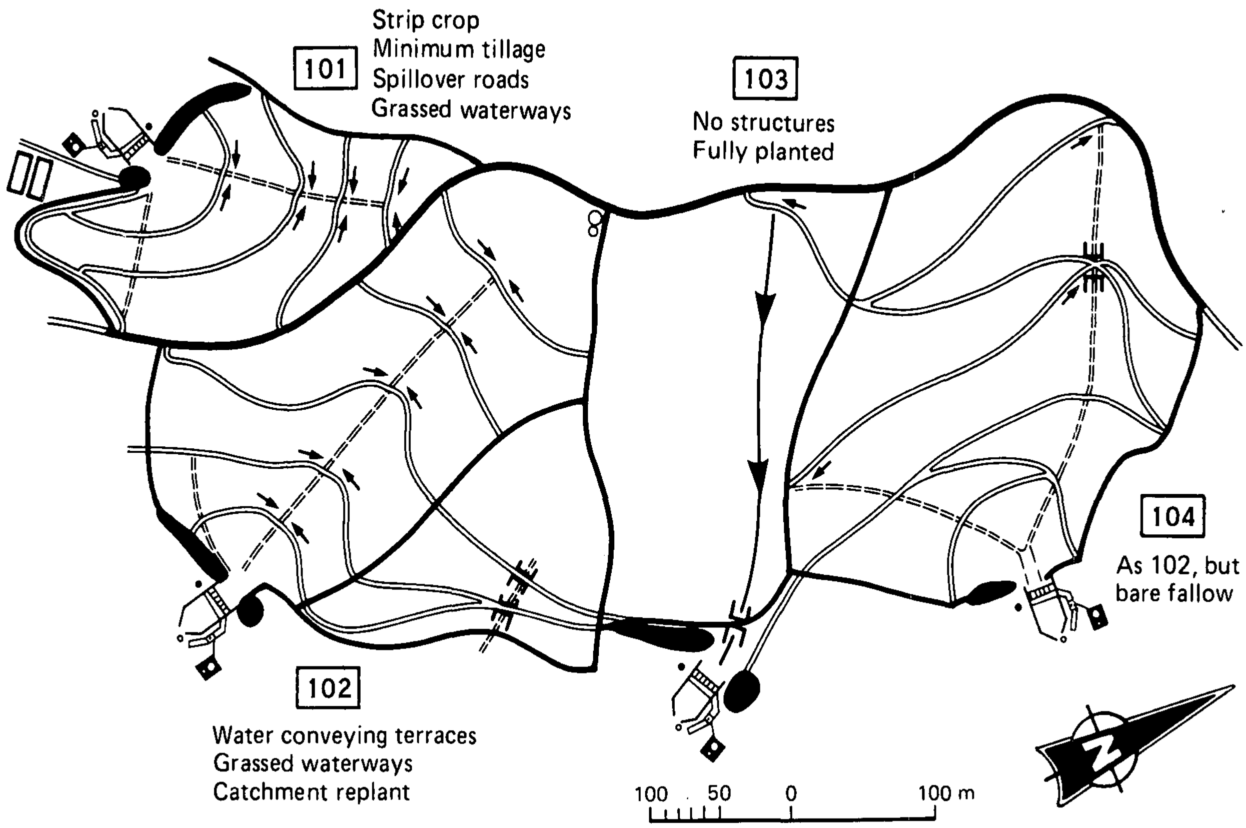

FIGURE 1 The different conservation layouts which have been completed.

Catchment 104: The conventional system of conservation works was used, similar to that of 102, except that there are diagonal roads in the catchment. Two panels were left bare fallow while the remainder were planted to cane. Cane was burnt before harvest.

Results

The period under review is from January 1984 to December 1988. After each rain storm the sample apparatus was checked and samples taken. The results for runoff were obtained through the collecting tanks and Coshocton wheel. A total of 32 samples were taken over the period. However some records were lost due to sampling equipment failure (Fig 2).

