# IRRIGATION

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## INTRODUCTION

REFERENCE to irrigation in Canterbury generally implies flood irrigation, although there is also a very big investment in sprinkler systems jotted throughout the area and some mention must be made of these.

It is also necessary to consider the large volumes of water needed for irrigation. The requirement of crops and pastures for water is much greater than is generally realized. To produce a 60-bushel wheat crop would require about ¾ of a million gallons of water per acre, as would a pasture producing some 10,000 lb of dry matter. Irrigation schemes which cover many thousands of acres therefore need to have very large supplies of water available.

There are large supplies of water on earth; 70% of the earth's surface is covered with it. However, 97.2% is in the oceans, too salty for general use or for irrigation, and 2% is confined in ice-caps and glaciers in areas where man does not require it. This leaves less than 1% generally useful to man. From a gigantic water cycle which contains 326,071,300 cubic miles which never gets less nor more, some 70 cubic miles fall on the earth each day as rain. A cubic mile contains 1,101,117,143,000 gallons of water.

Fortunatelv, New Zealand gets a very adequate share of this water, although not always where it is wanted when it is wanted. It is possible in Canterbury, at any rate, to make it available at the right place at the right time without too much difficulty or cost. At present, the flood irrigation areas in Canterbury are supplied with 1 cusec of water for each 150 acres of irrigable land, although it is now generally conceded that for total irrigation this should be 1 cusec per 100 acres of irrigable land. One can contrast this with a closed pipe supply for stock and domestic purposes in the rural water supply schemes where the supplv is about 1 cusec for each 500,000 sheep and 500 households. At this rate, 1 cusec of water would supply the mid-Canterbury irrigation area with its domestic and stock supply, whereas 1,000 cusecs are made available for irrigation. The starting point for a talk on irrigation is, have we the water? And the answer is yes.

## HISTORY

There is nothing new about irrigation; it would date back to the early civilization of man. In New Zealand it began with the early settlers. The first recorded irrigation system in Canterbury was constructed by a Wakanui farmer, Joseph Hunt, in 1878. The Ashburton County Council was the first local body to take an active interest in irrigation. A committee of investigation was set up in January, 1886, and in January, 1887, a 70 acre block of land under a Mr Claridge was irrigated in the Wakanui district. In August, 1890, the experimental area was closed and a motion passed, "that the worth of irrigation had been proved and that further experiments were unnecessary."

In the 1930s further efforts were made, especially by the Canterbury Progress League, and the State took a hand in developing schemes at Redcliffs, the Levels and with the Rangitata Diversion Race to serve the mid-Canterbury schemes. Progress is continuing with investigation for the Glenavy-Morven area for extensions to Valetta-Tinwald.

In mid-Canterbury today there are 166,400 acres served by State-sponsored schemes bringing water to 417 farmers. With some private flood schemes, some pumping schemes and a large number of sprinkler plants in operation, it is conservatively estimated that about 8% of the 700,000 acres of plains land in mid-Canterbury is irrigated at present despite the fact that less than one-quarter of the area is served by major schemes.,

## CLIMATE

The rainfalls of the areas range from 20 to 35 in. Except for the areas of Glenavy-Morven, rainfall appears adequate for dryland farming.

However, it is not the total rainfall that is important, but its distribution in relation to evaporative conditions. Soil moisture in the 30 in. rainfall belt has been studied in detail for the Lismore shallow silt loam which is representative of the majority of the soils to be irrigated in Canterbury. Taking a drought day as one when the soil moisture is at or below wilting point, the study showed there were 59 days of drought in the average year (ranging from 6 to 107) and that there was a drought in every year. In an area where the growing season is restricted to 250 days, this represents a significant part. In classifying the seasons from very wet to very dry, Rickard (1960) classed the percentage of seasons as 7% very wet, 14% wet, 27% moderately dry, 41% dry and 11% very dry. This shows 52% of all years being dry to very dry.

## WATER REQUIREMENTS

Considerable effort has been devoted to a study of two aspects of this question, first, how the soil moisture deficit influences pasture production and the relationship of correcting various deficits on irrigation frequency; secondly, the influence of several factors of soil, slope, pasture density and soil moisture on irrigation rate. Such information ,is basic to the design and distribution requirements of a flood irrigation scheme where no storage is involved.

