RESULTS OF CLIMATE STUDIES AND THEIR IMPLICATIONS FOR SEASONAL PRODUCTIVITY OF PASTURES

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It is accepted virtually to the stage of being axiomatic that our climate has been of key importance in allowing us to develop an efficient pastoral industry.

The main ingredients in that climate which regulate pasture growth are temperature, light, and rainfall, or, more directly, soil moisture. Although the country is free of extremes of all of these, there are still considerable variations between districts and between seasons.

Accordingly a considerable programme of work has been undertaken to determine their relative importance in regulating production during various parts of the year. Although light, temperature, and moisture often vary simultaneously, knowledge of their individual roles does allow more informed, and generally more efficient, procedures to restrict adverse effects and to exploit favourable situations.

There are many intricacies in relationships between climatic factors and often short periods of extremes are of critical importance. Here the objective is to state the broad pattern of relationships as can best be judged from data available to date. As the work develops the pattern can be defined with more precision,

For this paper, given in a predominantly sheep farming district, the aim is to describe the situation to be expected in a relatively closely grazed pasture. Where pastures are allowed to get several inches or a foot or more long, as frequently occurs in dairy pastures, other physiological factors modify the position. Comments are also limited to four species which are important in pastures throughout the country. These are certified perennial ryegrass, certified cocksfoot, browntop, and Yorkshire fog.

Temperature

Fig. 1 shows the extent to which temperature governed production during the 1957-58 season at Rukuhia and at Gore. It shows the ceiling level of production which could have been expected if optimum quantity of light had been available throughout the year and if there had been adequate moisture and nutrients available at all times. The temperatures used are the

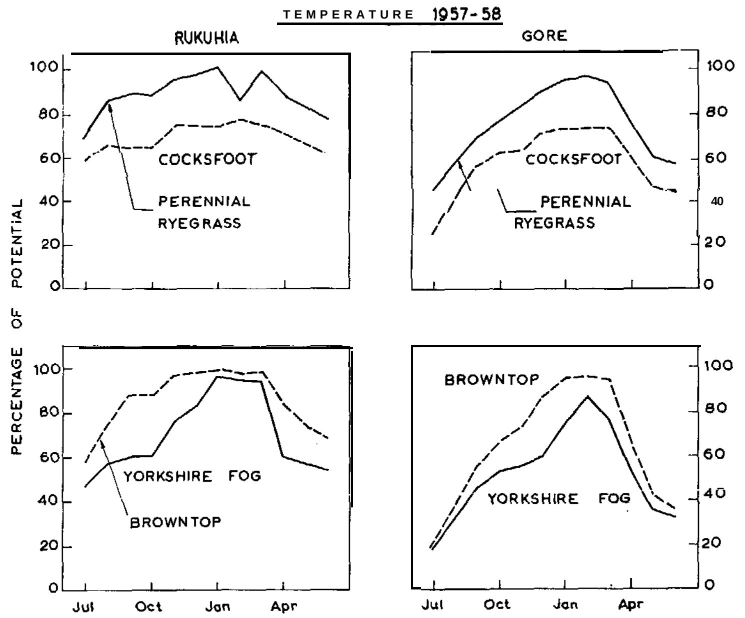

Fig. 1

averages of the monthly means of four values, namely the 1 in. air temperatures at 1 p.m., the minimum air temperature at 1 in., the soil temperature at 1 in. at 1 p.m., and the minimum soil temperature at a depth of $\frac{1}{2}$ in.

At Rukuhia variations in average temperatures during the year had a relatively small influence on the seasonal production potential of perennial ryegrass and cocksfoot, but even summer temperatures that year were apparently not high enough for cocksfoot to reach its ceiling of production potential. With perennial ryegrass there was a short period in summer when growth was limited by temperatures rising above optimal levels. Browntop showed a greater relative decline in potential production from the fall in temperatures during winter than did perennial ryegrass and cocksfoot. With Yorkshire fog the fall in production induced by fall in temperature during the winter was even greater.

