SOME RESULTS AND PROBLEMS FROM EXPERIMENTS AT WINCHMORE IRRIGATION RESEARCH STATION

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It has been estimated that there are almost 1,000,000 acres of light land on the Canterbury Plains. The term light land is really a misnomer in that it bears no relationship to the actual texture of the soil. The term is merely one which has come into general use in Canterbury to refer to land where there is a shallow depth of soil lying on top of the gravel or shingle. There is no clear definition of what constitutes light land, but it would probably be reasonable to assume that any land where the depth of soil and subsoil overlying the gravel is 16in. or less would be classed as light land.

In its undeveloped state light land is low in phosphates and lime. It has a low humus content. Much of it contains surface stones in varying amounts. The field capacity range is 25 per cent to 32 per cent, and the wilting point is in the range of 10 per cent to 11 per cent. Winter and early spring rains are usually adequate, but late spring, summer, and autumn rains can be Insufficient for maximum growth. Indeed a combination of low rainfall and hot drying winds can reduce the summer and autumn growth of pastures to a negligible amount.

The more progressive farmers on this class of country have developed a highly efficient farming system. Basically it consists of the development of good pastures through the use of lime, superphosphates, D.D.T., and certified seed and the efficient utilisation of those pastures by the breeding ewe. Lambing is arranged to correspond with the normal spring flush of feed and an endeavour is made to dispose of the majority of the lambs before the normal summer dry period. During the time when pasture growth normally is low the farmer is left with only his ewe flock and this can exist on short rations from weaning until about 3 weeks before the rams are put out. Indeed it is desirable that during this period the ewe flock should be kept on restricted feed supplies.

In 1946 the first major flood-system of irrigation in Mid-Canterbury was introduced on to this class of country where the system of farming briefly outlined above was being practised. A further scheme has since been introduced on to similar class of country and it is possible that other schemes may be introduced on to similar land in the future. A year after the commencement of the first scheme the Department of Agriculture purchased a farm of 750 acres within the scheme and gave it the name Winchmore Irrigation Research Station.

The Station is situated on a soil type known as the Lismore stony silt loam, which is an immature alluvial and aeolian soil derived from greywacke parent material. The depth of soil (soil and subsoil combined) varies between 12in. and 16in. The average rainfall approximates 30in. per annum, but monthly rainfall figures can show a very erratic tendency. For example, the average rainfall for February over 44 seasons is 2.45in. In February 1929, however, the rainfall was 0.13in. whilst in February 1945 a total of 10.03in. was recorded. Summer temperatures can be very hot. Frequently the temperature exceeds 80 degrees F., while strong drying winds are not uncommon. All irrigation on the Station is carried out by the border dike method. It is recognised that other light land soils in Canterbury show variations from that found on the Station. Similarly weather conditions in other parts vary also. It is suggested, however, that any principles established on the 'Station in regard to irrigation would be applicable, perhaps in a modified form, to other areas.

During the 10 years in which the Station has been in operation a considerable amount of research work has been carried out and the place of irrigation in Canterbury farming has become more clearly defined. It has been demonstrated over a period of years that irrigation will almost double the dry matter production from pasture. Even in the wettest season since recordings began an increase of 44 per cent was obtained while in the driest season three-weekly irrigations on pasture gave an increase of 115 per cent in dry matter production. There are indications, also, that an intensive irrigation programme will almost double the number of stock which can be carried under dryland conditions. There is. evidence that with adequate water available dairying is a feasible proposition on Canterbury light land. Small-scale trials and also field trials have demonstrated that irrigation will increase the yields of many of the farm crops such as swedes, tur-. nips, rape, potatoes, barley, and so on. There is evidence also that irrigation could make all-grass farming in Canterbury a feasible proposition. However, the primary objective of this paper is not to present the advantages or the benefits to be derived from irrigation, but rather the reverse. It is invariably the case that whenever methods are adopted to improve farming and increase production new problems are. created. It has often been said, for example, and it is probably true, that the most highly productive farms are the most difficult to manage. Certainly with the introduction of irrigation as a means of increasing production problems have been created and it is the desire in this paper to comment on some of the problems which have arisen as seen from the angle of the research worker.

