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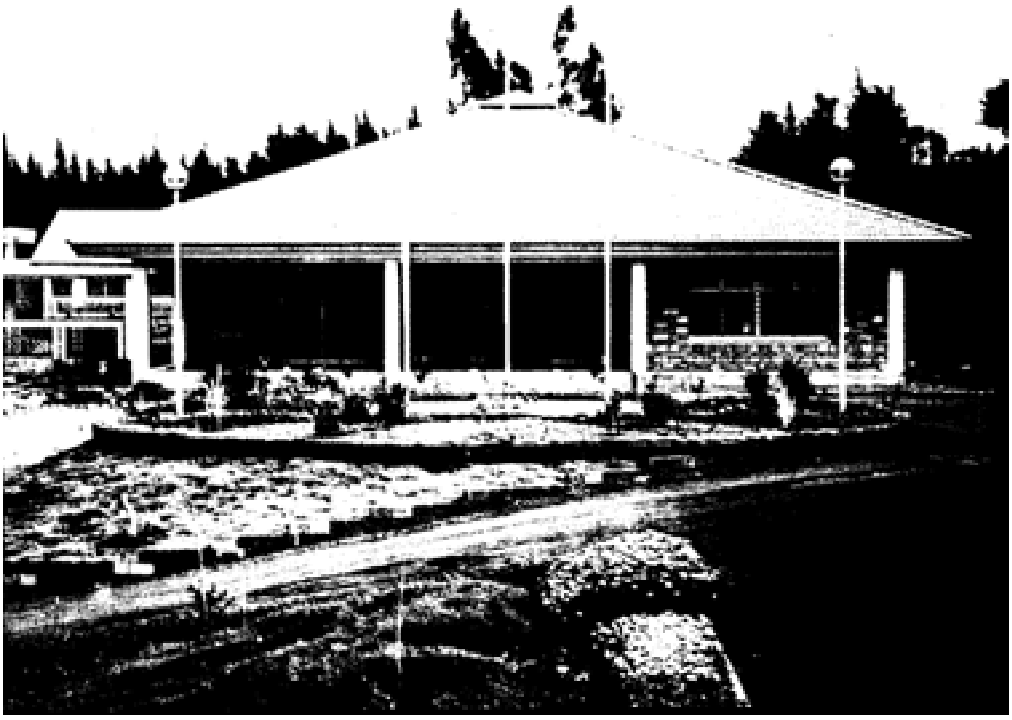

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Run-off Harvesting in Kenya: Experiences gained from the Njemps Flats of Baringo District.

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Introduction

The semi-arid areas of Kenya are mainly characterised by insufficient, unreliable and poorly distributed rainfall followed by long dry seasons. The rainy season normally lasts a few days and occurs as heavy downpours whose waters are largely lost as surface run-off due to the low infiltration capacities. This is typical of soil surface compacted and truncated by overgrazing. These areas have high moisture deficits which make tree establishment difficult hence the need for the adoption of run-off harvesting.

With a moisture availability index (rainfall/potential evaporation) of 25%, the Njemps Flats are classified as semi-arid. Severe destruction of the vegetation cover caused by overgrazing

accompanied by occasional torrential storms has resulted into serious soil erosion in the area.

As early as 1964, Pratt observed that some form of run-off harvesting was necessary for the successful reseeding of the Njemps flats and since then, several run-off; harvesting projects aimed at pasture improvement, agroforestry, fodder and fuelwood production have been sited in the area with varying degrees of success. The most commonly adopted run-off harvesting system is the use of micro-catchments (Fig. 1) where run-off is collected from the immediate vicinity of a seedling and into the rooting zone. Such moisture is then used to support the seedling in the dry season. Studies elsewhere (Hillel, 1971; Oron and Enthoven, 1978) have shown that micro-catchments are easy to install, have low maintenance and construction costs and do not require heavy technological inputs. The risk of failure from overtopping during heavy storms is therefore low compared to heavy engineering works.