Rainfall generally exceeded 1 000 mm per annum for the period concerned, except for 1986 when only 771 mm were recorded. A brief description of the rainfall characteristics is given in Table 2. Although the least rainfall fell in 1986, there were a fairly high number of storms exceeding 20 mm. The figures for 1984 and 1988 appear similar. However, there were heavy rain storms early in 1984 caused by cyclone Demoina.

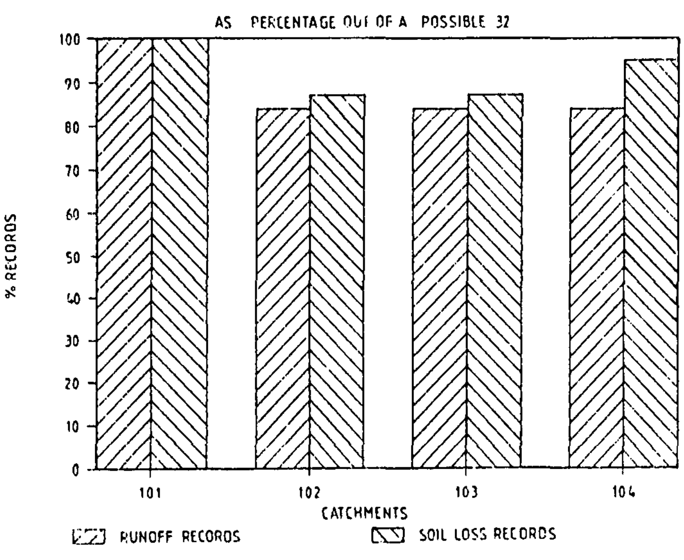

FIGURE 2 No. of complete records.

Table 2

Rainfall characteristics for period Jan 1988 to Dec 1988

	1984	1985	1986	1987	1988
Rainfall mm	1 118	1 037	771	1 361	1 153
Rain Days	89	74	78	121	79
Runoff Days	28	14	8	43	29
No. Storms > 20 mm	14	8	12	18	14

Comparisons

Comparisons have been made between the catchments, in the form of graphs, on a storm by storm basis. Annual comparisons also have been made, using all storms, for which complete data were recorded from *all the catchments.* All those storms that did not record completely on all catchments have been discarded. Unfortunately, the soil loss records for both cyclone Demoina and the September 1987 floods are incomplete due to failure of the sampling equipment. However, the runoff figures for both these have been recorded and are reflected in Figs 3 and 4. The crop cover and management practices were the same for all catchments in 1984, but by 1987 crop covers and management practices varied between the catchments.

