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Development of annual pasture species in south-western Australia

By Dr C. M. Francis, Chief, Division of Plant Production and Dr B. J. Quinlivan, Chief Research Liaison Officer

Western Australia, with its vast tracts of acid infertile sandy soil, has depended heavily on the development of pasture legumes. In particular the increase in the inherently low soil nitrogen status has substantially raised crop yields and total dry matter production potential of the pastures.

By far the most widely sown pasture species in Western Australia is subterranean clover (Trifolium subterraneum and T. yanninicum). The area of sub. clover peaked in the early 1970s to about seven million hectares and has subsequently declined, particularly in the drier margins of the cereal growing areas to about six million hectares. The precise details are difficult to glean from statistical registers because many pastures classified as “improved” contain very little of the introduced pasture legumes.

The first subterranean clover—cv. Mt Barker

The first subterranean clover introduced into Western Australia was Amos Howard’s selection from South Australia—the cultivar Mt Barker. This late-maturing cultivar was introduced largely in burr form; the earliest known introduction was by J. C. Warren of Katanning, who in 1902 brought seed in from his Mount Crawford property in South Australia. The variety became fairly well distributed in the south of the State from 1914 onwards, and became recognized as a very useful legume. Widely known as “Mid season”, it was soon realised that it was rather too late for regions of less than 625 millimetres average annual rainfall.

Major advances in 1927—Dwalganup

A historical advance in pasture development began when P. D. Forrest found an early maturing ecotype on his farm “Dwalganup” at Boyup Brook. He recognized a vigorous early cultivar which set seed plentifully. Being a seed producer, he encouraged the spread of sub. clover as a pasture plant throughout the State into regions as low as 375 mm average annual rainfall. His new variety Dwalganup has been the most widely sown in the State’s history and to this day it retains a relatively dominant form in many paddocks, particularly in the 375 to 400 mm average annual rainfall areas.

Within a moderate cropping rotation Dwalganup appears very much in balance with its environment. Its relative upalatability to stock may assist its persistence when grazed and this, together with its tall growing habit, assists in its competition with grasses and herbs. Dwalganup has a strong burr burial capacity and dominant Dwalganup paddocks as old as 40 years can still be seen today.

While P. D. Forrest was popularising the Dwalganup cultivar, A. J. Monger at his Daliak estate near York also noted a dominant sub. clover and distributed some burr and seed into the nearby district. He however did not have the interest of P. D. Forrest, nor the equipment or perhaps the energy, to indulge in large-scale seed harvesting.

In either case, the Dwalganup cultivar was a more showy variety than that of the Daliak estate ecotype. Daliak was again released 40 years later and has proven to be a very successful cultivar in the medium rainfall areas. The success of Dwalganup inspired agronomist A. B. Adams to collect naturalised strains of sub. clover, mainly in the Northam-York area about 1930. One of these strains, Northam A, was to be commercialized in the 1970s.

The ley farming system

Research with Dwalganup sub. clover showed its ability to regenerate after a cereal crop. Experiments at Muresk (425 mm average annual rainfall) in the early 1930s by T. C. Dunne and F. L. Shier led in 1934 to the proposal that Dwalganup be used in rotation with cereals to improve soil fertility, crop yield, and quality of grazing. This was the beginning of the clover ley system which revolutionized Western Australian agriculture in the medium rainfall wheat-sheep zones where Dwalganup could be grown reliably, and led to a great expansion of the sown area of sub. clover.

Sheep infertility

Researchers soon recognized in the pasture development boom immediately after World War II that sub. clover was responsible for very considerable declines in sheep lambing percentages. E. J. Underwood, H. W. Bennetts and F. L. Shier realized the ewe fertility problems that it caused. We can speculate that
the “clover disease” syndrome may never have been a serious problem had not the low oestrogen cultivar Dalak been somewhat stilled in its early stages by the enterprise of P. D. Forrest in promoting Dwalganup, which was proven later to be a major cause of sheep infertility in Western Australia.

The next sub. clover to make a significant contribution was a variety known today as Yarloop. It was also highly oestrogenic. In about 1947 seed from the cultivar, then known as “Albino”, was distributed to farmers from J. M. Riegert’s property near Yarloop. The sub. clover was noted to have great winter vigour and its waterlogging tolerance was a valuable characteristic in many of the waterlogged flats of the South-West. The variety was widely sown in wet spots and in dairying areas where the practice became to sow mixtures of Mt Barker and Yarloop.

Yarloop added to the sheep infertility problem rather than alleviating it. This was particularly the case when Yarloop was sown in large areas as a monoculture at Esperance by the Esperance Land and Development Company and on War Service Land Settlement Scheme farms at Ongerup, Jerramungup and elsewhere.

**The Geraldton era**

The next advance and again highly significant for pasture development came with the release of Geraldton sub. clover in 1959.