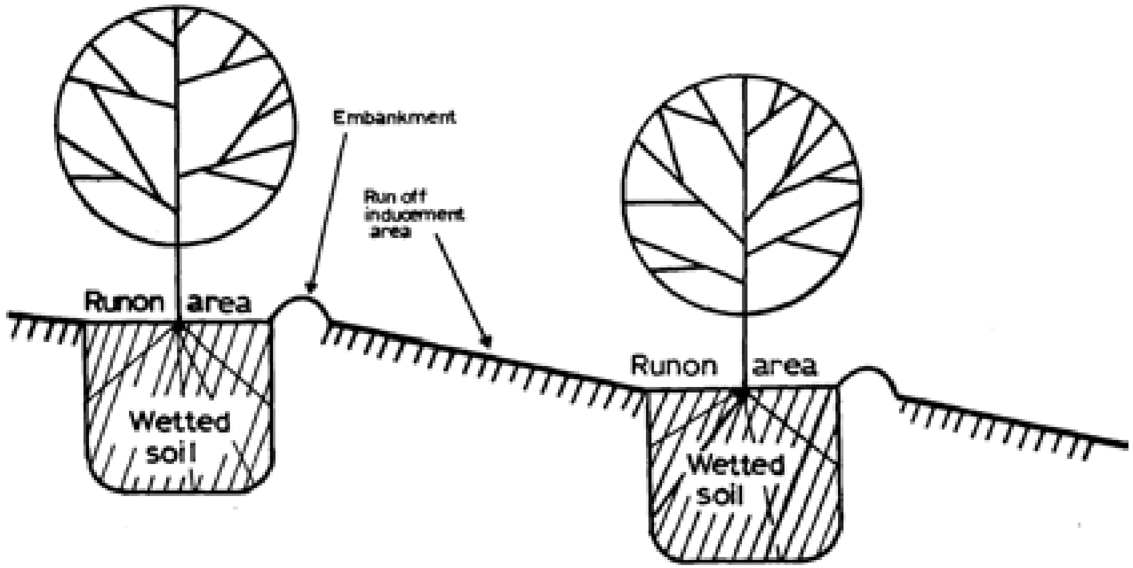


FIG. 1: A CROSS SECTION OF A MICROCATCHMENT UNIT.

More detailed studies have revealed that micro-catchments yield more specific run-off and have higher run-off frequencies compared to small watersheds (Evenari etal, 1982). This implies a higher chance of crop success with micro-catchments compared to other run-off harvesting systems. More recent studies (sharma, 1986) revealed that successful run-off harvesting requires a good knowledge of run-off behaviour on the target site. Such information for the Njemps Flats was not available and it was clearly a drawback to large-scale adoption of run-off harvesting in the areas. This note reports on the results of a study that aimed at modelling run-off generation in the study area with a view to providing run-off management guidelines for reforestation projects in and around the area.

Study methods

The study site

The study was conducted on two eroded sites; Eldume and Lameluk on the Njemps Flats in Baringo district, Kenya. The area is located in the Lake Baringo trough and it extends westwards and southwards from L. Baringo towards L. Bogoria (Fig.2). The soils of the Njemps Flat are clay loams derived from the rocks of the Tugen Hills. These soils are easily dispersed causing severe sheet and gulley erosion during the rains.

Experimental Procedure

The field part of the study aimed at determining the hydrological response of the soils. This was achieved by simulating rainfall and measuring infiltration capacities, run-off coefficients, threshold rainfall (minimum rainfall needed to generate run-off) and other run-off parameters.