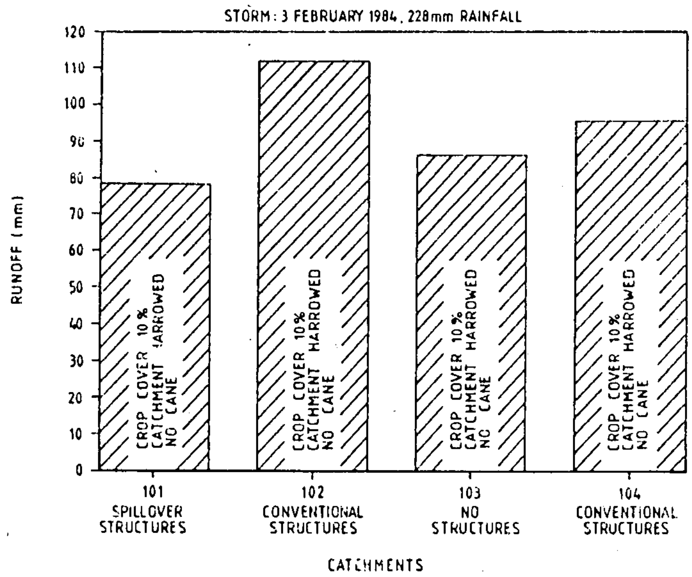

FIGURE 3 Runoff comparison – Demoina

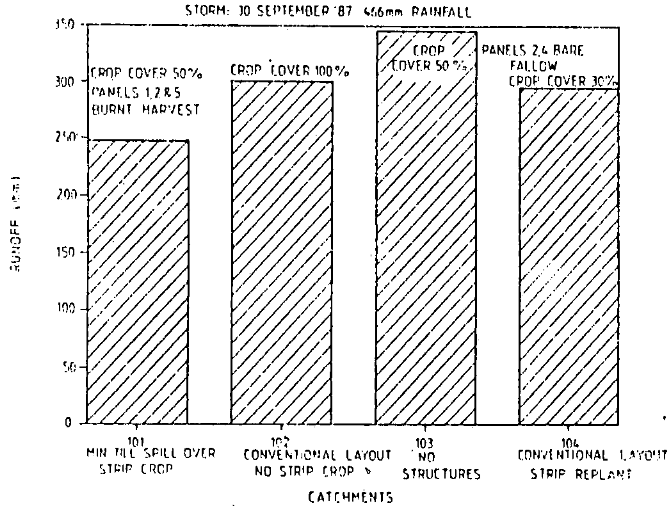

FIGURE 4 Runoff comparison – September 1987 floods.

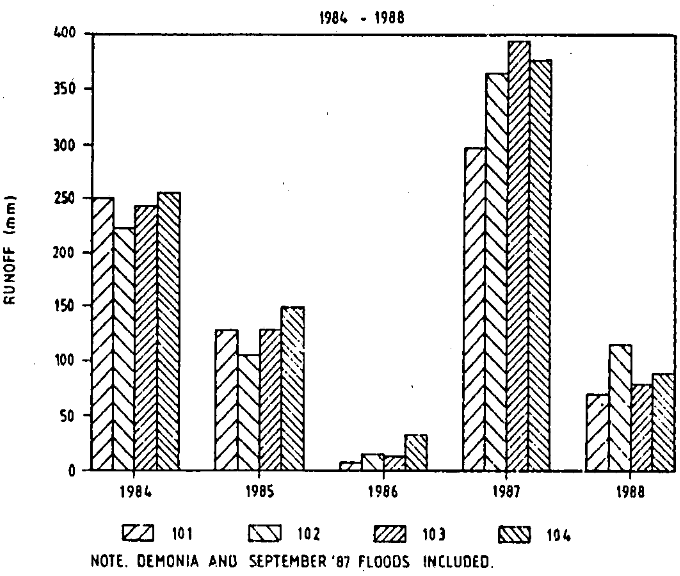

FIGURE 5 Catchment runoff comparison.

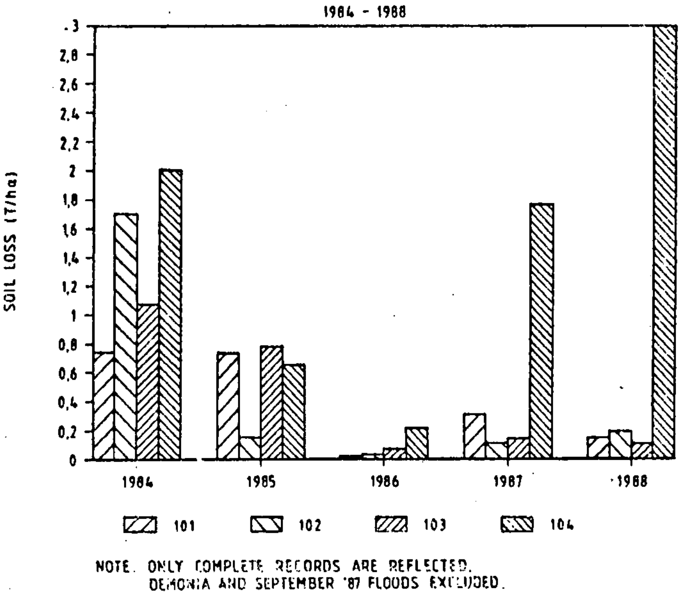

FIGURE 6 Catchment soil loss comparison.

Runoff and soil loss comparisons for each year from 1984 to 1988 are shown in Figs 5 and 6. It is interesting to note that runoff figures were high for all catchments in 1984 and 1985, when the crop cover was low prior to and during the planting stage in each catchment. The Demoina and September 1987 floods have not been included in Fig 6 for reasons already discussed. As with runoff, the soil loss figures are higher for 1984 and 1985.

