
Restoring Canterbury Soil Fertility Through Pastures

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THROUGHOUT Canterbury there is an abundance of farms, which, as a result of a protracted programme of cropping without due attention to a suitable rotation; have gradually become depleted of much of their original soil fertility. Under a continued system of incorrect management this depletion has inevitably reached the stage at which further cropping has become uneconomic, owing to reduced yields. When this regrettable stage has been reached something has had to be done—some alteration in the management has had to be made in an endeavour to rebuild the fertility of the soil.

When this point has been reached different farmers have adopted different methods of attaining the desired end. In a minority of cases when sufficient capital has been available to permit the owner to neglect temporarily the maintenance of income, the restoration of the soil to good heart has been accelerated. In most instances, however, restoration has been very gradual? as the farmer has been forced to maintain a reasonable annual income and at the same time return a small instalment to the "bank of soil fertility." A few farmers, through exceptional methods, have reached the desired end fairly rapidly without the use of capital which has not been produced on the farm—so with the property of 513 acres owned by Mr. E. Rands, of Springbank, North Canterbury. This farm, which is located 8 miles west of Rangiora, on the Oxford Road, has behind it a history of heavy cropping which, though very profitable in the early stages, led gradually to the depletion of soil fertility with a corresponding fall in crop yields. The climax was reached when the average wheat yield fell to the uneconomic figure of 19 bushels per acre, whereas in good seasons some years before yields had averaged 35-40 bushels.

History of Property

The property, which was taken over as a mixed farm more than 29 years ago, was called upon to produce approximately 100 acres of wheat annually for 25 years. In one year 200 acres were sown to this crop. The severity of this cropping programme is appreciated when it is realised that the soils on the property are far from heavy, approximately 200 acres con-

sisting of light, stony flats and 300 acres of fair to medium silt loam on shingle. But the farm may be taken as typical of a large area in the district, the unimproved value of the property being £8 per acre.

The 25 years of wheat growing constitute the soil-depletion period which was brought to a close by sadly-falling crop yields. The next period started 5 Years ago, since when the farm has been in the process of changing over from a typical Canterbury light-land mixed farm to a property of high-producing pastures devoted chiefly to the production of wool and fat lambs. During the last 5 years no wheat has been produced, the only annual cash crops grown being barley, oats, peas, and lupins. Yet within this short term cash returns have almost doubled what they were at the end of the 25-year period and indications of returning fertility are to be seen everywhere.

In bringing about this state of affairs Mr. Rands has adopted very successful and interesting methods of management, and always they have been methods which have maintained a working income-methods, in fact, which could be used by the average farmer under similar soil and climatic conditions. It is with the period of fertility restoration which this paper will deal chiefly, but before doing so it may be of interest to give a brief account of the history of the property as a background to the present management.

Part of Big Station

Originally the property was part of "Springbank," a station of 23,000 acres. It was taken up in 1851 by Mr. W. Kaye and sold in 1853 to Mr. Robert Chapman. In 1882 Mr. Chapman divided the station among his sons, but it was not until 1912 that the present state of subdivision was brought into being. In 1919 the late Mr. Rands (Mr. E. Rands's father) purchased the property, which he farmed until his retirement, when his son took over the management. With the exception of two paddocks, one of which had been cropped and one sown down with danthonia, the farm at that time was covered with tussocks and matagouri. There were several extensive areas of manuka and blackberry. The 513 acres was divided into 7 paddocks with wire fences and manuka hurdles.

There were several small clumps of trees. The buildings comprised a 4-roomed cottage and thatched stable on the eastern boundary. A water race followed a devious course through the property.

The late Mr. Rands soon had a man at work with a B-horse team and a plough. Most of his own time during the early period of possession was devoted to the erection of his homestead, farm buildings and yards, and the planting of shelter belts. The farmyard and buildings were placed well behind the homestead and shut off from view with shrubs and hedges. The house was thus removed from the main line of traffic and its location and pleasing appearance are a tribute to the late Mr. Rands's foresight.