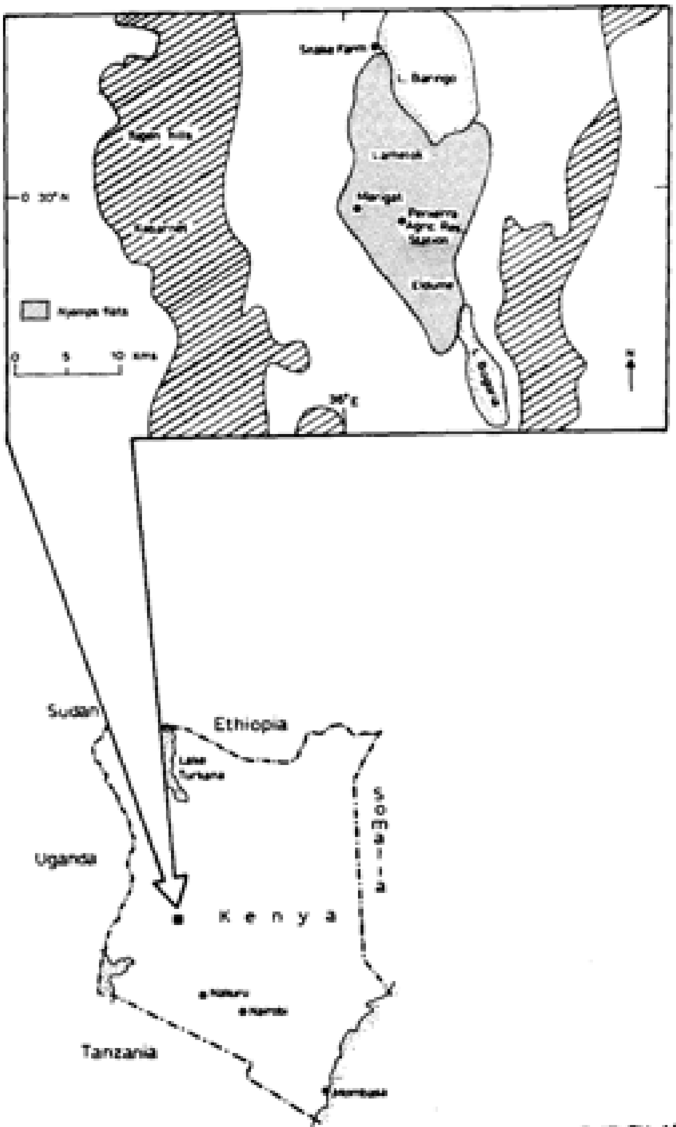


FIG 2. MAP OF STUDY AREA

The linear Regression Model of Rainfall-Run-off analysis (Oron and Enthoven, 1987) was used to derive estimated run-off potentials of local rainstorms using the obtained data. The derived run-off potentials were then used to determine run-off behaviour patterns in the second part of the study.

Results and Discussion

Hydrological Response of the Njemps Soils

Fig.3 shows the average infiltration curve for the two study sites. It is apparent that the equilibrium infiltration capacity of the two sites lies between 11 and 16mm/hr implying that any effective storms for run-off harvesting must exceed similar intensities. The mean intensity of 1 hour duration storms which contribute more than 63% of total annual rainfall in the area is 14.2 mm/hr (Rowntree, 1988) showing the high magnitude of run-off occurrence.

The high case of run-off occurrence is also apparent in Figures 4 and 5 whose slopes of greater than 0.5, imply that more than 50% of any effective storm forms run-off. Such high run-off co-efficients describe the high sheet erosion prevalent in the study area

Little of the rainfall is stored as soil moisture for plant use. This poses a big problem to reforestation and run-off harvesting is therefore necessary.