At Gore the decline in temperature during late autumn, winter, and early spring was sufficient to limit considerable potential growth by all four species. The relationships between the species remained similar to those noted for Rukuhia.

Light

When light is considered a very different picture emerges. Fig. 2 shows the amount of growth which would be allowed by the

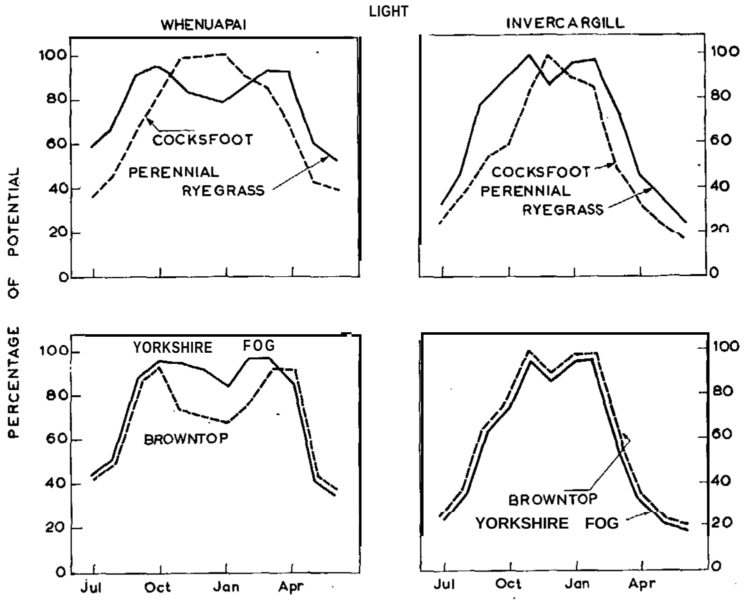

Fig. 2

average daily quantity of light received during each month of the year if temperatures remained optimal. The data are for Whenuapai and Invercargill, the nearest recording stations to Rukuhia and Gore. The season is 1957-58.

At Whenuapai shortage of light considerably limits the growth of perennial ryegrass during the winter. The data available indicate further that during the summer the growth of perennial ryegrass in a pasture grazed short will be limited by its receiving too much light. If further investigation confirms these results, it would clarify many field and experimental observations.

Cocksfoot growth at Whenuapai during the late autumn, winter, and early summer would be more restricted by shortage of light than occurs with perennial ryegrass. On the other hand it can apparently utilise the higher levels of light during summer and there is no present evidence of any check to its growth during summer from surplus light.

At Whenuapai growth of Yorkshire fog is rather more severely restricted during the winter by shortage of light than is that of perennial ryegrass, but it is apparently much more tolerant of high quantities of light during the summer. Browntop appears affected more than is perennial ryegrass by both a shortage of light in the winter and a surplus in the summer.

At Invercargill the great fall in quantity of light during the winter causes a major reduction in growth of all species, but in summer there was in that season probably only limited restriction of growth by surplus light.

In terms of ability to maintain a high level of growth under the various light levels perennial ryegrass shows the widest seasonal spread and cocksfoot the narrowest of these four species.