Selected comparisons with complete data on a storm by storm basis are shown in Figs 7 to 11. From these graphs it seems that catchment 104 fairly consistently recorded more runoff and soil loss than the others. However, catchment 103 varies more than others. Catchment 102 was consistent until the May 1988 storm. Catchment 101 recorded similar runoff figures to 102. It must be noted that although soil loss figures reflected in the graphs are lower in 101 than in 102, the result of a storm (10/02/85) have not been included because catchment 101 was being planted and therefore an unfair result was obtained.

From the results obtained from the four catchments and the comparisons made, catchment 101, once fully planted to cane, recorded the least amount of soil loss. Catchment 104 recorded the highest soil loss, with catchments 102 and 103 recording similar results.

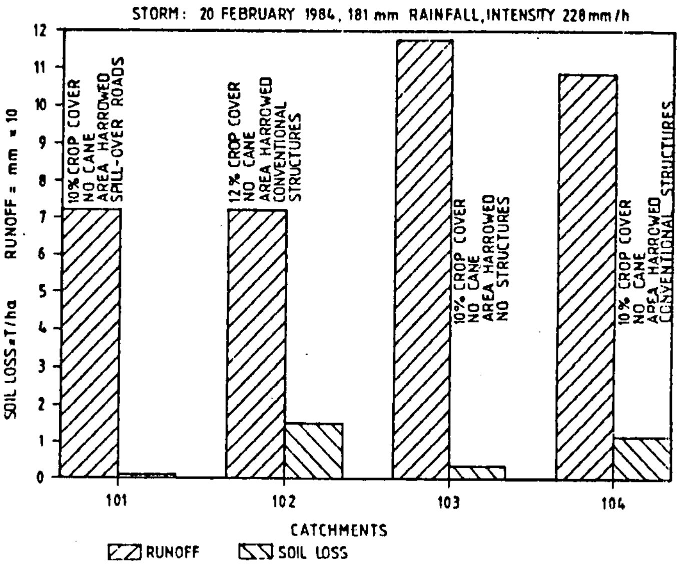

FIGURE 7 Runoff and soil loss comparison.

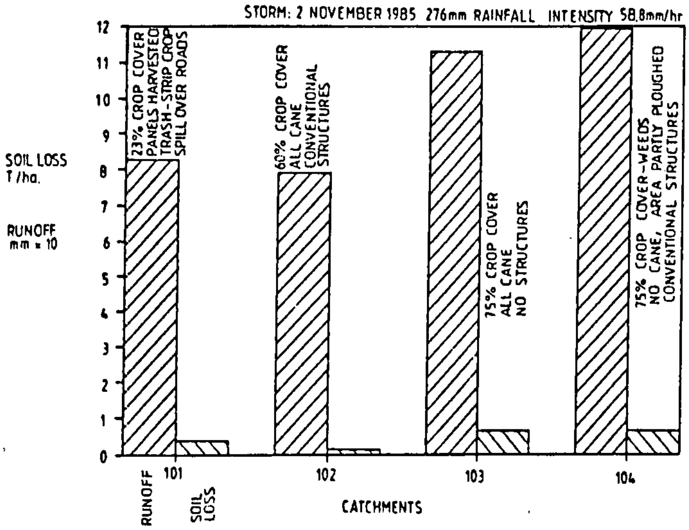

FIGURE 8 Runoff and soil loss comparison.