A. J. Millington had been working at the Institute of Agriculture, University of Western Australia for ten years developing improved sub. clovers for Western Australia. Concentrating on seed and herbage production, he was particularly interested in an earlier maturing sub. clover to replace Dwalganup. A naturally occurring ecotype he and G. L. Throssell found in 1950 at Moonyoomoooka near Geraldton was so named after Geraldton town, and widely sown in the 1960s in the wheat and sheep regions virtually to the margins of the wheatbelt

**Woogenellup and Dinninup**

A common impurity in the Mt Barker variety found at Manjimup on Group Settlement properties during the 1950s was first described by B. J. Quinlivan in 1957. The origin of the new variety was traced to the Elgin property of Wesley Scott. Subsequent seed increase was at Woogenellup (F. Ford), Bridgetown (E. and M. McKelvie) and Boyup Brook (H. S. Rogers). After a series of rather quaint spelling errors, the variety found at Woogenellup became Woogenellup and was first certified in 1959. During the 1960s it became the most widely sown pasture species in the higher rainfall areas of Australia, reaching a total production of more than 5000 tonnes.
Another dominant impurity in cv. Mt Barker was noted in the Boyup Brook area on E. A. Miller’s property by B. J. Quinlivan in 1959. This particular variety had begun to dominate many swards in the area. It was described by B. J. Quinlivan in 1962, and named Dinninup because a farmer, C. Sumner of Dinninup, in association with the Miller family generally helped popularise the cultivar.

Released in 1962, Dinninup is highly hard seeded and has strong physiological dormancy. It is tolerant of root rot, has a high yield of rather small seeds and is probably the most aggressive of sub. clovers in higher rainfall areas. It is widely found in older Mt Barker pastures. Many farmers who believe they have Mt Barker have substantial portions of Dinninup in their pastures.

Although no longer recommended by the Department of Agriculture because of its high oestrogen content, Dinninup is still widely sown, especially on cattle properties, and on sandy soils of the coastal plain where it generally seems to out-perform other cultivars.

The low oestrogen era—Daliak and Seaton Park

Looking at the line up of varieties in 1962 only one, Woogenellup, could be classed on present knowledge as a low oestrogen sub. clover. The major sub. clovers Dwalganup, Yarlool, Dinninup and Geraldton are all highly oestrogenic. It was in the early 1960s that H. Lloyd Davies showed a difference between Mt Barker and Dwalganup in oestrogenic activity in sheep using newly developed uterine weight bioassay techniques.

The subsequent discovery by A. J. Millington, C. M. Francis and N. R. McKeown in 1964, that the “ogre” in sheep fertility was the isoflavone formononetin and not genistein, as had been thought earlier, led to a renaissance in the selection of new sub. clovers.

R. C. Rossiter of CSIRO had been studying the persistence and relative success of sub. clovers in mixtures in the field for a number of years, and two of the more successful varieties, Daliak and Seaton Park, had proven to persist very successfully at trials at Glen Lossie, Kojonup. Being low in formononetin they were ready-made for their subsequent commercial release in 1967. They have become major sub. clovers in the medium to high rainfall zone and are still widely sown today, with seed production figures each of about 500 tonnes a year.

An “oestrogen-free” sub. clover developed by C. M. Francis and A. J. Millington was released at the same time. Uniwager (University of Western Australia-Geraldton), developed using a chemical mutagenic agent, proved not productive enough and soon faded from the scene after much pre-release publicity.

The National Subterranean Clover Breeding Programme

In the early 1960s, J. S. Gladstones and Western Australian Department of Agriculture colleagues started a systematic survey and collection of naturally occurring sub. clover strains, the first since that of A. B. Adams in the 1930s.

This work corresponded with the unfolding of the formononetin story. Many of these ecotypes were used in a new crossbreeding programme started in 1966 at the Institute of Agriculture as a joint project with the Department of Agriculture with C. M. Francis and J. S. Gladstones as principal plant breeders. This became known as the National Subterranean Clover Breeding Programme.

From this arose a selection of important sub. clovers designed to replace the earlier oestrogenic varieties. For example one of the first cultivars Trikkala, bred to replace Yarlool, was released in 1976. Trikkala, one of whose parents originated in northern Greece, has proven highly successful as a replacement for Yarlool. It is recommended in all Australian mainland States and has virtually replaced Yarlool in the commercial seed scheme.

Larisa and Meteora, late maturing sub. clovers originally collected in northern Greece by the late J. S. Katznelson, were released in 1976 and
1981 respectively as a result of the programme. Direct selections rather than crossbreds, they are suited only to the higher average annual rainfall areas (more than 800 mm) of the State. Larisa is of similar maturity to Mt Barker while Meteora is slightly later.

