

# DESERT CONQUEST

A review by N. S. Tiver of the main events which have contributed to the development of the Ninety-Mile Desert.



## INTRODUCTION

On the Dukes Highway, approximately 14 km north-west of Keith, a historical marker will be unveiled by His Excellency Lt-Gen. Sir Donald Dunstan KBE, CB, Governor of South Australia on 22nd October, 1986. The marker commemorates the conquest of the Ninety-Mile Desert. It has been erected by the Australian Institute of Agricultural Science as part of South Australia's Jubilee 150 celebrations.

"Desert Conquest"\* is an appropriate title for the story of the Ninety-Mile Desert development. On one of the three granite boulders comprising the historical marker, the inscription under this title reads as follows:-

"The breakthrough which led to the transformation of the infertile wastelands of the Ninety-Mile Desert into the productive farmlands, now known as the Coonalpyn Downs, was made possible by the field experiments of Dr. David Riceman of CSIRO during the period 1944-1950.

These experiments, located on several properties in the Keith district, revealed the need for trace amounts of copper and zinc, in addition to superphosphate for the successful growth and persistence of legume-based pastures, which paved the way for the development of this huge area. One of the properties involved was that of Mr. Jack Summers adjacent to this marker.

Tribute is also paid to the many Agricultural Scientists associated with the CSIRO, Waite Institute and Department of Agriculture whose research findings provided solutions to other problems encountered in the course of land development undertaken by the AMP Society, Hugh Robinson & Co. and individual farmers."

## GENERAL DESCRIPTION

The Ninety-Mile Desert, located in the Upper South-East region of South Australia, was an extensive tract of poor sandy soils, supporting an uninviting vegetative cover of heath and mallee heath with scattered pink gum and stringy-bark. For almost a century after the State's proclamation, it remained undeveloped and represented a barrier to communication between the more fertile areas of the Tatiara district in the south and the Murray lands in the north. However, some pockets of better country in the vicinity of Coonalpyn, Tintinara and Keith were settled by 1870 and a railway line from Adelaide to Bordertown was opened in 1886.

The Ninety-Mile Desert comprises about 1.5 million hectares, but the same type of country extends into Victoria as the Big and Little Deserts covering another 1.0 million hectares. The approximate boundary of the desert country is shown in the locality map (Figure 1) which is also reproduced on one of the granite boulders of the historical marker.

The early settlers used the term "desert" to describe these wastelands which produced nothing of any agricultural significance. This was not because of lack of rainfall (it receives a reliable rainfall ranging from 400 mm in the north to 500 mm in the south) but because of the extreme poverty of the soils. The grazing capacity was limited to about one wether per 16 hectares and even then sheep carried on these scrublands had to be moved after a few months to better country, otherwise they would become "scrub-sick" because of nutritional disorders. Wherever cereal production was attempted, generally yields fell rapidly after the first crop or two, as the meagre reserves of soil nutrients were soon exhausted.

\*This title was first used by the AMP Society for one of its brochures and a documentary film describing the AMP's Land Development Scheme which covered extensive areas of the Ninety-Mile Desert.



## SOILS

The first objective study of the nature and extent of the Desert soils was undertaken by the Soils Division of CSIR (later CSIRO) in 1932. This involved a detailed soil survey (Taylor, 1933) of an area, comprising the Hundreds of Laffer and Willalooka, which was then considered to be representative of the "desert" soils as a whole. A number of distinct soil types were recognised and mapped. Approximately one-third of the area was found to be hilly country, characterised by deep sands with some limestony ridges. This was regarded as the poorest country. The remaining two-thirds consisted of three main soil types: the Laffer sand, representing 20%, the Willalooka sand 31%, and the Monkoora sand 11% and swamps and red gum flats 5%. Of the three soil types, the Willalooka sand was considered to be the most important for future pasture development.