The mid-Canterbury schemes are supplied with a continuous flow of water from a diversion of the Rangitata River. This flows for 24 hours a day, virtually for 365 days a year. Its first call is for irrigation from September to April and for power during the winter months of May to August when peak power demands occur. The flow is generally accepted as being 1,000 cubic feet per second. The flow is delivered to the farm at 8 cusecs. This has to be rostered to the farm in accordance with the acreage and the entitlement of 1 cusec per 150 acres. This means that, for each 100 acres of land, a farmer is entitled to 12 hours per week.

During the development of irrigation in Canterbury it has not been possible for farmers to use this water for 24 hours per day. Attempts to do so were associated with decreasing the rate of irrigation so that the water would not need shifting at night. Furthermore, work at Winchmore has shown that, with the best irrigation design yet available, and with automatic equipment operating to keen the flow in constant use for the 24-hour period, 1 cusec will irrigate only 105 to 110 acres under average falls and conditions. It is hoped that this might improve slightly as techniques improve but it is not thought that substantial gains can be made *except* on areas of steeper than average falls. The original design, therefore, to supply water to half the title area could have been met, but this would not have meant total irrigation. However, the present thinking to supply water with a contract for 1 cusec per 100 acres could provide the contracted area with full irrigation. Water availability has had some bearing on the rate of irrigation development but has not been a serious limitation for the schemes in mid-Canterbury. It has, however, at Redcliffs and the Levels.

## DEVELOPMENT

Perhaps no other phase of agricultural development has been hedged round by emotional attitudes as has irrigation. This has not been peculiar to New Zealand. In Canterbury it started with the early efforts to introduce irrigation. Perhaps Marmaduke Dixon with his scheme to irrigate 15,000 acres of land at Eyrewell in 1892 could have been the man to establish irrigation had it not been for a controversy which led to a court case. Some.bitter verbal battles and near-violent ones arose over the establishment of the present mid-Canterbury schemes.

It was freely proclaimed, as the records of 1939 can show, that irrigation would ruin the soil and destroy its fertility. It was predicted that the lowland would be constantly flooded and that it would not be possible to grow wheat, at that time the crop on which the county's prosperity depended. Furthermore, it would not be possible to grow half-bred sheep or cattle and unsuspected diseases would ruin the farmers. It was further proclaimed that gorse carried in the irrigation water would smother the land and insects would also destroy any crops or pastures grown. Many similar predictions foretold the calamity of irrigating the Canterbury Plains.

Just thirty years of progress have not substantiated these predictions, but we are still not free from the emotions which generated them. At present mid-Canterbury irrigation farms are at record levels for wheat production and are carrying record numbers of beef cattle grazing old, permanent, irrigated pastures which are not insect, gorse or weed invaded, and the lowlands are not flooded, but much of this lowland area is now irrigated and there is, in fact, a plea for more water to be made available.

At present 34% of the Ashburton-Lyndhurst area is border-dyked; 16% of Mayfield-Hinds and 48% of Valetta.

As the area prepared for controlled irrigation increases, the water use increases, so that at present the average use of irrigation water for the three schemes is running at about 85,000 acre-feet or about 2 acre-feet for each acre of border-dyked land.

Outside the areas served by the State schemes there are a considerable number of areas where water is drawn from rivers, pumped from the aquifers, or from drains. Some of these use large flows and flood-irrigate with border-dykes, and others use conventional sprinker systems. There are about 100 of these plants operating in the county and over 60 are in the district served by the Hinds drainage area. Most are serving cropping farms on heavy soils.

While it is outside the scope of this paper to discuss the pros and cons of flood versus sprinkler irrigation, it must be obvious that both have their place. Flood systems require certain contours and gradients for successful use. Most of the Canterbury Plains provide these. They are much cheaper in terms of water distribution and labour involved in operation. Development of farms for flood irrigation is slower and requires more skills than is the case with sprinklers. Sprinklers offer advantages for smaller flows of water, for areas too rough to border-dyke, and for special-purpose crop irrigation. However, both systems are used for crops and for pasture in this area, and both could in fact have a place on the one farm. The choice is more often than not governed by water availability. My recommendation would be to control flood wherever this is possible. Which all adds up to the fact that irrigation, whatever the method, is better than no irrigation.

## PRODUCTION

It is somewhat difficult in dealing with production to produce a satisfactory result. First one would like to deal with potentials. Winchmore has done this for some 16 years and nobody wished to accept these. Now one finds, of course, that what were irrigation potentials have become dryland potentials. There is little dispute, however, that irrigation has resulted in substantially increased production from the areas where it has been efficiently used.