Subdivision

The farm was then subdivided into 21 paddocks, which involved the erection of more than 10 miles of fencing and the provision of 60 14ft. gateways. When the water race had been straightened and a new one formed, water flowed through every paddock on the farm.

During the period it was being worked as a mixed farm the property carried 400 half-bred ewes. South-down rams were used and all lambs that did not go away fat off their mothers were fattened on rape. Ewes were wintered on turnips and, owing perhaps to the fact that hay was not always available, the death rate was fairly high. The flock was maintained by the purchase every year of 4-year-old ewes. The practice was to breed from these ewes for 2 years and then sell them as fats.

During the 20 years from 1919 until his retirement in 1939 the late Mr. Rands concentrated his efforts on the production of wheat, wool, and lambs. The average yield of wheat from an area of 100 acres or more each year was very good for the class of land and almost equalled the returns from wool and lambs. In addition to the wheat Mr. Rands grew about 30 acres of oats each year for chaff and about the same area of rape and turnips. The rotation invariably followed was from grass to rape or turnips, with two crops of wheat following. Half the wheat area was spring sown to pasture under the crop. The other half usually went into oats and was sown down after harvest.

Pastures were thus left down for 4 or 5 years. This method of pasture establishment occasionally gave good results; eventually, however, it was found to be too uncertain, and, while pastures were still sown down after oats were harvested, they were no longer spring sown under wheat. Though a good strain of perennial rye-

grass was always sown, pastures reverted to sweet vernal and other low-producing species within 2 years. During the remaining 2 or 3 years they were left down, stocking was necessarily light and, consequently, fertility declined steadily.

The Years 1936 to 1940 were marked by a change over to Certified pedigree strains of perennial ryegrass and white clover and the adoption of a programme of experimental topdressing with lime and superphosphate. These two factors gave promising results—results which pointed the way to the future development.

Lucerne Hay for Winter Feed

In 1940 Mr. Rands laid down an 18-acre stand of lucerne. He realised the importance of lucerne hay for winter feed and, subsequently, by feeding this hay, found that his ewes wintered better, there were fewer losses, and it was possible to reduce the area of thou moellier and turnips. After the stand had been down for 2 years extremely dry weather was experienced and it was found necessary to utilise the lucerne for grazing. Since then it has been fed off regularly, being fenced in breaks to prevent over-grazing, and, after several years of this type of treatment, the stand is still quite good.

Though Mr. Rands realised the detrimental effects of such cropping on the soil, he continued to grow wheat through the war years, until the average yield over 100 acres dropped to 19 bushels per acre. He then tried to maintain production by growing barley and peas for 2 years, but met with little success. Continuous cropping over a long period had drawn on fertility to such an extent that the growing of annual cash crops was no longer payable.

This was the point at which it was decided to try to build up fertility by growing lupins and by establishing better pastures. In effect, Mr. Rands decided to change over from a mixed farm to a sheep grazing property growing only occasional cash crops.

It is necessary to give a short description of the farm in order that the outline of the management, given later, may be better understood: A terrace runs east and west along the full length of the property dividing it roughly into two fairly distinct soil types. The lower area of approximately 200 acres lying between the terrace and the road is light and very stony; the 300 acres above the terrace is fair to medium silt loam on shingle. The whole farm has a northerly aspect.

Use of Lupins

The basis for the improvement of the farm has been the growing of lupins. These built up soil fertility and as a result newly-sown pastures had the vigour which ensured good establishment. Mr. Rands's practice is to sow 89lb. of lupins with a bushel of oats in the autumn, thus producing the greenfeed required during winter and spring. The paddock is then closed from stock until after harvest and yields as high as 20 bushels of oats and 30 bushels of lupins per acre are obtained. Whatever method of harvesting lupins is adopted much seed is shed and, by lightly working the ground after harvest, a dense crop of self-sown lupins is available for winter feed. The lupin paddock is then ploughed in early spring, summer fallowed, and sown to pasture about the end of January.