Since this early survey, our knowledge of the area's resources has been greatly enhanced by numerous soil and vegetation surveys undertaken by Jessup (1946), Coaldrake (1951), Blackburn et al (1953), and Jackson and Litchfield (1954). Coaldrake's survey proved particularly valuable in helping to define development strategies for the AMP development scheme.

## SOIL DEFICIENCIES

The CSIR survey of the Hundreds of Laffer and Willalooka revealed an extremely low soil phosphate status, which was confirmed in early field experiments conducted by Trumble (1938) and Donald and Smith (1938) at Tintinara on similar soils. Lucerne was found to be the most successful pasture legume, provided the seed was first inoculated with an effective strain of *Rhizobium* bacteria (Strong, 1938). As the soils were also low in nitrogen, the importance of legumes to increase soil nitrogen was fully appreciated by these early workers who also experimented with the growing of cereals. However, the real breakthrough did not occur until the advent of the trace elements — copper and zinc.

## Trace Elements

The trace element story in South Australia actually began in 1928 with the discovery by Samuel and Piper of the Waite Institute that small amounts of manganese would correct grey-speck disease of oats. This was followed in the 1930s by the work of the CSIR's Division of Animal Nutrition on Coast Disease, which showed this disease of sheep was due to a dual deficiency of copper and cobalt. The disease was associated with the coastal areas of Kangaroo Island and the South-East, principally Robe, where the predominant soils were calcareous sands. Many CSIR research officers within the Division of Animal Nutrition, including Dr. Hedley Marston, Mr. Ted Lines, Dr. Ian McDonald and Mr. John Lee, were involved in this work. David Riceman, a pasture agronomist in the Division, was working on crops and pastures in association with his animal nutrition colleagues at Robe. He decided to investigate the copper clue provided by their work and enlisted the help of two other agronomists, Colin Donald and later Alf Anderson. As a consequence of this, responses of pastures and cereals to trace amounts of copper were established, both in the field

and in pot experiments at the Waite Institute (Riceman and Donald, 1938), and under some circumstances further benefit was obtained with zinc as well as copper (Riceman and Anderson, 1941).

With the Robe experience behind him, Riceman was well-equipped to tackle the Ninety-Mile Desert and was quick to appreciate the significance of two important clues. The first of these was the occurrence of ataxia, steely wool and other nutritional disorders, similar to coast disease, in stock grazing in the Upper South-East, locally referred to as "scrub-sickness". This suggested that crop and pasture production might also be limited by copper deficiency and possibly zinc deficiency as well. The second important clue was provided by the work of R. L. Crocker (1946), ecologist in the CSIR Division of Soils, whose studies on the origin of the siliceous sands in the Upper South-East indicated that these were derived from the aeolian, resorted, leached A-horizons of the coastal calcareous sands, of which the Robe calcareous sand was an example.

During the period 1944-1950, Dr. Riceman conducted numerous field experiments on farmers' properties in the Keith district, including those of Mr. J. E. (later Sir Ellerton) Becker, Mr. Wally Hansen and Mr. Jack Summers. These experiments demonstrated quite conclusively that both copper and zinc in addition to superphosphate were needed for successful growth and persistence of legume-based pastures in which Bacchus Marsh sub-clover and Hunter River lucerne were the two best adapted legumes; lucerne responded only to copper, whereas Bacchus Marsh sub-clover required both copper and zinc. Riceman and Powrie (1948) also showed that Dwalganup sub-clover was more tolerant of zinc and copper deficiencies than the Bacchus Marsh sub-clover.

