TABLE OF CONTENTS

VI. LAND SYSTEMS

The basic aim of this survey of some 14,000 square miles has been to describe the various natural environments in north-western Victoria and their relationships to land use. The chief features of the natural environment which affect land use are climate, soils and topography. Many classifications of land have given prime importance to one or other of these features. This has not only limited their usefulness but in some circumstances it can be misleading. For example, in this region a classification of land based primarily on soils would fail to emphasise the differences in the productivity of the light clays for cropping as affected by changing climate. The light clays are productive cropping soils in the Culgoa land system where the average annual rainfall is 14 inches but they cannot be economically cropped in the Millewa land system where the rainfall, is only 10 inches.

The Soil Conservation Authority has adopted a method of land classification in which due weight is given to each feature of the natural environment. The principles on which the surveys are based and the methods used have been presented in detail by Gibbons and Downes (in press). They have shown that, in addition to climate, soils and topography, another feature may be of use, namely the native vegetation which is usually an expression of the other three factors.

In the preceding chapters the features of the natural environment have been classified to levels suitable for discussion of dry land cropping and grazing. The Soils have been classified into morphological groups and sub-groups, the topography into land forms and the native vegetation into structural units. The average annual rainfall is used as the climatic index, a difference of 1 inch being regarded as significant.

At the reconnaissance level involving hundreds or thousands of square miles, it is not possible to map individual occurrences of a land form or a soil morphological group so that larger mapping units are required. Thirteen such units known as "land systems" have been delineated. In each there is a limited range of land forms and soils which occur in a characteristic pattern. Some of the land systems contain a significant range in climate and here subdivisions can be made into climatic zones on the basis of the isohyets which are superimposed on the land system map.

In Figures 16-28 there is a summary for each land system of the natural environment and its relationship to land use. There are two kinds of diagram for each land system. The uppermost of these presents an idealised cross section of country showing the distribution of land forms. Where the east-west aligned dunes occur the most suitable transect runs north and south, whereas for the N.N.W.-S.S.E. trending ridges, an east-west section is required. In land systems containing both of these land forms, two transects are shown. Where the direction is not shown it is not critical. The lower diagram shows the average annual rainfall, land forms, soils and native vegetation. The land-use features of the soil on each topographic situation are shown-the moisture characteristics, fertility reserves, nutrients required in fertilisers, recommended pastures and the erosion hazard. The nutrient requirement is that of cereals sown after fallows, under the average system of management. The bulk of the fertilizer used within the region is applied at this time.

The land system diagrams also indicate the relationship of the soils on each landscape position to "land use classes" (see Appendix II). These are relatively broad categories drawn up by the Soil Conservation Authority to classify land according to the most suitable form of land use as influenced by the erosion hazard.

The land systems describe the soil pattern on the basis of its distribution relative to topography. Unfortunately this relationship is by no means consistent on the hummocks and ridges which occur in several land systems. These land forms contain a wide assortment of soils ranging in texture from sand to clay and a wide range can occur on any one position, particularly on the crests and the upper slopes. In general, heavier soils occur on relatively gentle slopes towards the base, with lighter soils on the upper slopes but this is not invariable. Sometimes the soils on the eastern or upper eastern slopes are lighter than those on the western faces. This is due to the stripping of material by wind in past arid periods from the western faces and to the deposition of coarse materials on the eastern slopes. These poor relationships on hummocks and ridges are reflected by the complex data for soil-topographic units and erosion hazard in the tables beneath several of the land system diagrams.

Land use in the various land systems is discussed primarily from the point of view of the erosion hazard, erosion incidence and the pattern of conservation farming which has been developed to combat the problem. The historical background to the development of these conservation measures has been treated most fully in the Central Mallee land system. Similarly, the problem of salting which has developed in widely-scattered areas is discussed in detail in the section on the Hopetoun land system.

VII. SOIL CONSERVATION

Where the native vegetation has been removed in north-western Victoria, wind erosion has occurred on susceptible land forms and soils. Erosion has not been restricted to the period since settlement. It apparently occurred widely during a succession of and periods in recent geological times. During each and period the native vegetation became sparser, thus giving less protection to the ground and resulting in the stripping and deposition of soil materials. During each ensuing humid period, the plant cover improved to stabilize the landscape once again. The region was in this stable condition when white men arrived. When farming began the native timber was removed and the land kept bare by fallowing and overgrazing so that the wind began once more its process of stripping and deposition.

Among the land systems which are mainly cropped and grazed erosion is greatest where the susceptible dunes are most dense. The hazard is greatest in the Central Mallee. land system where dunes occupy on the average, 30 per cent of the landscape and it decreases through the Tempy (15 per cent) and Millewa (15 per cent) to the Hopetoun land system (5 per cent). The hazard is relatively low in the Boigbeat land system which is composed mainly of hummocks. It is even lower in the Culgoa land system which contains heavy plains with relatively few hummocks, and is only slight in the Wycheproof land system which consists entirely of heavy plains.