The fattening of lambs during the dry summer period always creates a serious problem on the light-land farm. Mr. Rands soon realised that to increase carrying capacity he must prolong the growing season by the judicious use of the various high-producing pasture species. It was therefore decided to establish special-purpose pastures each fulfilling a definite role in the grazing programme. Some such pastures would take up the running in early December when those of the conventional perennial ryegrass-white clover or subterranean clover type fall in production. Others would then carry on for varying periods until the ryegrass-subterranean clover paddocks came into production again. The feed supply would thus be maintained at a fairly-steady level during the greater part of the year.

With this plan in view, Mr. Rands decided to sow down the whole of the lower area in such permanent pasture as would be not only resistant to grass-grub but would serve the main object—that of producing good grazing during early spring and summer. His reason for choosing the lower area of the farm for sowing down in permanent pasture was to avoid the high cost of frequent cultivation of stony land. In a few years he had 3 well-established paddocks of cocksfoot, perennial ryegrass, and subterranean clover. Each one was sown after a summer fallow following rape or turnips. One ton of lime was applied before sowing and 1cwt. of superphosphate was drilled with the seed. These areas have given consistently good production. In the recent provincial pasture competition the oldest area was placed first in its class.

The rate of seeding was cocksfoot 10lb., perennial ryegrass 16lb., and subterranean clover 3lb.

A. cocksfoot-lucerne pasture was laid down 4 years ago with 6lb. of cocksfoot, 11lb. of lucerne, and 1lb. of white clover per acre. Subterranean clover was not included as the pasture was spring sown. Drilled in on limed and fallowed land in October it established well and produced a good bulk of feed.

In the spring of 1946, 30cwt. of hay per acre was baled. Later 100lb. per acre of machine-dressed white clover seed was harvested. After harvest the pasture was attacked by both grass-grub and porina but, though it presented a very sorry appearance during the winter months and no white clover was left in the sward, both the lucerne and cocksfoot made a wonderful recovery and the pasture is now even better than it was before the attack. This gives Mr. Rands ample proof that this type of pasture is very suitable for light land.

An effort to establish a second cocksfoot-lucerne pasture was not successful. The area was summer fallowed and sown with cocksfoot (7lb.), lucerne (11lb.), subterranean clover (2lb.), and white clover (1lb.). The cocksfoot and subterranean clover dominated the pasture with the result that lucerne failed to establish. However the pasture is still a very useful one.

One paddock is being fallowed preparatory to its being sown down to cocksfoot and lucerne pasture next autumn. The whole of this light stony area will then be in cocksfoot in association with lucerne in some paddocks and subterranean clover in others. Growth in all these pastures is strong and vigorous, giving high production and maintaining growth in dry periods.

Special-purpose pastures

On the better land above the terrace some paddocks have been sown in short-rotation ryegrass and white clover, some in perennial ryegrass and white clover, and others in a mixture of perennial ryegrass-Montgomery red clover and white clover. Each of these pastures, together with those on the lower area, provides good grazing during various periods and all combine to maintain production at a high level throughout the greater part of the year.

Every care has been taken in the laying down of pastures. Thorough preparation of the seed-bed after a summer fallow, the sowing of Certified pedigree seed, and subsequent controlled grazing have, in all cases, ensured good establishment.

The short-rotation ryegrass-white clover pastures sown at the end of January produce well from April to September. During October, November, and early December the perennial

ryegrass-white clover pastures are at their best. From mid-December to March the Montgomery red clover paddocks, together with the cocksfoot-lucerne pastures, carry the stock well through this critical period. In addition to these pastures, which produce well in succession, the cocksfoot-subterranean clover areas, if nursed through the autumn, provide good out-of-season grazing during winter.