Over many years, production studies at Winchmore have shown that pasture production can be doubled and lucerne production can be increased by 40%. Potato yields were increased by 70% and these increases ranged from 24% to 380%. Optimum yields were obtained with from one to three irrigations. With wheat, responses have been from 7 to 62%. Irrigation is more effective in increasing yields in high-fertility conditions. Where fertility was reduced by previous cropping, yield responses to irrigation were 26% compared with 62% for high-fertility conditions. These increases were obtained with one or two irrigations.

The sheep carrying capacity trial has given a 16-year average return of 240 lb of lamb meat and 73 lb of wool per acre. This has been achieved with 2.4 acre-feet of water per year. The average gross return has been $68.57 and the cost of stock replacement, water and fertilizer has been $13.41.

Many local farmers achieve consistently high returns from animal produce, crops and seeds. One fully irrigated farm has produced a gross income of $86 per acre made up of: $32 from cash crops, $11 from small seeds, $13 from wool, $28 from meat, and $2 from sundries.

Stewart (1963), in his survey of the Ashburton-Lyndhurst irrigation area, found that production had been increased by 50%, that there were nearly twice as many farms and nearly twice the labour force employed on an equal area of irrigated compared with unirrigated land. He found that the gross income had been increased by 50% and that, for each acre where irrigation was available, a further $10 was produced. Only half the area. was irrigated at the time of the survey.

## COSTS

In Canterbury as a whole, the national investment in State irrigation schemes is of the -order of $5 million. This represents an "off farm" cost of some $27 per acre. It is estimated that there could be at least $2 million invested in sprinkler plants in Canterbury. The average capitalized cost of these plants is not known but they variously range from $16 to $76 per acre.

"On farm" costs for flood irrigation vary but the average for the present developed area would be about $18 per acre. The present range would be from $10 to $50.

Final water charges for the existing schemes have not been settled but, with the exception of Valetta, the settlers have had the advantage of very cheap water from the inception of these schemes. Until 1966-7 the contract charge was 40c for 1 ft of water applied to *half* the title area. It then rose to 50c for a foot on the title area and now stands at 60c, rising in 10c steps for the next two seasons to 80c in 1970-l.

Valetta have just completed a lo-year development period and their present charge is $1.20 per acre-foot for 1 foot of water on the title area and 45c for each additional foot used (all charges quoted are net ).

The intention of the Public Works Act now in force, and to be applied to new schemes, is to strike a charge which will recover operation and maintenance costs and one-quarter of the interest on the capital cost of construction. From the time the water is available, a ten--year development period would apply, so that one-tenth of the charge was struck in the first year, rising by one-tenth each year until the full charge was met at the end of the development period.

## LAND PRODUCTION

Flood irrigation is not just a matter of providing an intake at a farm and turning in a flow of water. It is necessary to have a survey which will allow planning of the irrigation and race system on the farm. Staff and equipment are then needed to construct the dykes, level the land and cut the races. These then have to be equipped with “in-race structures” and sills to control the water in and out of the race. Until very recently, the survey and the land preparation work have been done under contract by the Ministry of Works. The farmer is required to pay for this work before the job is begun. Private contractors are now operating in many districts, especially those not served by the Ministry of Works. With the introduction of automation, it is necessary to have a constant-flow pond to regulate the 8 cusec flow to the farm. In the new scheme design these will simplify the operation rather than complicate it.

## GENERAL ,

As far as can be ascertained’ at present, irrigation has introduced no new problems with regard to animal health, pasture persistence or management, soil fertility, or any other factor which would mitigate against its use. On the contrary, it has conferred many benefits which have assisted with the ease of management. Stock health is good and, as feed supplies can be predicted, animals can be well fed at all times; foot-rot may be even less a problem than on drvland farms; in general, pastures are less weedy because, if well managed, invading weeds have less chance to establish; insect pests are less of a problem; parasitism has not emerged as a threat, and there is little doubt that fertilizers are used much more efficiently in terms of animal output per pound of fertilizer applied. For each **1%** cwt of superphosphate applied, the Station farmlets carry 7 ewes.

Perhaps the greatest advantage of irrigation is that- pasture production and crop yields are predictable.- There is little variation from year to year. Without irrigation, yields can fluctuate by more than 300% between years. In general, the variability between years on irrigated'areas is about 30%.

The next great advantage irrigation confers is that it allows a truly low cost system of farming to be operative.

## FUTURE TRENDS

Much has been said about the unsatisfactory system of using irrigation 'water on pasture to produce wool and lamb. However, returns at Winchmore substantiate that it would have been possible for a farm of, say, 300 acres to run 2,100 ewes producing 2,400 lambs to sale, on grass alone, with no pasture renewal and with an average gross return of $20,571 over the past 15 years. For fertilizer, water, and stock replacement, expenditure would have been $4,023, leaving a fair margin for labour, operating costs, fixed charges, interest and living expenses. In fact, it is doubtful if any alternative land use would have been better.'