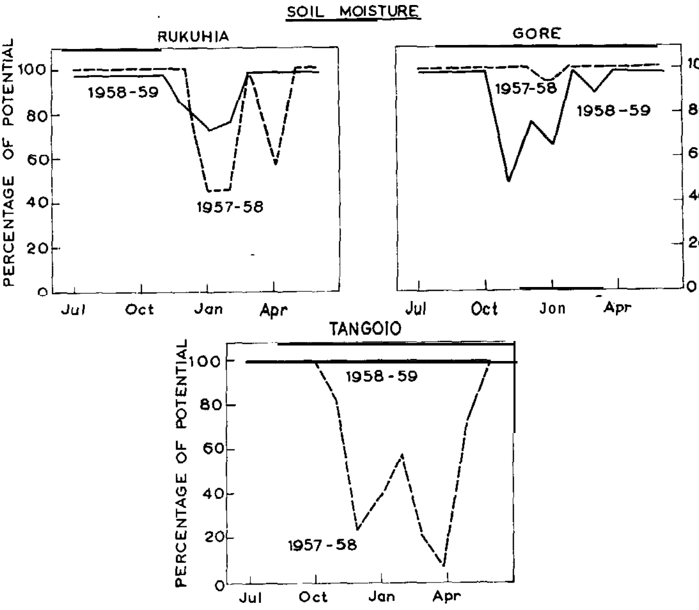

Fig. 3

Soil Moisture

Experimental data on the extent to which various degrees of drying out of the soil restrict the growth of pasture plants is limited. For that matter it is scarce for most crops. However, a first approximation to the position can be got from use of American results with bean plants. Fig. 3 shows the limitations of growth suggested to have occurred during two seasons at Rukuhia, Gore, and Tangoio. It is based on the monthly averages of pF at a depth of 2 in. The figure illustrates the extent to which soil moisture shortage may limit growth and equally how much that varies from season to season.

Alleviation of Limitations

The main purpose of the paper is to outline the relative role of the major climatic factors in determining the growth potential for various districts and for various seasons. However, it is possible to comment briefly on the management procedures which microclimate and controlled climate results indicate could alleviate the position at various times of the year. Although it would be impracticable to expect any complete smoothing out of winter and summer limitation, much can also be done to help the situation by plant breeding techniques.

Climate study results indicate that management procedures can also be used to restrict the adverse effects of both limited rainfall and surplus light, particularly early in the summer.

Allowing a pasture to become reasonably long results in considerable mutual shading between leaves, thus reducing the average intensity of light on each leaf. At the same time the total quantity of light received can be spread over a greater area of foliage. Taken together this results in more efficient use of the summer light for creating herbage.

Further, holding pasture reasonably long will often lead during early summer to a considerable saving of soil moisture. Fig. 4 shows the manner in which during summer a considerably higher reserve of moisture will remain in the soil under a long pasture than under a short pasture. We have to do much more investigation of this phenomenon before its potential significance in various districts is understood. It is important, for it promises considerable saving of water in areas which cannot irrigate in the summer.

In summary, increased length of pasture promises in early summer not only high production from more efficient conversion of light into herbage, but also growth over a longer period as a result of slowing down of rate of loss of soil moisture.

In bringing these matters to your notice it is clearly realised that discretion is needed in application of such suggestions, particularly in avoiding excess length in a pasture. Also a farmer's ability to exploit them is influenced by other seasonal, management, and market conditions, all of which have to be given due weight. There is the further aspect that just as rising fertility and more intensive management is almost certainly aggravating difficulties from facial eczema, thrift difficulties may also come from other fungi and micro-organisms not yet recognised if pastures are held long.