Although the Big Desert and Berrook land systems have been cleared only in a few places, consequent erosion of the dunes and jumbled dunes shows that each of these areas has a higher erosion hazard than any other land system. The relatively small Ned's Corner land system is perhaps the most badly-eroded area of all. Although its hazard is only moderate and it has been used only for grazing of the native vegetation, the long history of land-use, combined with overgrazing and the low regenerative powers of the native species under the low rainfall has resulted in widespread wind scalding. The extent of erosion is less in the Raak land system where, although there is a severe overall hazard the native vegetation has in general not been overgrazed. Erosion is most serious on the lunettes. The hazard in the Tyrrell Creek land system is moderate but the incidence is generally low because of the satisfactory retention of the native vegetation. Severe scalding does occur, however, on sandy loams of Group C, both on the plains and on lunettes. The hazard in the Lindsay Island land system is on the average low and severe erosion is confined to "spot" areas such as sandy hummocks or lunettes.

Soil erosion has serious monetary and aesthetic disadvantages. It results in heavy financial losses, due largely to a decline in yields of crops and pastures. Chemical fertility is lost by the removal or burial of topsoil whilst unsuitable physical conditions follow the exposure of subsoils. The clearing of drift from fences, channels, roads and railway lines is another financial burden both for individual farmers and for the general public. The public cost of clearing channels has frequently been over £60,000 per annum whilst the greatest cost was over £300,000 in 1945-46 (State Rivers and Water Supply Commission, Annual Reports). Because of its direct nature, the expense of clearing drift has received more attention than the far greater loss from the insidiously declining yields. Among the more important aesthetic disadvantages of erosion are the lowering of the farmers' pride in their land husbandry, and the production of unpleasant living conditions on the farms and in the towns.

The widespread erosion which followed settlement brought the realization that changes in farming methods were needed. The problem, of course, was not confined to north-western Victoria. It occurred in other parts of the State, in other States and in other newly-settled countries. Governments have acted by setting up soil conservation organizations and their activities have expanded rapidly since the second world war. In Victoria the Soil Conservation Authority was constituted in 1950. The establishment in 1932 by the Department of Agriculture of the Mallee Research Station at Walpeup has also, been of major significance to the region as a whole. At this centre a large body of scientific and applied data has been built up concerning the most suitable types of cereals, pastures and sheep, fertilizer requirements and many facets of farm management, including erosion-control techniques.

Erosion is much less extensive now than in the earlier phases of settlement. The turning point came after the general instability which accompanied the disastrous drought of the mid 1940's. The subsequent decline in the level of erosion can be attributed to a combination of many factors. A run of good seasons in the late 1940's and the 1950's provided excellent conditions for improving the ground cover. In addition the high post-war prices for grain, wool and lambs improved the financial position of the farmers, enabling them to put into practice the improved conservation techniques which had been developed. The ground cover was further improved by the spectacular decline in the rabbit population following the introduction of myxomatosis in the early 1950's. The introduction of cereal rye made possible the reclamation of the dunes which subsequently became highly productive sites when lucerne became available. Barrel medic and Wimmera ryegrass became widely sown, thereby improving the cover afforded by pastures. Finely-worked bare fallows have been replaced by fallows which have rough surfaces or a protective cover of either stubble or green cover crops. The replacement of horses by tractors has enabled farmers to avoid dry-working of fallows which gives rise to smooth surfaces. With tractor power rough surfaces can be quickly prepared by working "round the clock" after rains before the surface dries out. Finally the danger of overgrazing has been limited by the generally favourable seasons. It is not possible here to indicate all the techniques which have been developed to minimize erosion. Reference should be made to the management practices stressed by the Soil Conservation Authority in its annual Hanslow Cup Competition Reports for the Mallee districts and by the Department of Agriculture's annual guide books for the Mallee Research Station, Walpeup.

The ultimate objective of conservation farming is to achieve maximum economic permanent production. It implies far more than the reclamation of eroded land and the minimizing of erosion by the techniques outlined above. Conservation farming involves the adoption of a form of land use which, to the best of our scientific and technological knowledge, will minimize the risk of erosion. As before the advent of white man, the key to the prevention of erosion lies in the maintenance of vegetative cover on susceptible land. The unstable sands should be protected by perennial pastures. Only the heavier soils should be regularly cropped and where they show signs of declining soil fertility the land should be spelled under pastures which contain a legume. Thus differential treatment of soils is required and the original fencing layout needs to be modified to include, as far as practicable, soils of the one textural group within paddock units. Adequate fodder reserves should be kept, not only to preserve a cover on the land and to maintain the condition of stock during times of drought, but also to improve the quality and yield of livestock products during normal seasonal periods when paddock feed is inadequate.[*] It can be seen that conservation farming involves considerable

[*] The amount of fodder which should be conserved varies considerably from farm to farm depending on many factors including the number of stock, the stocking rate and the condition and type of pastures. Where medic burrs are plentiful the amount of conserved fodder needed is reduced. The following figures (Hyland

managerial skill. Apart from their role in providing technical advice, governments can help by ensuring that finance is available for farmers to implement their plans. for conservation farming.