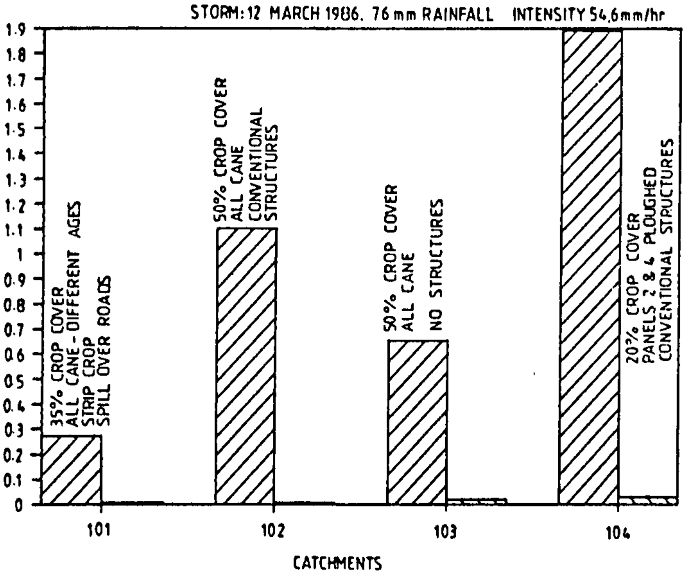

FIGURE 9 Runoff and soil loss comparison.

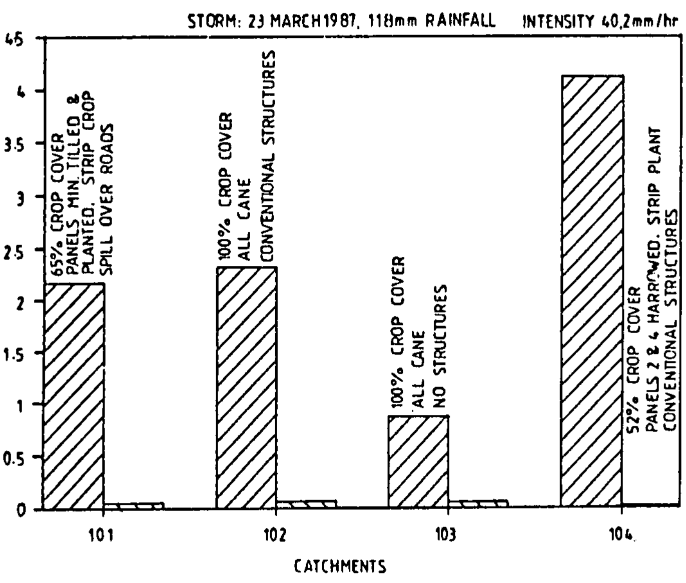

FIGURE 10 Runoff and soil loss comparison.

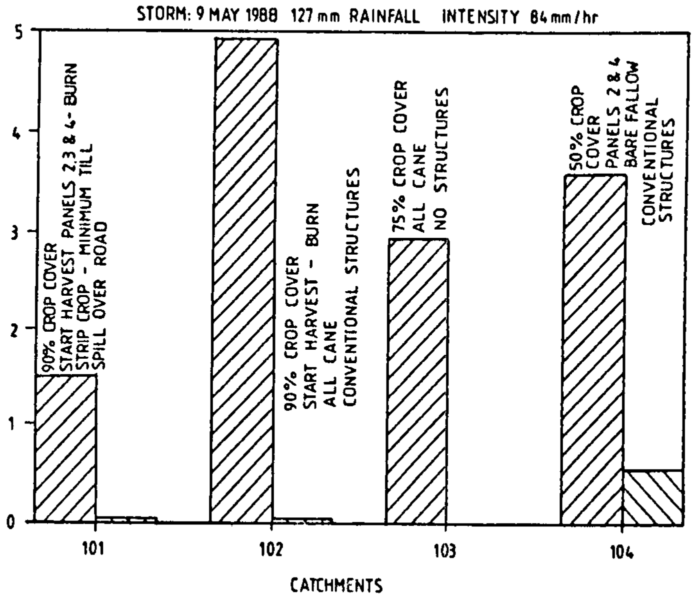

FIGURE 11 Runoff and soil loss comparison.

Discussion

Runoff and soil loss figures should not be considered in isolation and other factors must be brought into consideration. From the above comparisons it seems that once cane had been established, catchment 104 suffered more soil loss than the others, and 101 the least. On further investigation the reasons for this occurrence become clear.

The soils on all four catchments are fairly similar but the slopes vary. Management practices, although similar in the initial stages, varied with time. Stage of crop cover was also an important factor to consider. If each catchment is analysed separately, an explanation can be given for the differences in runoff and soil loss results. Catchment 101 is the steepest, but also the smallest, with minimum tillage and a strip plant programme with spillover roads. Initially, soil loss and runoff were high when there was no crop cover, but this was dramatically reduced once cane was planted and the strip plant procedure came into effect.