Fig. 3. infiltration capacity curves for Eldume & Lameluk

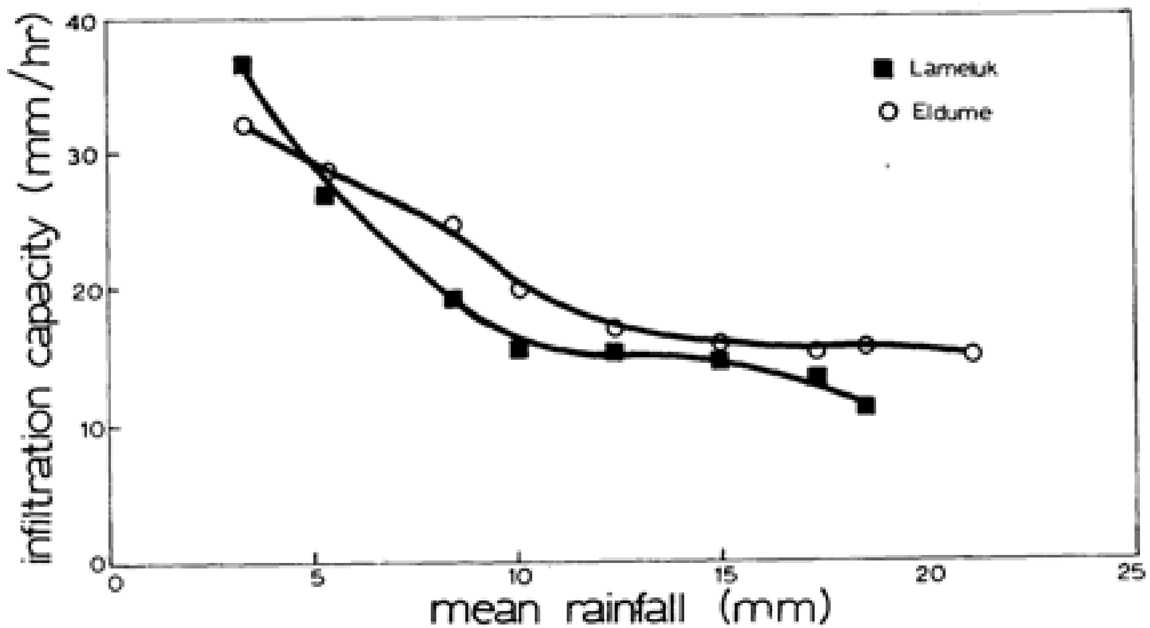


Fig. 4: Rainfall runoff relationship for Lameluk

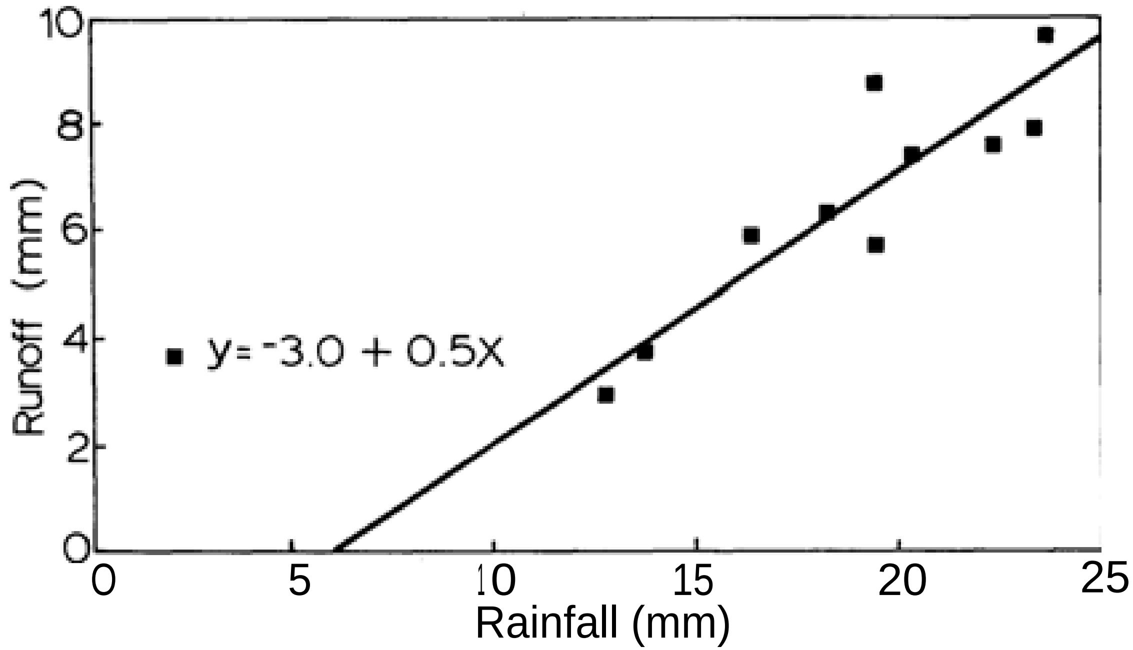
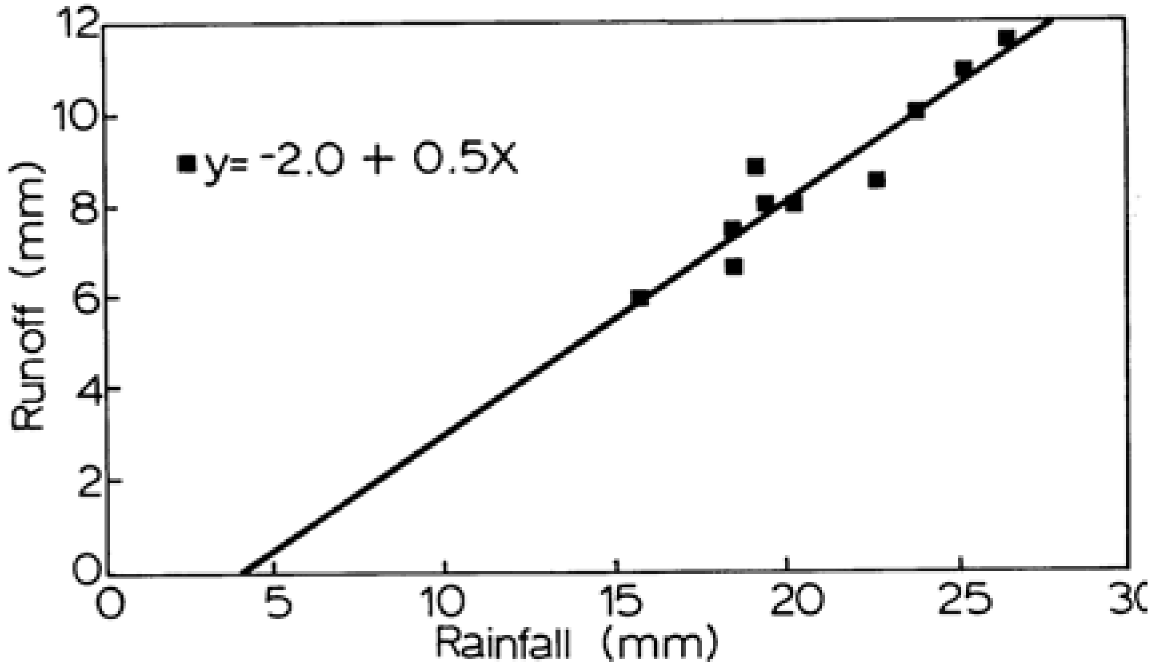


