STUDIES AT COBAR EXPERIMENTAL AREA, COBAR, N.S.W.

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INTRODUCTION

The initial study program relating to reclamation of the hard eroded ridges of the Cobar Pediplain, has recently been completed at Cobar Experimental Area.

The studies involved treatment of the area by mechanical methods and subsequent measurements of their effects.

SITE DESCRIPTION

When investigations commenced at Cobar, the site was a bare, eroded ridge supporting very little ground cover. The 81 hectare area had been heavily grazed for many years and most of the larger trees had been removed for mining and other purposes.

The site consists of a main ridge about 10 metres above the centres of the drainage flats which surround it on three sides. Slopes vary from about level on the ridge tops to five percent on the steeper areas. The site is approximately 250 to 270 metres above sea level.

The median annual rainfall at Cobar Experimental Area is 325 mm. Temperatures are hot in summer and cold in winter (34.6°C mean maximum for January; 4.1°C mean minimum for July). Limited evaporation measurements indicate annual loses of 2350 to 3005 mm from a free water surface.

The major tree species include bimble box *(Eucalyptus populnea)*, red box *(Eucalyptus intertexta)*, white cypress pine *(Callitris columellaris)* and mulga *(Acacia aneura)*. A wide range of shrubs is also evident.

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Soil descriptions were carried out as part of a larger scale soil survey, and involved examination of a typical ridge catena and of selected sites on and adjacent to the Experimental Area.

On the ridge crests and upper slopes occur shallow stony medium - textured lithosols (Northcote Um 1.43). These are acid, reddish brown in colour and no more than 30 cm deep, and are, in fact, the B horizons of the original soils, from which the surface 10 cm or so of coarser textured materials has been eroded by water sheeting. The present soil surface is vary hard, and has a very low infiltration capacity.

The soils of the mid-slopes and lower slopes become gradually deeper and less stony than the ridge soils, and have uniform medium - textured profiles (Um 1.43) on the mid-slopes with gradational red earth profiles (Gn 2.13, 2.12) on the lower slopes. These lower soils are underlain by a "Hardpan" - an apparently fluviatile layer which is impenetrable to soil sampling equipment and most plant roots. The greatest effective plant rooting depth measured at the site is 65 cm .

All soils contain low levels of available phosphorus, total nitrogen and organic matter, and relatively high levels of exchangeable sodium.

Small areas of residual topsoil and water or wind deposited coarser material (sandy loam, sand) occur in rill-lines and near the ridge crests. These soils have a much higher infiltration capacity, because of the coarse surface layer, and it is only in these situations that vegetation growth occurs in all but very wet years.

MECHANICAL TREATMENTS

Three different structural treatments were used at the site in an endeavour to stimulate revegetation. These were:-

Ripping - belts of three contour rip lines with one metre between the individual rip lines forming a belt 2 metres wide. These were separated from adjacent belts by an untreated space of 6 to 10 metres width. Similar belts of rips were later constructed midway between the original belts.

Close Furrows - contour furrows from 1 to 1.5 metres apart down the slope. These furrows were approximately 30 cm wide and were interrupted every 50 to 60 metres, by an unfurrowed gap one of two metres wide.

Wide Furrows - contour furrows from 3 to 5 metres apart down the slope and constructed as above.

An untreated area served as a control. Superimposed on these treatments were grazing and enclosure. Most furrowing and ripping on the Experimental Area has been carried out on the upper and mid-slopes and the ridge crests.

VEGETATION STUDIES

a) Ground Flora

i) Period 1963 - 1968

Observations over the five years immediately following treatment indicated that structural treatments as well as exclosure were essential to the revegetation of this eroded site. Close furrows were the most effective structural treatments, followed by wide furrows and ripped belts. Exclosure alone showed little response.

There were few significant differences in vegetation establishment following winter and summer structural treatment, but experience suggests that where possible, treatment should be carried out in cooler months to aid plant establishment.

Both exclosure and soil disturbance were essential to the establishment of perennial forbs. These species were conspicuously absent under grazing but present in wide array after five years of exclosure. The harsher perennial grasses, however, appeared less susceptible to grazing and were the predominant species on heavily and continuously grazed areas.