Catchment 102 is the second largest catchment and is second steepest. Soil loss and runoff were high in 1984 when there was no cane, but the soil loss was drastically reduced in 1985 once cane had been planted. This resulted in the lowest recorded soil loss for the year 1985. After 1985, soil loss and runoff were fairly low and consistent.

Catchment 103 is the third largest and the flattest catchment. Soil loss and runoff were high in 1984 and 1985, even though by early 1985 there was a 50% crop cover on the catchment. Once a good canopy had been established runoff and soil loss were reduced. Catchments 102 and 103 were harvested at the same time in 1986 and 1988, where soil losses proved to be very similar.

Catchment 104 is the largest but the second flattest. This catchment provided the most soil loss and runoff over the 5 year period. Two panels were left bare fallow and harrowed regularly, and this was the cause of most of the soil loss. After Demoina and the September 1987 floods the bare fallow panels were so badly damaged that soil had to be replaced.

From the first phase of the project it was observed (Platford[1]) that under the bare fallow conditions prior to 1984 and before structures were implemented catchment 104 recorded the most flow, followed by 103, 102 and finally 101. However once structures were implemented, and cane planted this trend did not persist as uniformly.

Problems with Sampling Equipment

Records from some of the major storms were lost due to equipment failure. The most common problem, especially with a storm producing high runoff, was the collecting tanks being washed away by the force of the water. The 'A' bin usually produced a result but the 'B' bin would be washed away, rendering the results useless. When storms occurred after harvesting, trash would collect on the splitters at the opening of the flume causing them to block up, and resulting in a much reduced flow into the collecting tanks.

Theft and vandalism were also a problem with intensity gauges being badly damaged and the copper wire and tubing being stolen from the automatic recorders.

Conclusion

From the results obtained from the four catchments it can be concluded that crop cover and management practices do have a significant effect on the amount of runoff and soil loss, regardless of the type of structures found within the catchment. The crop cover percentage seems to be more important in reducing soil loss than in reducing runoff. Even on different slopes, once cane has been established, runoff is affected importantly by the soil type (intake rate), the rainfall intensity, the antecedent moisture content, and finally the crop cover, which helps to slow down the runoff rate. Soil loss on the other hand is affected to a lesser extent by soil type, rainfall intensity, and to a greater extent by crop cover and management practices. The crop cover acts as a buffer which reduces the power of falling raindrops quite dramatically. Thus the greater the amount of crop cover the less the soil loss.

It seems from the results that crop cover and management practices reduce runoff and soil loss to a much greater extent than do conservation structures. This might imply that planting an area to cane without proper conservation structures is acceptable as all that is required is a good crop cover and trash blanket at harvest. However, good soil conservation measures are a combination of both mechanical and biological systems, as once the crop cover is removed during ploughout or after harvest, the role of the conservation structures becomes very important in reducing runoff and soil loss. Areas without proper structures are prone to serious erosion.

Once cane has been fully established, the effect of slope on runoff and soil loss seems negligible. Catchment 101 is the steepest, yet with a good crop cover, soil loss was still minimal, even with spillover roads present. However cane removal from one or two panels within the catchment caused the amount of soil loss to increase rapidly. Catchment 104 showed a loss of soil during nearly all storms because there were two panels of bare fallow. Catchments 102 and 103 gave results which were similar. It is obvious that maintaining a good crop cover is very important, but this is not possible for the entire life span of the crop. The most dangerous period is when the land is fallow (ploughout), and hence the most practical solution is to retain as much crop cover as possible and to disturb the soil as little as possible. It is therefore concluded that the grower should opt for maintaining as much crop cover as possible by strip planting and disturbing the soil as little as possible by minimum tillage, especially on the steeper catchments.

Acknowledgements

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REFERENCES

1. Platford GG (1985) The small catchment project at La Mercy. *Proc S Afr Sug Technol Ass 59*: 152-159.