A listing of forage accessions sown in evaluation studies carried out by CSIRO in southern and central Queensland, Australia (1950-2000)

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Abstract

This paper gives a listing of all published reports of early stage evaluation of forage accessions carried out by CSIRO in southern and central Queensland in 1950-2000. Almost all of these trials were grazed.

The experiments described were established at 78 sites between 1953 and 1997. They included 189 accessions of temperate legumes, 44 accessions of temperate grasses, 735 accessions of tropical legumes and 586 accessions of tropical grasses. Accessions that were sown, but where no seedlings emerged, have not been included. Each accession in each sowing was rated as: 1 (showing no merit), 2 (intermediate) or 3 (showing some promise). References to the relevant publications are given.

Some brief comments are made about the results of testing within the 4 groups defined above, but the objective of this publication is to enable readers to find out which accessions were sown at which site, rather than to summarise results. It is pointed out that most of the widely sown cultivars are still those selected from evaluations in the 1950s - 1970s, and that "second generation" cultivars developed from screening a wider range of accessions have usually received limited acceptance.

Introduction

CSIRO has played an important part in evaluating introduced pasture species in northern Australia. In central and southern Queensland this has been done by the former CSIRO Tropical Agriculture, previously known as the Division of Tropical Pastures (1959-1972), Division of Tropical Agronomy (1972-1975) and Division of Tropical Crops and Pastures (1975-1996). CSIRO now has no role in evaluation of pasture plants and it seemed appropriate to summarise all published information from earlier studies on this topic.

The main reason for doing this is to make it easier for those involved in any future research on this topic to know what CSIRO has done in the past. A secondary reason is that there is now increased pressure, from an environmental viewpoint, for a complete listing (as far as possible) of where evaluation studies were carried out.

This memorandum lists all accessions sown in different trials, carried out in southern and central Queensland, where the results have been published.

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Methods

Lists of plants, sites and rating can be found on the accompanying file at http://www.tropicalgrasslands.asn.au/downloads/jonesspecies.xls

All relevant published papers have been scanned to produce a listing of sites and the accessions that established. Accessions that were sown but did not establish in a particular trial have not been listed in that trial, because the failure could result from poor quality seed and might not give a true indication of the potential of that accession at that site.

Criteria for inclusion

All trials listed in this memorandum ran for at least 2 years, with almost all running for 3 years and many for 4-5 years. In several cases, trial sites were revisited at irregular intervals over 10, 20 or even 30 years. With very few exceptions, trial sites were regularly grazed throughout this

period. However, even these exceptions were regularly subjected to cutting. The data from 2 trials, where the results have not been published, were included as I was familiar with them and had access to the experimental records.

Results of many other trials were not published or summarised. General references to trials of this type (e.g. Bryan 1973; Shaw 1967) give no details about the results from individual accessions, so such trials are not included in this memorandum.

Sites

The sites have been listed in Table 1, with details on the region, nearest town, latitude and longitude, soil type and rainfall. There is also a number for each reference to the trials at that site. Where the location of the site was known in 1998-99, the exact latitude and longitude were usually determined by using GPS. In the remaining cases, the latitude and longitude entries have been taken from the paper concerned, or have been deduced from a map. Hence, some localities had a number of trial sites, e.g. the former Samford Research Station. When nearby trials were laid out on different soil types and the exact location of each trial was known, they were entered separately as different sites. Table 2 gives the authors for each of the published references and also lists the sites that were referred to in that publication.