Even with complete exclosure, perennial cover decreased during severe droughts, illustrating the dynamic nature of ground cover and showing that major fluctuations in perennial cover occurred independently of man's influence.

In this period, cover was largely associated with mechanically disturbed sites, with some spread onto interfurrows and interbelt (rips) areas. Despite the influence of mechanical treatment, the greatest amount of ground cover established during this initial five year period was a 40% cover.

(ii) Period 1972 -1975

The prime difference between the (1963-68) and (1972-75) observation periods was that during the latter period some sections of the site were grazed to allow observations to be made on the effects of controlled grazing as opposed to continuous grazing on vegetative cover production.

One major factor demonstrated during this period was the lag in cover production after a dry spell. The minor drought of winter - spring 1972 and summer 1973, was followed by good rains from autumn 1973 onwards. However, mean total pasture cover did not rise significantly above the drought levels until autumn 1974. This result indicates the need to restrict stocking for a period after drought breaks, to allow plants to germinate and establish resistance to grazing.

The trial again indicated during the later observation period, that two inputs were required to reclaim eroded ridge soils in the Cobar area; structural treatment (surface disturbance) and stocking control (exclosure and spelling periods).

The type of structural treatment is important. In the trial, widely spaced furrows produced highly significantly more perennial grass cover than the close furrows regardless of stocking pressure. Under controlled grazing, close furrows produced more total pasture, while under continuous "Heavy" grazing the wide furrows produced more total pasture. The wide furrowed/ control grazed area produced the best balanced pasture, with annuals, perennial forbs and perennial grasses contributing approximately equally to the total pasture.

The selection of furrow spacings required will depend on costs, pasture type requirements and stocking management.

(iii) Change in Species Array

When Cobar site was exclosed, only twenty separate ground flora species (12 grasses and 8 forbs) were recognised. However, by June, 1974, eleven years later, 119 species (32 grasses and 87 forbs) were evident on the area

Although detailed information is not available on the original pastures, perusal of available literature indicates that the basic elements of the original pastures are still present, although relative abundance relationships may have changed.

(b) Tree and Shrub Growth and Regeneration

Heights of trees and woody shrubs were measured during the period September, 1964 to September 1974, in adjacent furrowed grazed (1 sheep per 2.5 hectares) and ungrazed areas, to determine the effects of grazing, season and rainfall on growth rates. The main species measured were mulga *(Acacia aneura)*, white cypress pine *(Callitris columellaris)*, and turpentine *(Eremophila sturtii)*.

It was shown that the growth rates of ungrazed mulga and pine trees were significantly greater than those of grazed plants, but for turpentine no significant difference occurred. Mean annual height increments of ungrazed mulga, pine and turpentine were 0.24, 0.20, 0.09 metres respectively, whilst for grazed plants mean annual increments were 0.14, 0.12 and 0.08

metres respectively,

From the limited seasonal data available, it appeared that growth was more rapid in summer than in winter. For all but ungrazed turpentine, height increments of grazed and ungrazed plants were significantly correlated with rainfall. Growth rates, especially of mulga, increased sharply in the wet September, 1973 to March, 1974 period, but were very low during the initial part of the observation period and during the dry year, 1972.

Deaths of plants during the trial were minimal (2 out of 68 mulgas, 1 out of 55 pines and 5 out of 91 turpentines).. Almost all deaths occurred before 1972.

Studies of shrub regeneration were also carried out. However, no significant difference between regeneration on grazed and ungrazed plots occurred, nor could regeneration be statistically related to current rainfall. A nil or only very slight increase in total plant numbers occurred up to 1969, after which a gradual increase occurred on all plots, and with a marked increase on one plot after September, 1974.

Final plant numbers were:

grazed mulga and turpentine 1.7 times the initial number
grazed pine 3.5 times the original number
ungrazed mulga 2.2 times the original number
ungrazed pine 5.5 times the original number
ungrazed turpentine 14 times the original number.

(c) Effects of Grazing on Vegetation

A small grazing trial carried out at the experimental site between 1968 and 1973 produced several significant results.