Nungarin, released in 1976, is the earliest maturing sub. clover yet produced. It matures ten days or more earlier than Geraldton, has a higher hard seed content and more vigorous growth and was bred specifically for the drier areas with less than 350 mm average annual rainfall. Considerable quantities of Nungarin seed have been produced. Much of its relative success, however, has been in regions of higher average annual rainfall than those for which it was developed. It is largely established in regions of 350 to 450 mm rainfall.

The 1970s have shown shortcomings in the use of sub. clover in the drier areas of the wheatbelt. Given the fairly unreliable finishing rains of the 1970s, Nungarin has not been able to persist in the current intensive cropping systems and good sub. clover pastures are becoming hard to find in areas of less than 350 mm average annual rainfall in the northern and eastern wheatbelt.

Northam A, a variety found by A. B. Adams about 1930 and recommended for the 350 to 400 mm average annual rainfall zone, has been somewhat kept in the background by the large scale release and publicity surrounding Nungarin. It has not yet assumed any major place in the commercial seed market, despite being an impressive looking sub. clover with the ability to “hang on” longer than Nungarin or Geraldton if the season permits.

Clover scorch—the first major disease problem

The disease Kabatiella caulivora—clover scorch—destroyed vast areas of Woogennellup, Seaton Park and Yarloop based pastures in the lower south coast in 1971 and losses were repeated the following year.

To this day the pastures have not really recovered. The weakened seed production in the bad Kabatiella years allowed wholesale invasion of grasses and herbs so that an “old land” situation developed almost over night. Despite reseeding the pastures have not regained the productivity of their sub. clover dominant phases.

D. L. Chatel and C. M. Francis of the Western Australian Department of Agriculture demonstrated suitable Kabatiella resistance in the variety Daliak.

The first release to counter the clover scorch problem was the cultivar Esperance (a Daliak-Bacchus Marsh cross) in 1979. With short growth habit like its Daliak parent, it is best suited to sheep production. About 1000 tonnes have been produced, sold and sown in the Esperance area. Although not a particularly showy variety Esperance, with its resistance to Kabatiella and tolerance of root rot, has helped stabilise pasture systems in the Esperance region.

As a result of the Kabatiella problem, Daliak was planted throughout the south coast, but rainfall and growing seasons were rather too long to achieve maximum production with this cultivar. Whilst Esperance is a more productive cultivar, it is still earlier than Woogennellup. A Kabatiella resistant cultivar of Woogennellup-type maturity is the prime requirement for the whole of the south coast, and is the current major aim of the National Subterranean Clover Breeding Programme.

Medics

Medics (Medicago spp.) have been far less extensively sown than sub. clover in Western Australia, largely because of our paucity of alkaline soils. Before the 1950s the variety Hannaford, a rather late maturing cultivar of barrel medic, was sown spasmodically.

A. J. Millington tested selections introduced by CSIRO from Cyprus and this seed formed the basis for the early maturing cultivar Cyprusat. Released in 1959, Cyprusat barrel medic was widely sown at the time on about 500,000 ha of red loamy soils of the northern and eastern wheatbelt.

The trend to successive cropping of heavy soils has weakened the position of Cyprus, so that few Cyprus paddocks are seen nowadays. Cyprus, unlike sub. clover, has shown ability to regenerate after two and sometimes three successive crops.

In the 1970s cv. Harbinger strand medic was sown on about 150,000 ha, largely on sandier soils in the north coastal and Geraldton areas, particularly soil types such as the Tenindewa yellow sand series around Eradu. Most of the original seed was imported from South Australia. Other successful sowings have been north of Esperance on the Circle Valley sand series where Harbinger has out-performed the sub. clovers and other commercial medics. Like Cyprus barrel medic, Harbinger strand medic regenerates extremely well after crops.

A disc medic, cv. Tornafield, bred by A. J. Millington and released in 1969, has specific adaptation to sandy soils. Although adapted to alkaline sands, the species grows better on neutral or slightly acidic soils than most other commercial medic species.

Some recent medic seedings involved M. polymorpha cultivars, a ubiquitous species very widely distributed in terms of rainfall and soil type. It is odd that it has not been more widely researched as a species because it is the most widely adapted of the annual medics.
Pasture legume recommendation zones

1. Recommended: larvae for general sowing in mixture with Trifolium. Experience to be included on gravelly hills where clover scorch is prevalent, but replace with Woogamulla if sward risk is low. Mt Barker can be used where roots are not panalized. Mekoa alone or with Trifolium is recommended for the long growing season south coast area for reliable hay production. Pitman serradella on banksia-sweat sands.