Changes in botanical nomenclature

Where changes in botanical nomenclature have been widely accepted, the new name has been used, although the earlier name was used in the published paper. The main examples of this are as follows: *Arachis glabrata (*not *A. prostrata), Chamaecrista (*not *Cassia), Kummerowia (*not *Lespedeza), Lablab purpureus (*not *Dolichos lablab), Macrotyloma africanum (*not *Dolichos baumanii), Macrotyloma uniflorum (*not *Dolichos bifloris), Macrotyloma axillare (*not *Dolichos axillaris), Macroptilium atropupurueum (*not *Phaseolus atropurpureus), Macroptilium bracteatum (*not *Phaseolus bracteatus) and Neonotonia wightii (*not *Glycine javanica)*. However, I have retained the species names used in the published papers for several species of *Digitaria*, which are now all referred to as *Digitaria eriantha*. This was because many of the former specific names, such as *D. decumbens, D. pentzii and D. smutsii*, have real meaning for pasture scientists. One paper (Strickland et al. 2000) has grouped all these species as *D. eriantha*, but in this memorandum the accessions listed in that publication have been included under the old species names. For similar agronomic reasons, I have retained the genus *Urochloa* rather than merge it with *Brachiaria*, as in the latest taxonomic revision.

Listing of accessions

The accessions have been grouped into 4 classes, namely: temperate legumes with 189 entries (Table 3), temperate grasses (44 entries, Table 4), tropical legumes (735 entries, Table 5) and tropical grasses (586 entries, Table 6). In almost all cases, this has presented no problems. However, in a few sowings, 1 or 2 notionally temperate species, usually lucerne, have been included in a sowing of many tropical species or accessions. In these instances, the temperate species has been listed along with the tropical species in that sowing so as to have a complete list of all accessions that established.

The list of accessions in Tables 3-6 is in alphabetical order. Two columns are used to define each accession within a species; usually only 1 is used to give the accession number. Where the accession is an Australian cultivar, the accession number is given in the second column. Both are given because the results in published papers may refer only to an accession number, even though the accession may have subsequently gained cultivar status. In rare instances, the second column is used to give an overseas cultivar name, where this is not used in Australia. As most accessions are known by their CPI (Commonwealth Plant Introduction) number, accessions within each species are listed in increasing numerical order of these numbers. Within each species, accessions with other identifiers (such as ATF or CQ numbers) are listed after the accessions with a CPI number.

Rating of success

The performance of each accession in each trial has been rated on a scale of 1-3, where 1 indicates no merit and 3 indicates some promise. Ratings have been based primarily on persistence and productivity, except for species that were intended for short-term pastures, where long-term persistence was not an issue. Often it was uncer-

tain whether a rating should be 1 or 2, or 2 or 3, so the ratings should be used only as a very broad indication of merit.

Usually the ratings were based on data in the published papers, although in some cases, where I have observed the trial site after it has formally ended, the ratings have been adjusted to allow for the long-term observations. Usually this experience has shown that accessions did not persist, so the ratings have been downgraded. However, in a few instances ratings have been raised.

Multi-site trials with other organisations

In several instances, CSIRO operated one or more sites in trials which involved other organisations such as QDPI (Queensland Department of Primary Industries, now Queensland Department of Primary Industries and Fisheries). In these situations, only data from sites run by CSIRO have been included in the listings. However, a column in Table 1 shows instances where the published paper refers to sites other than those referred to in this memorandum.

Pasture quality data

Table 7 lists some papers which present data on pasture quality. The first 2 columns indicate whether the samples were cut, usually to 5-10 cm above ground level, or were plucked to simulate what animals might eat. The next 4 columns indicate whether samples were collected from tropical grasses, tropical legumes, temperate grasses or temperate legumes. The next 12 columns (N, P etc.) indicate which elements were measured. The next column indicates if in vitro digestibility was measured and the following column indicates if there were some separate measurements of leaf and stem. The final column shows if any measurements were made of soil properties such as total N beneath swards of different species.

Results and Discussion

Ratings

The ratings of 1-3 should be viewed with caution. For example, poor establishment relative to other accessions might have resulted in lower yields for an otherwise promising accession, and hence a lower rating. However, taken overall, ratings provide some indication of broad-scale adaptation and potential. For example, pangola grass (*Digitaria decumbens*) rated 3 at a very wide range of sites, whereas accessions of *Alysicarpus* spp. usually rated 1. In general, there were more ratings of 1 in the series of trials carried out in the 500 mm rainfall areas of south-western Queensland by Strickland et al. (2000) than in most of the trials in wetter areas. This largely reflects the more difficult conditions for establishment and persistence in the drier areas.