First of all there is the difficulty of planning an irrigation programme for our light land due to the variable weather conditions which can be experienced from season to season. In many parts of the world where irrigation is practised the local weather conditions are such that it is possible to plan and operate an irrigation' programme with some degree of certainty that it will not be upset. This is not the case in Canterbury where seasonal variations in rainfall can be so very marked. From September 1914 to April 1915 inclusive, for example, the total rainfall recorded in Ashburton was 11.74 in. For the same period in 1952-1953 the rainfall was 36.28in. The first season quoted would require almost constant and regular applications of water for the production of maximum growth, whereas the second season may require *only* a very limited number of 'irrigations to achieve the same object. Even in an average season in Canterbury, from the point of view of rainfall, the timing of the rain and the intensity of the individual falls of rain can upset any irrigation programme which may be devised.

Another difficulty arises from the inability of the farmer to irrigate on a soil moisture basis. Evidence is available to show that for maximum production from pasture the soil moisture must not be allowed to drop below a certain percentage, which probably lies between 11 and 20. In a trial at Winchmore in the 1955-56 season, for example, 11 irrigations each applied at 20 per cent soil moisture produced 10,000lb of dry matter. The same number of irrigations carried out on a time basis (once every 3 weeks) produced only 6800lb of dry matter, a difference of 3200lb in favour of irrigating on a soil moisture basis. It is realised, of course, that a farmer must be supplied with water under a roster system and under these circumstances it is not possible for him to organise his irrigations on anything but a time basis.

Water is available for irrigating in Mid-Canterbury from 1st September to 30th April. For these 8 months it has been shown that about 22in. of rain are needed for the maintenance of maximum pasture growth. Actually about 20in. of rainfall is received during this period, but it is so unevenly distributed that about 40 per cent is normally lost as drainage into the gravel. This means that only 12in. of useful rain are received, and as a total of 22in. are required, there is on an average a deficit of 10in. per annum. If a pasture is not to suffer, this deficit has to be made up by irrigation.

Now if irrigation could be carried out with 100 per cent efficiency, in a way that all the water applied was used by the growing plant, then apart from rain, 10in. is all that would be needed. However, no form of irrigation is perfect and more water has to be applied at each irrigation than is actually required. No actual figures are available ; but it is extremely doubtful if the application efficiency of border dike irrigation on farms would reach 60 per cent, and this efficiency would be reduced still further by conveyance losses. Experiments are being carried out on the Station to determine whether application efficiency can be improved. Varying flows on borders of different length are being studied.

One of the problems which might be expected to arise is the possibility of leaching losses in the drainage water. It has been shown that fairly large losses of available nitrogen can occur in the irrigation of some crops, but this has not been found under normal pasture conditions. Lysimetric and other studies have indicated a possible loss of sodium and sulphate ions, and this aspect, together with the whole question of leaching, is bemg investigated. It does not appear likely that major elements are being leached in any very great quantities from soil under permanent pasture.

Shortcomings of climate and soil in the irrigation of light Canterbury land have been mentioned. However, compared with soils in some other countries where irrigation is practised most Canterbury soils possess distinct advantages. In the first place there has been no alkali or salting problem to contend with and. the fact that the water-table is down about 100ft or thereabouts and that the rainfall approximates 30in. per annum suggests that the deposition of alkali on the surface will never be a problem on most light Canterbury land. Secondly, there is no drainage problem. Many irrigation schemes depend for their success on an efficient drainage scheme to deal with surplus water. Thirdly, pugging of the soil with stock after irrigation does not exist. Indeed it is possible to irrigate light Canterbury land with cattle grazing in the paddock while it is being irrigated. Finally, the infiltration rate on light Canterbury soils is fairly high as distinct from some other soil types where the problem is to devise treatments which will enable the water to penetrate the surface soil more easily.