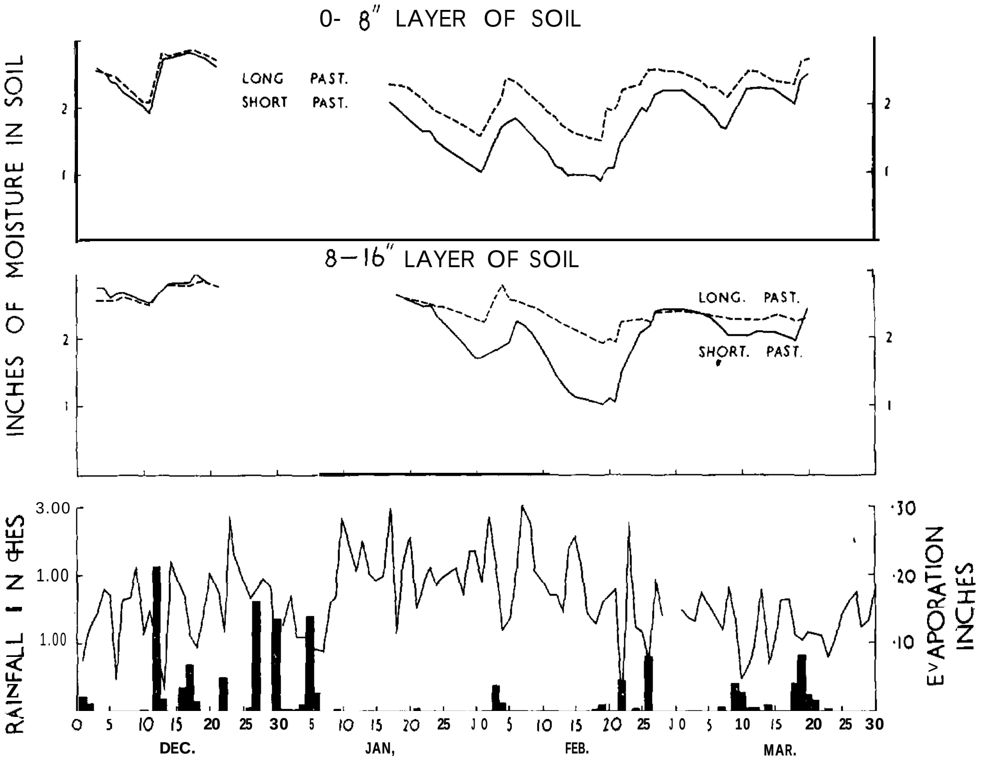
0- 8" LAYER OF SOIL
LONG PAST.
SHORT PAST.
8–16" LAYER OF SOIL
LONG. PAST.
SHORT. PAST.
INCHES OF MOISTURE IN SOIL
RAINFALL INCHES
EVAPORATION INCHES
3.00
1.00
·30
·20
·10
DEC.
JAN,
FEB.
MAR.

Fig. 4

DISCUSSION

Q. (P.B. Lynch): I believe the light assessments were made at a height 4 feet above ground level. Does the maximum light recorded by this method reflect the condition in an average pasture?

A. The amounts of light recorded by the Meterological Stations were used for the total light values. I deliberately referred to a short sheep pasture in the paper. In such a pasture recordings made in summer indicated that most individual tillers were receiving an amount of light approaching the maximum level. In a long pasture, however, individual plants are subject to a degree of shading.

Q. (I. L. Elliot): In the final graph an accumulation of moisture was shown in the lower 8 in. to 16 in. layer of the soil during summer. What is its importance to production?

A. We are not dealing with an accumulation. The figures showed a slower rate of moisture depletion down the profile under long pasture.

Q. (G. L. Banfield): If we follow the recommendations outlined in this paper we will run into other difficulties, e.g., a long pasture will be subject to army worm invasion, and the pasture might run to seed before being utilised and will be less useful.

A. The application of these findings must be considered in relationship to other farm management requirements.

Q. (A. G. Campbell): On what did you base the potential production figures used for comparing results?

A. We used the results obtained in control cabinets where light, temperature, moisture and nutrient supply were not limiting factors. The rate of growth of nine species have been studied.

Q. (W. A. Jacques) : The last table shows a considerably greater differential in moisture level between the short and long pastures at the 8 to 16 in. level than there was at the 0 to 8 in. level. In view of the greater root amount and activity and a greater rate of transpiration in the long pasture, one would imagine that the loss of moisture would tend to be the other way round.

A. Pastures dry from the top down and the greatest volume of roots is in the top 4 in. of soil.

Comment (W. A. Jacques): The deeper root system does in fact absorb moisture and is the main source of supply when the top layers of soil are too dry for root activity.

Q. (Williams): Does topping affect a pasture?

A. Topping will affect the pasture if it is cut too low but it is beneficial if it is done early at about 3 in. to 4 in. high.

Q. (P. D. Sears): Are there micro climate differences between sunny and shady faces?

A. The differences have been quite definite at Makara. They are a replica of short and long pasture during summer.

Q. What are the effects of spaced deciduous trees and pastures?

A. The possibilities of trees in Gisborne pastures as a supplementary source of fodder and as shade merit close examination.