These ratings are solely for persistence and productivity and take no account of palatability or weed potential. Species with significant weed potential, where sowing is not recommended, are mentioned later in the text.

The main objective of this memorandum is to record where individual accessions have been tested and to give some indication of their performance. While this is done in Table 3 (temperate legumes), Table 4 (temperate grasses), Table 5 (tropical legumes) and Table 6 (tropical grasses), some general comments can be made about the different groups of accessions.

Temperate legumes

Annual medics (*Medicago* spp.) have been consistently rated highly on heavier soils in subcoastal areas. In the late 1990s, Jemalong barrel medic (*M. truncatula*) was noted on 2 sites sown 30 years previously. This could reflect the fact that it is easier to see than other medics because of the characteristic black marks on the leaves. White clover (*Trifolium repens*) was rated only 2 in most trials on the higher rainfall (>1000 mm) coastal sites, which could reflect the fact that its contribution to pastures can vary markedly between years owing to the interaction between spring rainfall, survival of stolons and seedling recruitment (Jones 1982). While Kenya clover (*Trifolium semipilosum*) was rated 3 at several sites and persisted for over 30 years in some sowings, it has not been consistent in its performance in farm sowings (Cook et al. 1985). None of the species tested appears to have significant weed potential – overlooking the ability of white clover to grow in otherwise monospecific grass lawns.

Temperate grasses

The ratings given here refer only to dryland situations and have no relationship to the customary

use of temperate grasses under irrigation for dairy cows, usually in short-term pastures heavily fertilised with N. No accession was given a rating of 3 at any site and there is certainly no species with weed potential.

Tropical legumes

In broad terms, *Arachis* spp. rated well in coastal areas receiving more than 1000 mm rainfall and have shown extremely good persistence in sowings made in the 1960s and 1970s, persisting for 20-30 years or more. In subcoastal areas, *Desmanthus virgatus*, and sometimes *Stylosanthes seabrana,* often rated 3 on heavy-textured soils as did *Stylosanthes scabra* on lighter-textured soils.

The species, which consistently rated 3 for persistence and productivity on subcoastal clay soil sites, was *Indigofera schimperi*, but it was often inadequately eaten, and consequently has been or is being eliminated from all trial sites. *Aeschynomene brasiliana* was also eliminated from trial sites. Glycine (*Neonotonia wightii*) has not been a successful pasture legume in south-east Queensland but can become a serious weed in disturbed or regenerating bushland (Jones and Hacker 2003). Other species of twining or scrambling legumes can also have weed potential.

Tropical grasses

Paspalum notatum and especially *Eragrostis curvula* were poorly accepted by animals, although *P. notatum* is a very persistent species in coastal areas. As this species has been recorded for many years in south-east Queensland and occurs widely, even if often in small areas, no attempt was made to remove it from trial sites. *Eragrostis curvula* was successfully removed from 3 sites where it was persisting because of its weed potential, despite the fact that it is naturalised over many parts of subcoastal south-east Queensland.

Grasses in small plot trials were often fertilised with nitrogen. This would have improved the persistence of species such as green panic (*Panicum maximum* var. *trichoglume* cv. Petrie), which persists better at higher fertility levels (Jones et al. 1995). However, persistence might have been poorer after experimental fertilisation had ceased. Conversely, persistence of grasses in heavily frosted sites can be reduced by nitrogen fertilisation, as noted for pangola (formerly *Digitaria decumbens*, now *D. eriantha*) (author's unpublished data) and setaria (*Setaria sphacelata*) (Roe and Williams 1993).

Setaria, originating from more humid environments in Africa, rated more highly in coastal areas, as did makarikari panic (*Panicum coloratum* var. *makarikariense*) on heavy soils in drier areas. Buffel grass (*Cenchrus ciliaris*) rated more highly in drier areas than on higher-rainfall coastal areas. Pangola grass rated highly across a wide range of environments.