Sufficient evidence has been accumulated to show that under the border dike system of irrigation, the rate at which pasture can be irrigated approximates 2 acres per hour, and for crops such as lucerne, swedes, rape, and so on, 1 acre per hour. This implies that one of the major costs associated with the irrigation of light land in Canterbury is labour. In most cases when water is being applied to the land it is essential for labour to be in attendance practically the whole time. Furthermore the work itself is inclined to be both tedious and monotonous. Over the past few years attempts have been made to reduce the amount of labour necessary for irrigating by the introduction of some form of automatic irrigation. Already a measure of success has been attained in this direction, sufficient to suggest that some form will ultimately prove practicable. In Australia where pasture land has been irrigated for at least 50 years no form of automatic irrigation exists, nor is there any move to develop one. In Canterbury the normal practice is to be supplied with 8 cusecs of water or thereabouts and this quantity of water is allowed to flow down each border in turn. In Australia, on the other hand, farmers are usually supplied with 4 cusecs or less and this on arrival in the paddock to be irrigated is split up so that $\frac{1}{2}$ cusec or less is allowed to trickle down each border. By so doing constant attention while irrigation is in progress is avoided. Evidence is already available which suggests that the Lismore stony silt loam can be irrigated with quantities of water down to 2 cusecs per border and possibly less without any loss of application efficiency in the use of the water. It may well be that any system of automatic irrigation in Canterbury will follow the Australian pattern of irrigating. It is realised that no scheme of automatic irrigation could be introduced which would likely be 100 per cent efficient. Any scheme, however, which would reduce labour costs, no matter how little, would be a step in the right direction.

It is well known that after flowering or after the period in which it would normally flower, perennial ryegrass for a time tends to lose some of its ability to produce leafage. This period of lower production in perennial ryegrass is often referred to as the post-flowering dormancy period. It has been shown at the Station that even if ideal moisture conditions are provided by irrigation, there is still a significant drop in the daily production of a dominant perennial ryegrass-white clover sward for the period mid-December to April compared with the daily production for September to mid-December. In the 1953-54 season, for example, it was shown that the response in dry matter production per irrigation for the mid-December-April period was about half the response per irrigation for the September-mid-December period. It is possible that other species may show a better response to irrigation than does perennial ryegrass during the summer and a trial has recently been laid down on the Station to determine this point.

On an irrigated farm the ability to make provision for a good supply of winter feed for stock assumes great importance, as the carrying capacity is largely determined on the number of stock which can be wintered. There is plenty of evidence available to indicate that in most years, when it is necessary, irrigation will ensure reasonably good yields of any of the normal farm crops grown for winter feed such as turnips, swedes, or chou moellier. Lucerne, however, is a crop which up to the present has only been partially successful under irrigation. As hay is very desirable to feed in conjunction with any of the brassica crops or with winter-saved grass, the modest success obtained with lucerne under irrigation is a cause for some concern. Lucerne will respond to irrigation and it will obviate the erratic yields which occur between seasons under dryland farming. Lucerne, however, has shown two distinct weaknesses under irrigation;

(a) The response to irrigation does not appear high enough.

(b) The more the crop is irrigated the more quickly foreign growth appears in the sward and eventually assumes control.

In a trial on the Station extending over 6 years the average acre yield per season from lucerne not irrigated was 2.9 tons. Over the same period lucerne irrigated twice between cuts irrespective of weather conditions yielded 3.7 tons, an increase of only 28 per cent. With irrigated grass giving an increase from irrigation approaching 100 per cent it is of interest to speculate on the reasons for the much lower response to the irrigation of lucerne. Possibly it is a soil fertility problem and this aspect is being investigated at the Station.