Fig.5: Rainfall runoff relationship for Eldume



Run-off Potential of the Local Rainfall

Figure 6 is the annual rainfall run-off curve for the study area derived by plotting the predicted annual run-off against the corresponding annual rainfall. From the curve, the following are apparent:

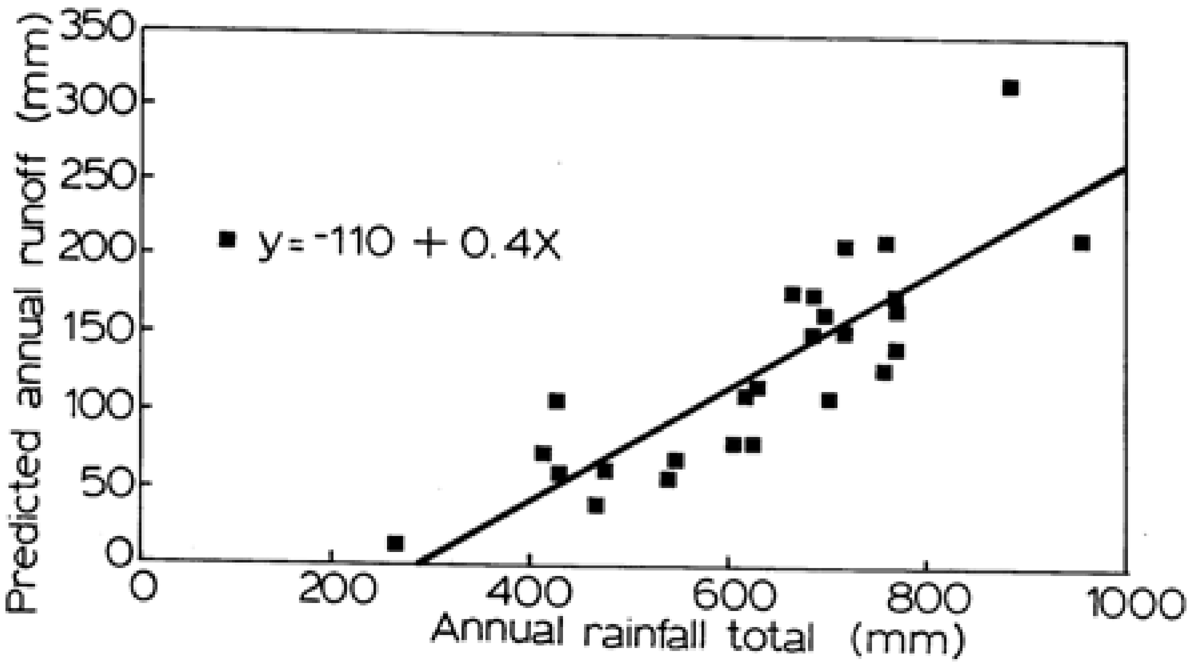
(a) That run-off is linearly related to rainfall total implying that seasons of heavy rainfall also receive the highest run-off yields.