Some farmers have fully adopted the conservation system of farming which has been evolved and they have shown that it is rewarding both financially and aesthetically. However, many farmers, whilst keeping erosion at a low level during average or above average rainfall years, are not prepared for a prolonged drought and if this should eventuate, there can be no doubt that there will be a great increase in the extent of erosion. The land has been intensively cropped for periods ranging from 40 to 70 years and although suitable introduced pastures have become available there is still far too much cropping, not only on the sands but also on the sandy loams. In general the latter require' a greater proportion of time under leguminous pasture to rebuild and maintain their fertility. This need is greatest in the southern parts of the region where the rainfall is relatively favourable. At present, cereal production within the region can be increased or maintained at its present level only at the expense of stability and fertility. On the other hand there is a considered potential for safely increasing livestock production by increasing the area sown to lucerne on the sands and to annual medics and grasses on the heavier soils. Thought should be given to the general introduction of beef cattle so that the source of farm incomes can be diversified.

Where the land is used mainly for grazing of the native vegetation-in the Raak, Tyrell Creek, Ned's Corner and Lindsay Island land systems, the potential for increased production is low. because of the widespread occurrence of heavy or saline soils and because low stocking rates are required on the lighter soils to maintain stability. In these areas the biggest increase in production should come from the reclamation of eroded soils. The time is not yet ripe for developing the extensive, uncleared land in the Big Desert, Berrook and Central Mallee land systems because of their severe erosion hazard. It is not known whether pastures can maintain stability in the Big Desert and Berrook land systems. The uncleared portions of the Central Mallee land system should not be settled until the general level of farming within the already settled districts becomes sufficiently stable.

As has been shown in the discussion of each land system, there are many problems of land husbandry requiring investigation. Perhaps the most important of these is the need to determine the most suitable techniques for managing the sands. In recent years lucerne has become widely sown on these soils in the central and southern parts of the region and it is by far the most suitable species for maintaining stability. Although the sands should not be returned to intensive cropping, flexibility of management is required and there is a need to determine the most suitable techniques for replacing lucerne by a crop and yet preventing wind erosion. In the drier Millewa land system further testing of lucerne is .required to determine whether it is the most suitable species for the sands. In this area the red sands have a relatively high nitrogen status so that a non-leguminous perennial species may be more suitable.

It is unfortunate that, with the wide fluctuations in climate from year to year, and particularly with the great variation in rainfall, several years of agronomic testing ar6 required to determine an average result In spite of this complication many further tests of crop and pasture growth are warranted. In the past, too little attention has been paid to the correlation of yields with soil morphology and with soil nutrient status. This aspect is essential because, within a particular climatic zone, growth will vary according to soil types, and on a particular soil type according to factors such as the number of crops sown in the past, the amount of fertilizer applied and perhaps the length of time under medic ley.

Studies are required into the maintenance and improvement of the fertility of the various soils for cropping. In each climatic zone there is a need to determine the extent to which medics should be grown to maintain a suitable level of available nitrogen. This level would be one which, in an average season, would promote an amount of cereal growth which would neither "burn off" through lack of moisture nor suffer from nitrogen deficiency.

Future investigations should also include efforts to determine the optimum levels of other nutrients in soils, particularly phosphorus, sulphur and potassium. The sulphur in superphosphate has masked any possible deficiencies of this element and its status in soils should be examined. With the trend towards producing phosphatic fertilizers low in sulphur this information will become significant. Although potassium deficiency has not been recorded on the sands, further tests with this nutrient are warranted in view of the low quantities present in these soils. In addition, heavier demands on soil potassium are being made with the introduction of lucerne on the dunes.

A thorough investigation is required into the incidence and control of seepage, channel and dry land salting. Preliminary studies should include hydrological aspects in relation to the soil strata involved.

There are still many farmers not applying the pattern of conservation farming which has been evolved and the task before extension workers is great. Meanwhile, there are many problems in research to be solved. It is hoped that this study will assist both the extension and research worker as it has attempted to resolve the complexity of the natural environment into units in which there is a reasonable degree of uniformity in -soils, climate and topography.

1960) are helpful in estimating the amount of fodder which should be conserved to tide sheep over a drought. To maintain an adult dry sheep in good store condition on bare ground in mild to hot weather, the weekly feed requirement is 6 lb. of wheat or barley, 7 lb. of oats and 11 lb. of good grass or oaten hay. These amounts will increase for lambing ewes, or in cold weather. Ideally farmers should have two years supply of paddock feed plus conserved feed as an insurance against drought. As this is expensive when composed almost entirely of conserved fodder, a supply of medic burrs should be built up in the paddocks, and stocking rates should be kept to a safe level.

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