Two grasses to be found growing naturally on much of the light land in Canterbury are browntop and sweet vernal. Experience so far has indicated that the speed with which either of these two species invades a lucerne stand is determined very largely by the intensity of irrigation. The more frequently the lucerne crop is irrigated the more quickly the browntop or the sweet vernal assumes control. It would appear that the life of a lucerne stand which is subjected to sufficient irrigation for maximum growth would be 5 to 6 years. Lucerne is a crop which offers a great deal of scope for more detailed research work.

The final point that it is desired to refer to in this paper? and by no means the least important one, is the question of utilisation. It has been stated previously that irrigation will double the production of dry matter from pasture, and this in turn will substantially increase the number of stock which can be carried.

Since the station was established a considerable amount of experience has been obtained on the way in which sheep behave at relatively high stocking rates per acre under irrigation compared with the lower rates of stocking which normally prevail under dryland conditions. So far as the breeding ewe is concerned there appears to be very little difference in behaviour. Major points such as lambing percentages, wool weights, and percentage deaths have shown very little variation under the two systems. The principal difference occurs in the rate of fattening of the lambs. Under dryland conditions lambs fatten more rapidly than do lambs produced under irrigation where the stocking rates are usually very much higher. This difference in the rate of fattening seems to be more pronounced in a wet season when the conditions are generally unfavourable for lamb fattening. It must not be inferred, however, that only store lambs can be produced under irrigation. In a trial on the Station, for example, where 7 ewes per acre have been carried for the past 4 seasons, it has been possible in each of these seasons to turn off lambs from the trial, admittedly with relatively light weights (30-32lb), with 75 per cent or more of them being graded prime at the works. Although individual lamb weights may be light, total lamb meat per acre and total weight of wool per acre can be very high. It would probably be correct to say, however, that a very high standard of flock management is necessary where fat lambs under high stocking rates are produced under irrigation.

DISCUSSION

Q. I would like to ask Mr McPherson whether from his experiments he would suggest that increased frequency of water would produce a higher dry matter return?

A. From the work we have done on the Lismore stony silt loam we now know the actual position with the field capacity of the soil at 30 per cent and the wilting point of 10-11 per cent range. We have found there that we have got our best yields of dry matter by not allowing the soil moisture to fall below 20 per cent. We have not tried what the position would be say between 11 and 20 per cent. We may find after experiment that possibly 1'5 per cent is just as effective as 20 per cent. Until we try we do not know. How many irrigations that means of course depends entirely on the season. Last season, which was a particularly dry one in Canterbury, to maintain soil moisture at 20 per cent or higher in our Lismore stony silt loam more than 20 irrigations were required. This season, may mean only four or five irrigations. It depends on what stock you are carrying. If you are stocked to full capacity you may be forced to put on 10 or 11 irrigations; if stocked at low low capacity five may be sufficient. We do not know what would be the most economic number of applications. It varies from farm to farm.

Q. When we introduce a new technique we must think not only in terms of superimposing the old systems but of adapting techniques to a new system. In Mr McPherson's comment about irrigation of lucerne I was extremely surprised to hear he did not get complete response from irrigating lucerne. In East Anglia whilst lucerne does not always need irrigation several farmers are irrigating and finding it worthwhile and are getting very big increases. What is the difference, possibly a question of feeding? We have found that the secret of growing lucerne is adequate potash, and to get good yields under irrigation, we must boost the potash by topdressing with 3-4 cwt per year. What potash applications do you make ?

A. We are not satisfied with the way lucerne behaves on 'the Lismore' stony silt loam under irrigation. Various theories have been put forward. We have in progress at the present time trials on the Station where we are using large quantities of phosphates and potash. Certainly the dressing we have applied, up to 4cwt are considered uneconomic, but we are using these quantities for trial purposes. The particular trial has not been going long enough to give results. In the old stand we have taken soil samples which show a slight potash deficiency.