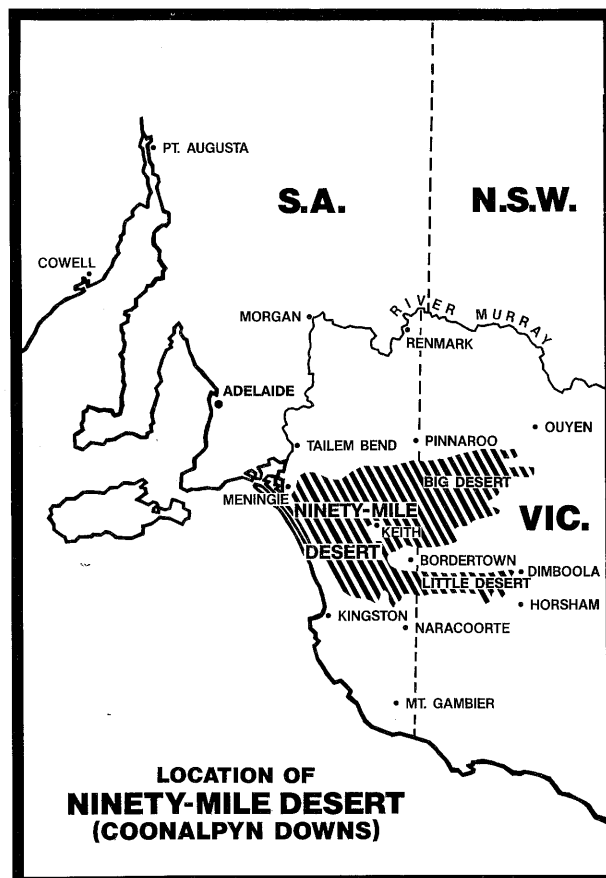


Figure 1 — Location Map.

Riceman's results were confirmed by Anderson and Smith (1951) at Woods Well and the trace element story was further extended by officers in the South Australian Department of Agriculture to other parts of the Ninety-Mile Desert; for example, Tiver (1955) diagnosed a manganese deficiency in subterranean clover and in oats growing on a Laffer sand, south of Keith in 1952. This was confirmed by a field trial in the subsequent season and the deficiency was observed over a number of years, particularly on the shallow phases of the Laffer sand. Manganese deficiency also occurred on the shallow limestony ridges of the hilly country.

The trace element story of the Ninety-Mile Desert would not be complete without some reference to the importance of cobalt in controlling phalaris staggers and of molybdenum and cobalt in the fixation of nitrogen by lucerne on deep acid sands.

## Phalaris Staggers

During 1941-1945, a series of trials designed to determine the response in sheep to cobalt and copper supplements were conducted in South Australia by John Lee and R.F. Trowbridge of CSIRO in areas away from the coast, where these deficiencies were suspected. These trials showed that cobalt deficiency occurred over a wide area, including the siliceous sands of the Upper South-East (Lee, 1949). In March, 1951, at the instigation of Dr. Hedley Marston of CSIRO and by arrangement with the AMP Society, experimental sheep were put on recently-established sub-clover, lucerne and phalaris pasture at "Brecon" near Keith and half of them were dosed with cobalt. Within a few weeks, most of the untreated group developed phalaris staggers, while none of the treated group was affected. Further studies at Brecon and elsewhere confirmed the protective action of cobalt against this disease and an effective preventative measure subsequently evolved using cobalt pellets (Lee et al 1957). These are sometimes referred to as cobalt bullets or pills and were actually developed by Mr. Doug Dewey, also of CSIRO. By placing a cobalt pellet together with a grinder (steel grub screw) in the animal's rumen, the animal was assured of a steady supply of cobalt over an extended period.

## The Deep Sands

Although Riceman's findings provided the solution to the successful development of the major part of the Ninety-Mile Desert, successful legume establishment on the deep acid sands still remained unsolved — the superphosphate, copper and zinc recipe did not work for these soils. Perennial veldt grass and evening primrose were the only pasture plants of any significance, but in the absence of a suitable legume these species suffered from nitrogen deficiency and low production.

A group of research workers in the South Australian Department of Agriculture led by Newton Tiver and including Kelvin Powrie and David Smith carried out a series of field trials on deep sands at Tintinara, Bangham Scrub, Fairview and Bakers Range from 1952 to 1960 in both the Upper and Lower South-East region.