The establishment of these special-purpose pastures has been the key to success. Carrying capacity has been more than doubled and everywhere there is evidence of increased fertility.

All paddocks have produced well—an area of short-rotation ryegrass and white clover can be given as an instance. This area was sown after an 18-acre paddock of Montgomery red clover was ruined by porina. The rubbish was ploughed in and in February, 1946, the area was sown down with one bushel of short-rotation ryegrass and 3lb. of white clover. The pasture carried 600 ewes for 8 weeks during the following June and July. It was fed off in .3-acre breaks and recovered so quickly that it was fed off three times. After a short spell the paddock was again grazed before it was closed for a seed crop and produced 40 bushels of machine-dressed seed per acre.

The white clover has taken possession in the pasture, now in its third year, and the short-rotation ryegrass has almost disappeared.

It has been the practice to close an area of Montgomery red clover each year in October for use as required. If the weather has been dry, the area has been used to wean lambs on to; if ample other feed has been available for the lambs, it has been saved for seed. Montgomery red clover, which is preferred to broad red clover because it is more persistent under grazing, is sown with perennial ryegrass and white clover, and, being later in making growth, it takes up the running when the ryegrass and white clover have dried off.

Loss of Crops

Though in the main all has gone well for Mr. Rands, he has had setbacks. He lost two good crops of peas—one with hail, and one with drought. On another occasion the greater part of 33 acres of barley was blown away. Grass-grub and porina have periodically taken their toll of pastures after small-seed crops have been harvested; then again, crops of perennial ryegrass have been affected by blind-seed disease.

The practice of topping pastures plays an important part in their management and control. Topping checks

the tendency of the earlier strains to run to seed and thus encourages the production of palatable leafage. Even with controlled grazing the topping of pastures is often necessary to maintain them at their highest state of production.

Mr. Rands appreciates the value of small paddocks and has subdivided 9 of his larger ones. Heavy stocking for short periods is possible on these smaller areas. This facilitates effective control of pastures and enables surplus feed to be utilised to advantage. Whenever necessary, pastures are grazed in breaks.

The ever-present possibility of grass-grub or porina attack is a serious concern of farmers, especially of those on light land. As a result of the ravages of grass-grub or porina, the whole feed position can be changed and the whole economy of the farm upset. With his cocksfoot and lucerne and cocksfoot and subterranean clover pastures well established, Mr. Rands feels that he is well insured against such periods of acute feed shortage.

Mr. Rands's success in establishing the various pastures has been largely due to:—

1. Growing lupins, usually two crops in succession, to build up fertility.
2. Summer fallow and careful preparation of the seed-bed.
3. Sowing of pedigree seed.
4. Controlled grazing, suited to the characteristics of the various species. (Topdressing then helps to maintain production.)

Lime and Fertiliser

One ton of lime is applied before final cultivation; then 1 ton is applied every fourth year or, alternatively, $\frac{1}{2}$ ton yearly. When it is available, 1cwt. of superphosphate is applied, usually in February or March.

A 7-ton roller has been used on all pastures to bury stones and consolidate the ground; its use has made topping and haymaking possible and topdressing easier.

Because of the attractive returns that have been received from growing small seeds in recent years, Mr. Rands has often been tempted to close some of his pastures for seed. He has spent a lot of money sowing down pastures and there was a time when he felt justified in gambling on small seeds when he had surplus feed rather than increasing stock numbers. He has occasionally harvested small seed crops, but he does not depend on them. His aim is to increase his flock, as he depends on heavy stocking to build up soil fertility. In 1946, however, as a

result of exceptional growth, a total area of 110 acres of white clover, perennial ryegrass, short-rotation ryegrass, and Montgomery red clover was harvested.