2. Recommended: Seaton Park for general sowing on all soils with gravel in the profile. In higher rainfall areas, Woogamulla should be included in the mixture. Dalkas or Northam should be included in the mixture in drier areas of this zone. Trifolium should be sown in waterlogged areas. Pitman serradella is recommended on sandy soils, except the deep white sands in this area which are not recommended for agriculture. It should be sown either alone or with a low rate of sub clover not more than 2kg/ha. Urserra can replace Pitman serradella in drier areas.

3. Recommended: Woogamulla and, particularly on winter wet areas, Trifolium. On the eastern and south-eastern edge of this zone, Seaton Park or Dalkas are recommended. Urserra should be included in the pasture mixture where clover scorch has been a problem.

4. Recommended: Northam generally but Dalkas or Seaton Park for the south-western edge of this zone. Nangarin for the eastern edge. Cyperus pennisetiformis on heavy red soils. Nangarin for the eastern edge. Cyperus pennisetiformis on heavy red soils. Northam is an alternative to Nangarin in the higher rainfall and more southerly parts of this zone. Urserra is an alternative to Cyperus and is also recommended on loams and sandy loams.

5. Recommended: An association of Trifolium mixture with Dalkas included in the drier regions. Woogamulla can be included if clover scorch has not been severe. Pitman serradella is recommended for medium to deep sands with Urserra as an alternative on the drier northern side of this zone.

6. In cropping areas north of Esperance, such as Spoddingsup and Grass Patch, Harlingin and Tarniwild are recommended for sandy soils. Cyperus on red soils and Jermeling on wetter edges of these areas. Urserra is an alternative to these soils in northern areas.

Vast areas of sub. clover-based pastures were destroyed by the disease clover scorch in 1971-72.
Programmes in Western Australia were initiated at the University of Western Australia in the 1960s by J. McComb, and cv. Serena resulted from this programme. The later maturing Circle Valley, selected by B. J. Quinlivan and C. M. Francis from a collection near Coolgardie by A. C. Linto, also shows considerable promise. Both cultivars are promising on sandy soils, particularly where cropping is likely to be relatively intensive. Serena and Circle Valley have at least some adaptation to the moderately acidic soils and they will probably be widely sown in the future, particularly if an improved *Rhizobium* strain more tolerant of acidic soil can be found.

**Serradella**

Two species of serradella have been tried. The pink flowered or French serradella (*Ornithopus satius*), first introduced commercially in the 1950s, has generally failed to persist because of erect growth, late maturity and lack of hard seedness.

The other, yellow serradella (*O. compressus*) cv. Pitman, has been much more successful and has achieved a limited but useful role. Found near Waroona in 1950 and named after farmer W. M. Pitman, it is well adapted to acid sandy soils and on the deeper sands is generally more successful than sub. clover. Cultivars currently available include Pitman (released in 1955) and Uniserra, developed by J. S. Gladstones and released in 1971. The latter is a chemically induced mutant. They represent but a small part of available variability and numerous more promising ecotypes are presently under evaluation.

Establishment remains a problem with serradella because of the difficulty in breaking down the hard seed content. The same characteristics and tolerance of grazing however ensure a persistent pasture once established.

**Further reading**


been shown to persist on the harder setting red mallee soils. The species probably still has a place in Western Australian agriculture, although the intensification of cropping may expose problems of hard seed content similar to those of sub. clovers.

**The future**

Western Australia has long been a leader in the development of annual legumes and this role will continue with a range of new species and varieties in advanced stages of field evaluation. The next five years should see additions at least to the range of sub. clovers, serradellas and medicus currently available to farmers.

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<tr>
<th>Major developmental events for subterranean clover in Western Australia</th>
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<tbody>
<tr>
<td>Cultivars produced</td>
</tr>
<tr>
<td>1902</td>
</tr>
<tr>
<td>1908 Mt Barker</td>
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<tr>
<td>1927 Dwallaganup</td>
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<tr>
<td>1934</td>
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<tr>
<td>1947 Yarloop</td>
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<td>1959 Geraldton</td>
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<td>1964</td>
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<tr>
<td>1967 Dalikar, Seaton Park</td>
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<tr>
<td>1971</td>
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<tr>
<td>1975 Trikkala, Nungarin</td>
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<td>1976 Esperance</td>
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</tbody>
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**Rose clover and cupped clover**

Rose clover and cupped clover were popularised by CSIRO in the 1960s by E. T. Bailey. Press publicity as a result of the sometimes brilliant showiness of rose clover (*Trifolium hirtum*) encouraged seeding of the species, if only on relatively small areas. One such area was around Lake Grace and Katanning where much of the early seed production took place, but the species is best suited to warmer climates of the coastal areas north of Perth.

Rose clover has generally failed to persist. Varieties such as Kondinin and Hykon have an aerial seeding and upright growth habit detrimental to their persistence, particularly in competition with sub. clover.

Cupped clover (*Trifolium cherleri*) on the other hand is a far more persistent species. Some early varieties like Beenong and Yamina have