The stocking rate prior to furrowing was assessed at one sheep to ten to twelve hectares. During the trial the furrowed areas were stocked on average at one sheep to 2.3 hectares, and on two of the paddocks used, the stocking rate over the five years of the trial was one sheep to less than 1.5 hectares. These rates were applied without any medium to long term pasture degradation.

An examination of the effect of length of time between contour furrowing and grazing (i.e. the spelling period) produced interesting results. Areas spelled for two and five years produced similar average pasture cover during the trial, whereas areas spelled for less than eighteen months produced much lower average cover. This indicates that newly treated areas need to be spelled for at least two years and possibly longer, depending on seasonal conditions.

During the trial, one paddock was grazed predominantly during the summer period, with another during the winter period. The summer grazed paddock produced a predominance of winter annual species whereas the winter grazed pasture had a dominance of perennial species, mostly summer growing. Although this result is confounded with differences in furrow spacing, there was an indication that species manipulation may be possible through grazing management.

SOIL STUDIES

(a) Rainfall and Runoff Studies

Runoff from two small plots 3.22 metres long by 1.22 metres wide (designed to simulate the interfurrow distance of wide furrows) was measured between May, 1968 and February, 1973. Rainfall amount and intensity were measured by a pluviograph.

One plot was located on a smooth, crusted soil surface and one was on a gravel-covered surface - the two soil surface conditions commonly occurring on the Experimental Area.

Wherever possible runoff from single rain fall events was measured, with 140 events being recorded during the trial period.

Recorded runoff ranged from 0 to 81 per cent of incident rainfall on the gravelly plot, and from 0 to 87 per cent on the smooth-surfaced plot. Rainfall amount accounted for 84 to 89 per cent of variation in actual runoff, and intensity accounted for a further 5 per cent of the variation. Neither antecedent rainfall nor season significantly affected runoff.

Threshold rainfall amounts for runoff to occur were calculated from rainfall/runoff regressions for each plot. These were 5.1mm for the gravelly plot and 4.8mm for the smooth plot. In practice, however, 21 positive runoff events occurred at lesser amounts of rain fall on the smooth-surfaced plot. The gravelly surface sheds 34 per cent of its annual rainfall as runoff, whilst the smooth surface sheds 45 per cent of its rainfall. Falls of less than 5mm of rain comprise from 4 to 50 per cent of its annual rainfall in this district, and runoff occurs about 19 times each year on average.

On contour-furrowed ridges irrigation of the furrows occurs after rains of 5mm or more. Thus an annual basis furrows 3 metres apart effectively receive about four times the incident rainfall.

(b) Soil Moisture Studies

Gravimetric soil moisture measurements were initiated soon after studies commenced at the Cobar site to ascertain the degree of the influence of the mechanical treatments on soil moisture levels.

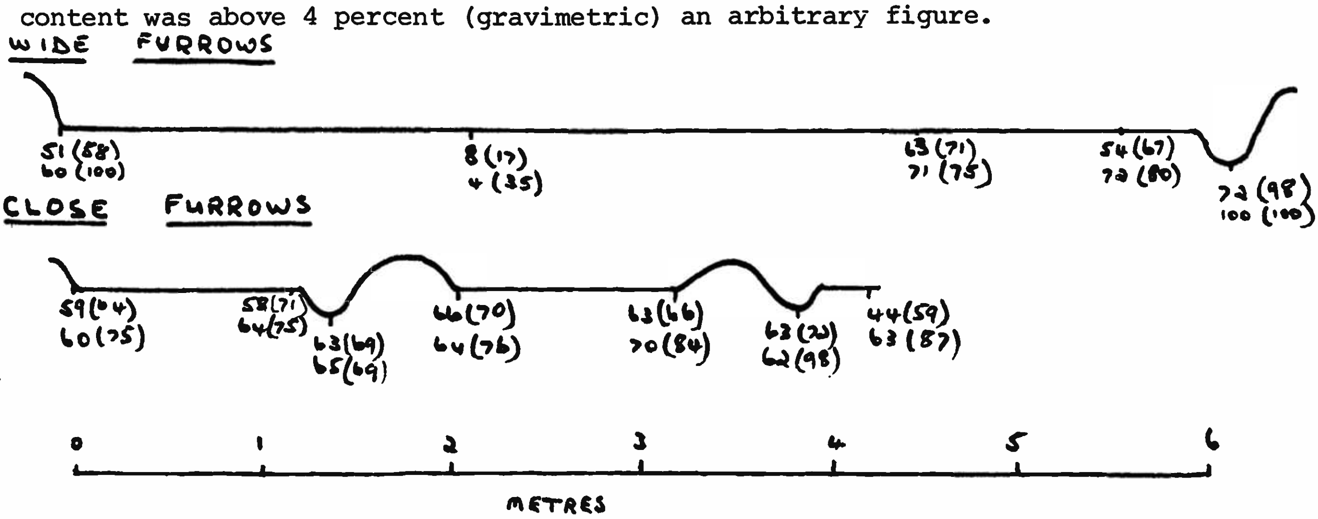
Sampling was carried out at the soil surface (0 - 1 cm depth) and at 10cm depth. Results revealed that the zone of influence for both riplines and furrows was limited to the immediate vicinity of the structure. The extent of this influence varied with depth, particularly on the ripped areas.