Stock

When Mr. Rands took over the farm in 1939 the carrying capacity was 400 half-bred ewes and dry sheep. By 1947 he had increased this to 1000 ewes but, on account of ill health, considered it wise to reduce his flock to 800 Romney cross breeding ewes and 200 dry sheep. Judging from the present feed position 1000 ewes would still cause no worry.

Mr. Rands changed over from half-breds to Romney cross ewes when better pastures had been established. He felt that with the Romney cross he would be better able to control his pastures, have a better lambing, and have lambs that would be more easily handled. Each year sufficient 2-tooth ewes are bought from hill country to replace the cast-for-age ewes, which are sold fat. Southdown rams are used.

Half the total crop of lambs usually goes away off the mothers by the end of January, averaging 33-35lb. Owing to the fact that nor-westers can soon alter the whole feed position, lambs are usually sold when prime rather than held on with a view to increasing their weights. It is not the practice to buy in lambs, though 400 were purchased last year and 4 fattened on surplus feed.

Realising that carrying capacity is governed by the amount of feed available during the summer period, Mr. Rands plans to have the minimum of stock on the farm at the driest time. To achieve this he arranged the lambing so that full advantage is taken of the high spring production to fatten lambs and cast-for-age ewes. This practice also enables him to get into good order the ewes he intends to put to the ram in early autumn. Approximately 200 of the older ewes lamb in June. Greenfeed (oats and lupins) is provided for these ewes in addition to the short-rotation ryegrass pasture, which is specially reserved, and a cocksfoot and subterranean clover paddock which has been nursed during the autumn for this purpose.

Over a period of 4 years, including some bad winters, this practice has proved profitable.

The main flock starts to lamb late in July so it is possible to have the bulk of the lambs off their mothers before production falls away with the dry weather. As mating at the end of February, which is early, does not allow time for flushing ewes bought in autumn, 200 ewe hoggets have latterly been added to the flock each year.

Though there have been periodical bouts of foot-rot, it has been found practicable by early treatment and isolation to keep infection to the minimum. No trouble is experienced with internal parasites, as the older sheep are disposed of every year and replaced by hill-country sheep, pastures are kept clean, and lambs are weaned on to fresh, clean paddocks. A hay crop is usually taken off the cocksfoot-lucerne paddock and the weaned lambs are put on the aftermath, which provides a clean pasture very well suited for the purpose. From the cocksfoot-lucerne paddock the lambs go on to rape. As they are in good condition by the time they go on to rape, a smaller area of the crop is required than would be the case where lambs lacked condition.

Implements

The 20 h.p. tractor used on the farm which was bought in 1938 is still working efficiently. A lighter one has recently been purchased for use at rush periods, and in addition a power mower, tedder, and new 3-furrow plough have been added to the range of implements. Very often heading, topping, haymaking, or cultivation have to be done at the same time. The header is regarded as a very necessary part of the farm equipment.

The policy throughout has been to pay for all equipment and improvements out of revenue. Mr. Rands has erected 70 chains of fencing, planted and fenced 30 chains of shelter belts, built a hay shed, and improved his dip and yards.

Crutching, shearing, lime spreading, hay baling, and carting of hay to the shed is done by contract. During the war years a boy was employed. Help for seasonal work is secured as required.

Mr. Rands intends to lay down a stand of 30 acres of lucerne next autumn, which he hopes will provide sufficient hay for 1000 ewes. He also intends to sow down another cocksfoot-lucerne area in the autumn and is considering the establishment of an area of *Phalaris tuberosa* for winter greenfeed.

There is no doubt that this property is being well farmed. A few years ago soil fertility was depleted to such an extent that the growing of white crops was no longer payable and stock-carrying capacity was poor. Today the fertility of the soil has been restored. If prices for wool and fat lambs drop, Mr. Rands can again turn to cropping and his crop yields will be quite satisfactory. With the knowledge he has acquired during the last few years, it is certain that by the adoption of a sound crop rotation, Mr. Rands will have no difficulty in maintaining soil fertility.