Their work led them to the conclusion that past failures were due to poor legume nodulation and subsequently to the development of a sowing technique for the

successful establishment of lucerne. This deep rooting legume was preferred to sub-clover because of its ability to exploit a greater depth of the soil profile for soil moisture and nutrients. The essential features of the sowing technique were to sow lime-pelleted inoculated lucerne seed in intimate contact with relatively small quantities of agricultural lime (200 kg/hectare) and to apply a mixed fertiliser containing superphosphate and the trace elements copper, zinc and molybdenum separately. Initially this was accomplished by sowing the lime and seed through a disc drill and applying the superphosphate and trace elements through a spinner broadcaster as a separate operation, or by using two drills in tandem in one operation. However, the development of the special three-box drill (refer later) enabled the new sowing technique to be accomplished in one operation with one machine. The precise role of lime in these situations has been described by Tiver (1960) in a scientific paper.

On deep sands at Tintinara and Bangham Scrub, Tiver and Powrie found that molybdenum greatly improved the colour of lucerne plants, suggesting better nitrogen fixation by the lucerne. As the additional cost of molybdenum was not great, it was therefore recommended for the establishment of pastures on all deep siliceous sands.

In 1958, Powrie transferred from the Department of Agriculture to the Waite Institute where he continued his investigations of nutritional problems. Over the next 10 years, before his untimely death in May, 1968, he made some very important contributions to our understanding of nutritional problems in the Upper South-East. One such finding was a cobalt response by plants. Prior to Powrie's work, cobalt was considered to be an essential element for animals only. However, during the early 1960s in a series of trials on deep sands at Bangham Scrub, Powrie showed that cobalt stimulated nitrogen fixation and increased dry matter production of both subterranean clover (Powrie, 1960) and lucerne (Powrie, 1964). As a result of this work, the Departmental recommendations for pasture establishment on deep siliceous sands now includes the trace elements copper, zinc, molybdenum and cobalt in the fertiliser mixture.

## LAND DEVELOPMENT

The post-World War II years were marked by a period of intense land development activity in South Australia. In 1946, the Land Development Executive started developing land for soldier settlement on Lower Eyre Peninsula, Kangaroo Island and the Lower South-East. In 1949, the AMP Society launched its Land Development Scheme in the Ninety-Mile Desert and by the mid-1950's private developers took up the challenge in all of these areas. In the Ninety-Mile Desert, the firm Hugh Robinson and Co. provided a consulting and a management service to a large number of these private investors.

## AMP Society Scheme

This scheme was unique as it was the first time a project of this type had been attempted by a financial institution in Australia and, appropriately, it was initiated in the AMP's centenary year, 1949. The idea of developing the Ninety-Mile Desert originated with the Society's Pastoral Manager, Mr. Hugh Robinson, who

had been closely monitoring the results of Riceman's field experiments and was firmly convinced that the Desert could be successfully developed for closer settlement. His plan was accepted by the Society's General Manager, Mr. M.C. Butfield, who gave the scheme his blessing and, throughout its development, his utmost support. Although Robinson is recognised as the chief architect of the bold plan, many able and enthusiastic associates, including such people as Bill Edgerley, Noel Gowing, Bob Hatch and David Davidson, assisted him to implement the scheme. The full story, with reference to the many personalities involved, has been told by June Fergusson in her fascinating book "Bush Battalion".

The Society was granted leases over almost 200,000 hectares of the Ninety-Mile Desert by the South Australian Government and about 130,000 hectares in the Big Desert by the Victorian Government. It commenced development operations in 1949 using potential settlers as the basis for its labour force.