Perhaps the major outcome of the study was the revelation that soil moisture levels on control areas and those between the furrows and ripped belts rarely exceeded accepted field capacity levels. This explains why vegetation establishment on these areas was poor during the initial stages of the Cobar studies. It was only after the prolonged wet periods of the 1970's that vegetation establishment began in earnest.

This study also revealed greater soil moisture levels under the furrows than under the ripped areas, suggesting greater efficiency in runoff water trapping by the furrow line.

The soil moisture regime in transects across wide and close furrows was measured again with gypsum blocks in a more detailed study between October, 1974 and September, 1975. Blocks were placed at 5 cm and 10 cm depths between, adjacent to, and in furrows, and the drying cycles of the soil were measured. Wetting rate was estimated from pluviograph records and antecedent soil moisture.

The percentage of total time that the moisture content at each depth was above wilting point (taken as pF 4.2 for want of a better figure) is shown diagrammatically below. Figures in brackets indicate percentage time moisture content was above 4 percent (gravimetric) an arbitrary figure.



These figures show that furrows markedly affect the soil moisture regime at all positions in and adjacent to furrows, with the exception of the interfurrow space between wide furrows, where the moisture regime would be very similar to unfurrowed ridges. At this site a fall of 39 mm of rain was required to bring the soil moisture content at both depths above wilting point. This is not surprising since the site is characterised by the absence of vegetation except for a few Bassia diacantha plants after 13 years without stocking and 3 years of excellent rainfall. Mixed vegetation of varying quantities grows at all other sites.

(c) Soil Temperature Studies

Limited measurements of surface and 10cm depth soil temperatures were made over a four day period in May, 1965. Maximum temperatures as well as the diurnal fluctuations were recorded in furrow base and interfurrow sites under varying amounts of cover.

Increasing degrees of cover produced increasing reductions in maximum daily temperature as well as in the diurnal fluctuations. This effect was evident both at the surface and at 10cm depth.

The overall effect of this amelioration of the soil temperature regime by the primary coloniser cover in the furrows was to provide suitable germination sites for more useful pasture species. Grazing at this time removes this primary coloniser cover and results in a less favourable environment for establishment of more useful species. This provides a further case for exclosure in the years following treatment of bare areas in the Cobar district.

It is unfortunate that a parallel study was not conducted in summer to quantify summer maxima and diurnal fluctuations. However, the study illustrated the major temperature fluctuations experienced on bare sites in winter and showed that relatively high temperature maxima (30°C approx) can be experienced in winter.

CONCLUSION

Studies at Cobar Experimental Area have provided a much needed quantification of the soil environment of an eroded ridge site representative of large sections of the district. The information obtained has explained why, without soil disturbance, water trapping and grazing control little can be achieved in regenerating eroded areas in "non-wet" years.

The trials also illustrated the value of contour furrows as a revegetation tool and showed how soil disturbance combined with exclosure has greatly widened the array of ground flora species.

The limited grazing trial at the Cobar site has provided an encouraging indication that pasture species composition in the area may be manipulated by grazing at specific times.