(b) That the mean annual rainfall of 640 mm yields an average of 130 mm of run-off per year. This is the mean annual run-off potential on the Njemps Flats and it's the value that should be used in planning run-off harvesting projects in the area. However, the annual run-off yield has a potential to fluctuate from 13-300 mm due to fluctuation in annual rainfall total.

(c) About 270 mm of annual rainfall is lost as threshold rainfall in the area. With high fluctuations in annual run-off yield, run-off harvesting has a chance of failure should rainfall fail in a season. This calls for the use of draught tolerant tree species.

Assuming that any storm exceeding 7 mm (the minimum rainfall needed to generate run-off) forms run-off in the study area, monthly run-off potentials and probabilities were calculated using 27 years of rainfall recorded at the Perkerra Irrigation Research Station (Fig. 2 and Fig. 7). The graph shows that monthly run-off probability on the Njemps Flats ranges from 0.19 to 0.77 in the driest and wettest months respectively which agrees with the values obtained by Rowntree (1988). Such values imply that monthly run-off probability rises in the sensitive periods of seedling establishment until it peaks in July. Accordingly, seedlings should be planted early in the beginning of the rainy season so as to make use of all available moisture.

Fig.6: Annual rainfall runoff relationship on the flats



It is suggested that seedlings be planted in March after any storm exceeding 15 mm has fallen. Going by the Linear Regression Model of Rainfall Run-off analysis, such a storm would yield:

(15-7)*0.5=4 mm- -------(i)

of equivalent rainfall in form of run-off which when collected by a 10 sq.m micro-catchment plot would yield close to 40 mm of run-off for storage in the planting hole. This is likely to be enough to support the seedling until more rain falls. Unfortunately, a dry period exists between October to mid-March (Fig. 7) when no run-off events are expected. Such a situation calls for the adoption of drought resistant tree species.

Optimal microcatchment plot size

The Njemps Flats has a large moisture deficit ranging from 960 - 1,660 mm per annum (Fig. 8) and monthly rainfall has exceeded potential evaporation in only 12 instances in 27 years (BPSAAP, 1984). Such a deficit is the amount of moisture that must be supplemented with the mean run-off potential for the area. According to Fig. 4, the mean run-off potential in the area is 130 mm which must:

Annual moisture deficit 1330

--------- = -- 10.2 sq.m ---- (ii)

-_------------- _------ _------ _----- Annual runoff potential 130 to give a plot size of about 10.2m ^{2} which closely agrees with the 10 m ^{2} plot size determined through trial and error in the run-off harvesting projects currently in the study area. Such a micro-catchment plot size implies that the highest stocking density that can be supported by local water resources is 1,000 trees per hectare. However, other silvicultural factors may demand the use of a lower stocking density.