An important feature of the Society's development was the evolution of cheaper and quicker ways of doing the work without loss of efficiency, because it was imperative that development costs be kept within reasonable limits, as these would be reflected in the ultimate purchase price to the future settlers. Furthermore, the AMP did not enjoy the benefit of all of the tax concessions available to the private developers. As a consequence of these constraints, new and innovative land development techniques and equipment were devised. Initially, "logging" was used to knock down the scrub, but this gave way to "chaining" using long lengths of anchor chain hauled between two crawler tractors. Following ploughing with Shearer "Majestic" disc ploughs, fabricated levellers replaced conventional harrows for working back. These levellers also served to loosen and pull out stumps left by the ploughs. No attempt was made to remove the stumps, however, so that, in place of conventional drills, the distribution of seed and fertiliser was accomplished through spinner broadcasters, mounted in pairs on frames fabricated in the project workshop. Various seed-covering devices were employed, but these were ultimately replaced by the chain.

During the 2½-year period following seeding, the land was divided into "living areas". A "living area" was defined as an area of land varying in size, but designed, when fully developed, to carry 1,500 dry sheep equivalents. Towards the end of the 2½-year period, each holding was subdivided into five paddocks and a minimum of three fully-equipped water points were established. During the development period, the men and their families were housed in temporary houses, but as properties became available they were moved to permanent housing on their own blocks.

When the AMP ceased development operations in 1974, it had developed a total of almost 100,000 hectares of pasture in South Australia and Victoria. In South Australia, approximately 39,000 hectares comprising 78 farms were occupied by AMP settlers in accordance with its planned land settlement scheme. Apart from about 23,000 hectares which were returned to the Crown, the balance of its South Australian concession was sold to various private developers after some 10,000 hectares of developed pasture had been completed. Approximately 47,000 hectares of pasture were developed on the Society's Victorian concession representing 91 blocks which were also sold privately.

Following its land development experience in South Australia and Victoria, the AMP Society extended its rural activities to other States, including the land development scheme at Tea Gardens in New South Wales and the formation of the Standbroke Pastoral Company in Queensland.

## Hugh Robinson & Co.

In 1953, Hugh Robinson resigned from the AMP for health reasons, and moved to his own property "Desert Downs" located between Keith and Bordertown. However, in the ensuing months he received so many requests from private investors for advice on land development and property management that he decided to set himself up as a Land Development Consultant and Pastoral Manager.

When the original AMP scheme for helping people with limited finance had run its course, the idea of providing only partial development and selling large allotments to private buyers was adopted by the AMP Society with the concurrence of the two State Governments. Many of these private investors who bought land from the AMP used the services of Hugh Robinson to help them develop and manage their properties. Because many of them represented substantial sources of capital and enjoyed favourable tax concessions, Hugh Robinson & Co. was not constrained by the need to use low-cost methods of development. Using local contractors, such as the Dutschke Bros., Schreiber Bros. and Clarrie Hutchins to undertake the various land development operations, the Company planned, directed and supervised the work and, where required, accepted general management responsibilities over an extended period. Problems of mallee regrowth and stump removal were overcome by the use of the Fewings ripper (in place of the Shearer majestic plough), and the Wake stump rake (developed by Horwood Bagshaw). Furthermore, the Company was able to take advantage of the more recent technology on lucerne establishment that had become available and to successfully develop many areas of deep sands which had been excluded from the AMP development.

At the instigation of Hugh Robinson & Co. John Shearer and Sons developed the three-box drill in 1961 to cope with the special seeding technique developed by the Officers of the Department of Agriculture for deep sands and contractors were trained by Hugh Robinson & Co. to lime-pellet and inoculate the lucerne seed.

The Company was responsible for the development of almost 100,000 hectares of desert country in South Australia and Victoria and, as a result of its experience in this region, subsequently extended its land development skills and consulting capacity to Western Australia, Northern Territory and Queensland, and finally to Third World Countries overseas, where it continues to operate under the name of AACM.