Other publications on earlier stages of evaluation

CSIRO has carried out many early stage characterisation/evaluation studies, where species were sown in rows and not regularly grazed or cut. The results from these trials are not reported here. Results from early stage evaluation on site 22, on a duplex soil at Narayen Research Station, which was one site in a multi-site COPE (co-ordinated plant evaluation) project, have been reported elsewhere (Pengelly and Staples 1996). In this study, a large number of accessions were sown in rows and grazed only at the end of the growing season.

A number of publications in the former CSIRO "Genetic Resource Series" report the results from growing, describing and grouping a large number of accessions from one or more species. These studies concentrated on classification, and agronomic considerations were secondary. Issues in this series that report on CSIRO studies on forage genera or species are: *Clitoria ternatea* (Reid and Sinclair 1980), *Centrosema virginianum* (Clements 1983), *Rhynchosia* spp. (Harding et al. 1989), *Cenchrus ciliaris* (Eagles et al.1992), *Macroptilium* spp. (Pengelly and Eagles 1993), *Paspalum* spp. (Hacker et al. 1996; 1999), *Vigna* spp. (Hacker et al. 1996), *Teramnus* spp. (Eagles and Pengelly 1996), *Bothriochloa pertusa* and *B. insculpta* (Pengelly et al. 1997) and *Urochloa* spp. (Pengelly and Eagles 1998). Similar studies on *Desmodium intortum* have been reported by Imrie (1973) and on a range of *Stylosanthes* spp. by Edye et al. (1974).

Evaluation of native species

There has been no evaluation of native grasses, although blue grass (*Dichanthium sericeum*) was used as a companion grass in 3 experiments. There has been some limited evaluation

of native legumes, primarily *Glycine*, *Psoralea* (now *Cullen*) and *Neptunia* spp. The most promising result was obtained with *Glycine latifolia* CQ 3368 that at one time was registered under PBR as cv. Capella. However, it was decided not to proceed with commercial release, owing partly to problems with seed production and partly to inconsistent results (see Jones and Rees 1997; Jones 1998; Clem et al. 2001). Previous research projects with Australian native legumes failed to identify a legume to be released as a commercial cultivar.

Success rate

While several successful cultivars have been released from these and related studies by other organisations, the success rate is low – Smith (1996) listed 42 cultivars with a probable seed production of 1 t/ha or more, whereas even this memorandum records that over 1200 accessions were evaluated. Furthermore, often the first cultivar of a species has remained the most important, or even the only cultivar, despite testing of a wider range of accessions. Examples of successful early cultivars, with their dates of release, would include the legumes Oxley finestem stylo (1965), Verano stylo (1971), Seca stylo (1977) and Glen joint vetch (1973) and the grasses, Gayndah, American and Biloela buffel grasses, Petrie green panic (all pre-1960), Callide rhodes grass (1963) and Narok setaria (1969). Many of the early evaluation trials outlined in this memorandum were involved in the release and/or wider testing of these accessions before their wide-scale commercial use. Despite further widespread testing within these genera, with some additional cultivars being released, these early releases are usually the most widely used. However, there have been a few successful 'second generation' releases; for example, Bisset creeping bluegrass (1989) is now sown more widely than Hatch (1978).

Further successful releases of the promising cultivars from 'new' species, such as Milgarra butterfly pea, Amarillo pinto peanut and Floren bluegrass have been made in the last 2 decades. It remains to be seen whether further testing will result in new cultivars, which will take the place of these initial releases. Some other promising lines, such as *Vigna parkeri* CPI 100846, are still under scrutiny.

In hindsight, it could perhaps be argued that the input into the search for 'second generation' cultivars has not been justified by the results to date, with relatively few successes. However, this could not be foreseen at the time. Furthermore, some of the newer lines could well find broad acceptance over time. Widespread testing, such as summarised here, has also assisted in the selection of first generation cultivars, their adoption by farmers, and in better understanding of where they are adapted. It has also given better understanding of the extent and importance of variability within all the species that have been evaluated. Access to this information will be invaluable in planning any future searches for additional or replacement species/cultivars.

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(Received for publication June 23, 2006; accepted February 14, 2007)