Fig.7 Mean monthly runoff and associated probabilities on the flats

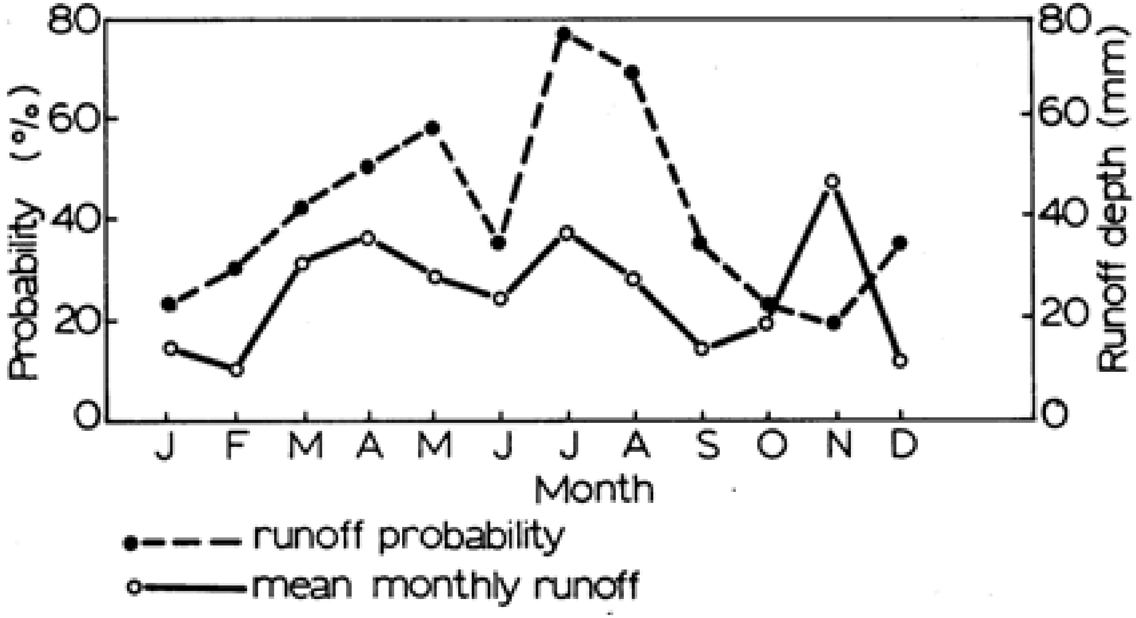
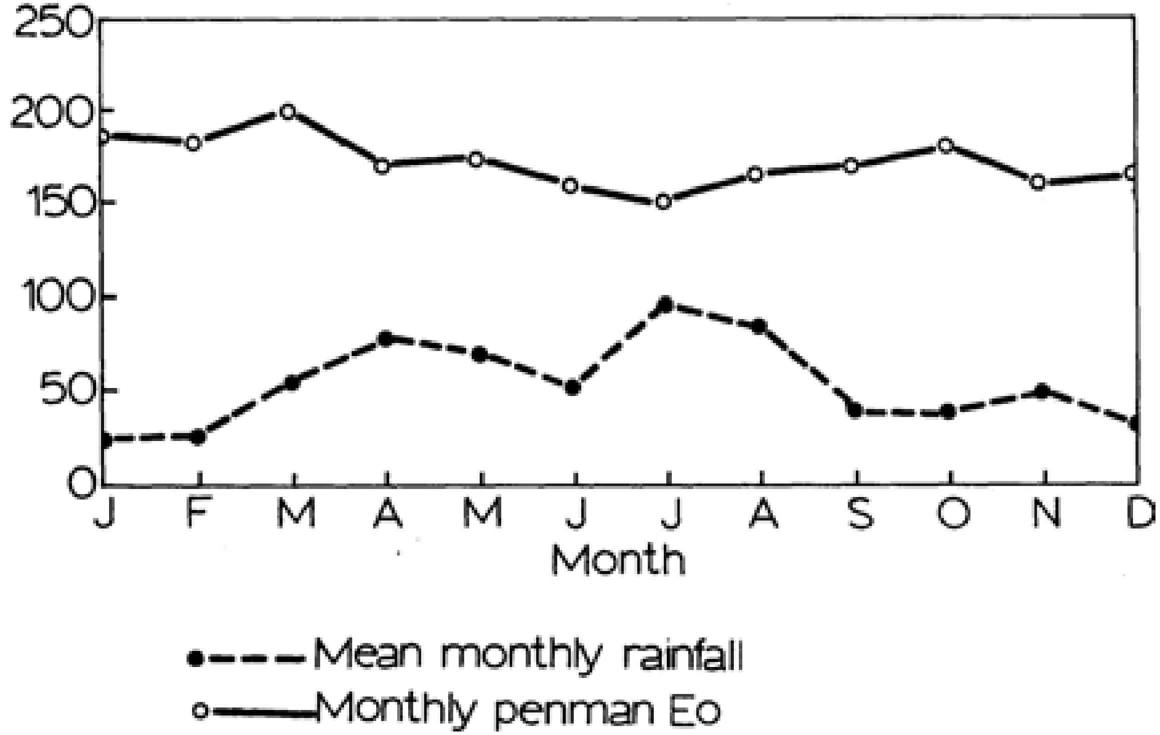


Fig. 8. Available moisture deficit on the Njemps flats
(27 yrs mean)



Conclusion and Recommendation

The study shows that from a knowledge of hydrological response of soils and a good record of rainfall data, it was possible to derive information on run-off behaviour on the Njemps flats. As such, lack of hydrological data such as from run-off plots or catchment studies need not hinder efforts to obtain information on run-off behaviour on any site.

The study has given useful information
for run-off management in the area and can be applied to other dry areas with similar conditions. As an effective run-off harvesting requires a good knowledge of run-off pattern, the following steps are recommended

(a) determination of the hydrological response and run-off potential of the planting sites.

(b) Determination of the moisture deficit (moisture supplement requirements) and then the micro-catchment plot size.

(c) Determination of the run-off variability patterns which then determines factors like the planting dates and species selection.

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