## Private Development

In addition to the development carried out by the AMP Society and Hugh Robinson & Co., it should be appreciated that many local farmers and other private developers engaged in land development on their own account and it was the collective action of all these groups which transformed the desert wastelands into the Coonapyn Downs, using the technology provided by the researchers.

## SUBSEQUENT PROBLEMS

Several problems, notably water repellent sands, the invasions of the spotted alfalfa aphid and sand fescue in pastures, and an increase in acidity of the sandy soils have arisen following the initial land clearing and pasture development phase.

### Water Repellent Sands

Non-wetting or water-repellent sands were first recognised as a potential problem in the Coonalpyn Downs by Dr. Roy Bond of the Soils Division of CSIRO in 1959. Over the next 15 years he researched the problem, discovered its cause and developed methods for measuring repellence. He also showed how repellence varied with the seasons and the years following development and how it reduced the productivity of pastures and crops.

Immediately after the initial clearing and soil preparation operation, repellence is generally low, but it usually increases under pasture over time. In severely affected soils, large volumes of surface soils remain unwetted after rain. Instead of uniformly wetting the soil profile, the water runs across the soil surface and percolates down preferred sites, e.g. local depressions, furrows, hoof prints, etc. In autumn, annual plants germinate where the water has penetrated the soil, but the unwetted patches remain as bare ground. These bare patches gradually cover in winter, but remain unproductive. Subterranean clover thins out and is replaced by grasses and broad-leaved weeds.

Mr. Peter King of the South Australian Department of Agriculture began his investigations of the problem in 1975 and since then has devised practical solutions for crop establishment involving new tillage methods, seed inoculation procedures for lupins and techniques for re-establishing lucerne following the loss of stands as a result of aphid attack. Furthermore, recent work at the Waite Institute by Max Tait's group has now identified the materials causing water repellence and has demonstrated that the materials can be removed from the soil. It is hoped that this breakthrough will lead to a practical solution to the problem.

### The Aphid Invasion

The reported discovery of spotted alfalfa aphid (SAA) in New South Wales in 1977 was seen by Officers of the South Australian Department of Agriculture as a serious threat to lucerne in South Australia, which at that time was well and truly recognised as the key pasture legume for all the well-drained sandy soils, particularly the deep sands in the Coonalpyn Downs.

The SAA did not reach South Australia in time to do significant damage in the autumn of 1977, which enabled a campaign to be devised to deal with this threat. The initial thrust was to maintain the existing lucerne stands for as long as possible by the use of insecticides and grazing management, to be followed by the introduction, mass rearing and distribution of aphid parasites as widely as possible. Good success was achieved with a small parasite wasp, *Trioxys*, but it was soon appreciated that, for lucerne which had deteriorated under aphid attack, the solution was resowing with aphid-resistant varieties.



Foreground: Mixed pasture sown with Superphosphate and trace elements.  
Background: The natural scrub vegetation.



Fortunately a well developed lucerne breeding programme of wild and cultivated lucernes was already in progress at Northfield under Mr. Ian Kaehne dating from 1970. The breeding material was subjected to intense selection for aphid resistance. In addition, breeders' lines of lucerne from other breeding programmes including New Zealand were reselected for SAA and later blue green aphid (BGA) resistance. Within a few years, the four adapted SAA-resistant lucernes, Springfield, Wakefield, Sheffield and Hunterfield were released to South Australian farmers.

The acute phase of the aphid invasion has now passed and substantial areas destroyed by the aphid have been resown. Because of the water-repellent nature of many of the soils, and the accumulation of weed seeds, expensive soil preparation, erosion and weed control measures need to be undertaken if lucerne re-establishment is to be successful.