However, trends have established which require detailed examination. First, the rising schedule for beef offers an opportunity for the irrigator to make better use of pasture. The fact is, however, that prior to this, beef returns have fallen away behind. On full utilization figures from Winchmore, the 15-year average sheep return has been $68 and the 6-year beef return $81 per acre. If the replacement cost is subtracted from this, the margins become $58.45 for sheep and $28.20 for beef. However, in the year just past (and not a bad one for sheep) the margins were $44.12 for beef and $43.39 for sheep. This is the first time, and, who knows, could be the last, that. beef has been ahead of sheep. However, the potential to raise past outputs of beef is probably better than are the chances of increasing our sheep outputs.

Intensive cropping and seeds production in conjunction with heavy stocking is another obvious diversification. It is clear that irrigation is becoming an adjunct of the cropping farm and that cropping is moving on to the irrigated areas. There is not an unlimited demand for crops, and the ultimate outcome of this trend will be that, because irrigation confers an economic benefit by way of reliable and increased yields, dryland croppers will not be able to compete when crops are in over-supply. This is already evident with the potato crop and to a lesser degree with some seed crops. Mid-Canterbury offers a good example of this trend with the large commitment in sprinkler plants on the heavy cropping land.

One cannot escape the conclusion that, if a large industry for processing crops were to be established, irrigation in Canterbury would come into its own. Predictable yields and the large area of land available would surely make this the most favoured province.

The area of farm land in New Zealand cannot be increased; irrigation offers a means of doubling the effective use of the land there is.

In conclusion, if Canterbury wishes to realize its full potential it must have irrigation. However, it is certain that this will not come as a matter of course. Unless the farmers want it, and unless there is a united effort to have it, irrigation will remain the prerogative of those who now have it and of those few who, by virtue of their situation, can generate their own water supply.

Perhaps the greatest retarding influence on irrigation development is a psychological one. Except for the few, no individual effort towards irrigation can be made; it is something beyond one's own endeavours. Therefore, one finds an excuse to do without it. With other forms of farm development, farmers can generally "have a go". Furthermore, education in irrigation science is lacking and our generation have learned their irrigation by "rule-of-thumb". There is a need for a better education and extension service if irrigation is to expand.

Irrigation can be a national asset. If production increases of the order of those mentioned above can be obtained, each cusec of water available for use in agriculture can return from $2,000 to $12,000 from the conventional products of meat and wool. Returns from orchards and special crops could be much greater. The three mid-Canterbury schemes, even at the stage of partial development, are earning, by way of increased production, 23% on the capital invested. This is earned as overseas funds.

It will be a long time before the remaining ¾ million acres of Canterbury's flat land is irrigated but some planning to have a small fraction of it under continuous development should be our immediate responsibility. If not, our families should have cause to ponder.

REFERENCES

Rickard, D. S., 1960: N.Z. *J. agric. Res., 3:* 431-41.
Stewart, J. D., 1963: *Lincoln College Pub. No.* 1.

## DISCUSSION

To a request for an explanation of his statement that there might be less foot-rot on irrigated land, Lobb replied that there would be a very different environment from that in long pastures under wet climates because water was often applied on dry days. In addition, with the high stocking rates under irrigation, pastures were often much shorter than under dryland farming.

An observation was made that the production of 240 lb lamb meat per acre per annum was not as good as the 3001b produced in Southland under a poor light regime and without irrigation. It was asked what the limitations were to production. In reply, Lobb maintained that Southland had a better climate, and that rostered distribution of water under irrigation was not as effective as the regular rainfall enjoyed in Southland. He did not think that maximum outputs had yet been attained in mid-Canterbury, where the present pasture production was approximately 10,000 lb D.M. per annum, and most of the pastures were up to 20 years old.

On being asked to comment on the possibility of producing 240 lb lamb meat/acre/annum under a 30 in. rainfall in Canterbury, without irrigation, Lobb said he thought the potential was there if plants such as lucerne were exploited. However, a watch would have to be maintained on cost inputs. Under irrigation, costs are low because there is less pasture renewal and no cropping. Reserves were carried as hay or silage. Economics would certainly be the most important aspect of dryland production.

To a question on the use of fertilizers on irrigated compared with non-irrigated pastures, Lobb said that the input of fertilizer was much more efficiently used under irrigation than with dryland farming.