## Sand Fescue

Sand fescue (*Vulpia fasciculata*) is an undesirable annual grass which is currently a major problem on many farms in the Coonalpyn Downs. Its increase has coincided with the destruction or thinning of lucerne stands by SAA. The grass has a great capacity to establish at high densities and to grow and produce seed on infertile sands, particularly when more productive and desirable species are absent. Its seeds have sharp points which easily penetrate wool and skin, causing blindness, damaging carcasses, reducing feed intake and, in extreme cases, causing fatal infection. Successful re-establishment of lucerne will help to control sand fescue, but this involves chemical topping of sand fescue in the year prior to sowing and the use of pre-emergent herbicides in the year of sowing.

## Soil Acidity

Increases in the acidity of sandy soils in the South-Eastern region of South Australia have been reported by Lewis, Clarke and Hall (1986) in a paper recently submitted for publication. The major factor causing this decline in soil pH is associated with the age of the pasture, for example on sandy soils in the Hundred of Willalooka, the pH in the 0-10 cm soil layer has declined from 6.7 to 5.6 in 20 years and for sandy soils in the Hundred of Senior, there has been a decline from 7.0 to 6.2 in the same period. This means that for lucerne establishment, lime is expected to be even more important on old pasture land than on the virgin land.

## FUTURE OUTLOOK

Under the current economic conditions, farmers generally are experiencing financial hardship. For farmers in the Coonalpyn Downs, some relief may be feasible and their future prospects improved, if costs for maintaining lucerne stands can be minimised and if full use is made of their farm's agricultural potential.

## Costs

A major component of a farmer's operating cost is fertiliser. In the 1960s, Powrie made a close study of the economics of superphosphate in pasture management in the Coonalpyn Downs, particularly the

respective roles of phosphorus and sulphur (the two important constituents of superphosphate). His work demonstrated that, once a satisfactory level of inorganic phosphorus in the soil had been achieved, substantial reductions in superphosphate could be made without loss of production, providing the sulphur requirement is satisfied by the application of gypsum (Powrie, 1963). Sulphur does not accumulate in the soil in the way that phosphorus does. The Department of Agriculture (Lewis and Clarke, 1975) has since established recommended annual maintenance dressings of superphosphate for various forms of land use, but has indicated that where these rates are being used, sulphur may be inadequate to maintain good clover production, especially on sandy paddocks in wet years. Extra sulphur can be applied by using superphosphate fortified with additional gypsum or alternatively by using coarse-grained gypsum. However, lucerne is much less demanding than clover for both phosphorus and sulphur, and providing aphid resistant cultivars are used and appropriate grazing management employed, this plant has emerged as the best-adapted pasture legume for the well-drained soils of the Coonalpyn Downs.

## Agricultural Potential

Livestock production based on sheep and cattle has been, and will continue to be, the main form of land use for the Coonalpyn Downs. However, in this respect, many properties are not producing to their full potential because of the low carrying capacity of many lucerne pastures which have deteriorated as a result of poor grazing management, aphid damage, and invasion by inferior weed species, especially sand fescue. Increases in carrying capacity of up to 100 per cent are feasible following a programme of pasture renovation involving resowing with aphid resistant lucerne cultivars and the use of appropriate cultural practices as recommended by the Department of Agriculture.

A glimpse into the future and what may be feasible is provided by the achievements of some enterprising farmers who are diversifying into other forms of production. Lupin has become a significant legume crop and the lupin barley rotation is expected to have wide application over substantial areas. Small seed production, especially lucerne seed production using underground water resources for irrigation to increase both forage and seed yields, is another recent development. In this connection, the experience of the Summers family is of particular interest.

In 1937, Mr. Jack Summers took up a block of "desert" country on which he attempted to grow cereal crops, with poor results. However, with the advent of copper and zinc and improved legume-based pastures in the 1940s, the carrying capacity of his farm and crop yields were dramatically increased. Today, some fifty years after taking up the block, his son Mr. John Summers is irrigating 200 hectares of lucerne, much of it for hay and certified seed production, which is now his major source of income. In a very real sense, the desert can be said to have "blossomed like a rose".

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Note: References to published work which have been the source of the information used in this review have been well documented in scientific publications.