Opportunities for the development of new tropical forage cultivars

B.C. PENGELLY[1] AND I.B. STAPLES[2]
[1]*ATFGRC, CSIRO Tropical Agriculture, St Lucia, Queensland, Australia*
[2]*Queensland Department of Primary Industries, Mareeba, Queensland, Australia*

Abstract

Over 100 cultivars of grasses and legumes have been released for use in the grazing industries of northern Australia over the past 36 years. However, many opportunities for new pasture plants remain in the Beef, Dairy and Cropping Industries as well as in land rehabilitation. Opportunities also exist for developing cultivars for farming systems of other tropical countries. Given these opportunities, priorities for research need to be developed in partnership with user communities, research providers and funding bodies.

Introduction

A total of 113 cultivars have been released by Australian state and territory Herbage Plant Liaison Committees in northern Australia since 1961 (Hacker 1997). Forty of these are commercially available today. These cultivars fill a variety of roles in the northern Australian pastoral industries with large differences between cultivars in the amount of seed produced and sown annually. Up to 500 tonnes of seed of buffel grass (*Cenchrus ciliaris*) cultivars (mainly Gayndah, American and Biloela) are produced each year and sown in the southern and central dry tropics and subtropics, whereas about 200 tonnes of shrubby stylo (*Stylosanthes scabra* cvv. Seca and Siran) are produced each year for sowing on light-textured soils of the tropics and subtropics. In contrast, as little as 0.5 tonnes of seed of *Vigna parkeri* cv. Shaw and *Lotononis bainesii* cv. Miles are produced and sown each year. Nevertheless, these low-volume cultivars are extremely valuable in the limited areas to which they are well adapted.

Correspondence: Dr B.C. Pengelly, ATFGRC, CSIRO Tropical Agriculture, 306 Carmody Rd, St Lucia, Qld 4067, Australia. e-mail: bruce.pengelly@tag. csiro.au

The impetus for future cultivar development will come from 2 directions: (i) through pastoral industries setting priorities for research and development in response to perceived needs of the industries; and (ii) from pasture scientists advocating biological possibilities for future plant improvement. New cultivars can be developed by the evaluation and domestication of "new" species, or the development of improved cultivars of species which are already being utilised commercially.

This paper summarises the authors' perceptions of the needs of the pastoral industries and opportunities for the development of new cultivars in northern Australia.

Grasses

Beef Industry

Higher stocking rates in use in northern Australia over the last decade have frequently resulted in a decline in the frequency of many of the more palatable native perennial grass species such as black speargrass (*Heteropogon contortus*). This has led to the pastures becoming legume-dominant or, more often, to an increase in annual grasses, less productive perennial grass species (*e.g. Aristida* spp.) or the stoloniferous Indian couch (*Bothriochloa pertusa*). If the use of higher stocking rates continues, there will be a need for high quality, persistent, perennial grass cultivars to be developed. The genera most likely to be useful are *Urochloa, Bothriochloa, Dichanthium* and *Digitaria*. All of these include species which are persistent under heavy grazing and are adapted to the light-textured soils of low fertility common in northern Australia.

Urochloa mosambicensis is already an important grass in some semi-arid tropical regions, and accessions which are more stoloniferous and productive than cv. Nixon and the naturalised ecotypes, have been identified (Burt *et al.* 1980; Harwood *et. al.* 1996). Based on present knowledge, these elite accessions should be fully assessed before further acquisition and evaluation of germplasm collections.

The genus *Bothriochloa*, and its close relative *Dichanthium*, have already provided several cultivars for northern Australia, including 2 cultivars of *B. insculpta,* 1 of *B. bladhii* and a number of cultivars or ecotypes of *B. pertusa.* Regional evaluation studies have shown that *B. pertusa, B. insculpta* and *B. bladhii* are all species with broad adaptation in the tropics and subtropics and warrant further evaluation (C.H. Middleton, personal communication). Although there is currently a large and diverse collection of *B. pertusa* available in Australia for evaluation (B.C. Pengelly and I.B. Staples, unpublished data), there are only 12 accessions in the present Australian collection of *B. insculpta* and further collection activity for this species is warranted .

At present, 2 seeding cultivars of *Digitaria milanjiana* have been released (cvv. Jarra and Strickland) but only the former is as yet commercially available. Regional evaluation studies and provenance information have consistently shown that *D. eriantha* and *D. milanjiana* are well adapted to light-textured soils of the semi-arid tropics, are persistent under heavy grazing, and are palatable to livestock. Large collections of these species are already available for regional evaluation studies. New collections of *D. eriantha* have been made recently from soils with low phosphorus in high latitude (*c.* 30°S) and low rainfall (<500 mm) regions of South Africa and these may provide new cultivars for light-textured infertile soils of southern inland Queensland and northern New South Wales.

While *Paspalum dilatatum* is well known to beef and dairy producers of coastal Queensland and New South Wales, preliminary characterisation of the genus has shown that some other *Paspalum* spp. are likely to provide cultivars for specialist uses. The Florida cultivar *P. atratum* cv. Suerte will soon be released in Australia to provide an additional option for quality forage production in coastal and subcoastal regions. Cultivars are also likely to arise from the more palatable forms of *P. notatum* to replace the existing Pensacola, which has low palatability, and the ergot-susceptible cv. Competidor. *P. nicorae*, a strongly stoloniferous species, may also be important on light-textured soils in the coastal and subcoastal regions of the subtropics. Both *P. nicorae* and *P. notatum* include palatable and unpalatable forms and care will need to be taken to commercialise very palatable accessions only and avoid releasing unpalatable forms which could become weeds.

Panicum (*Panicum maximum*) and rhodes grass (*Chloris gayana*) cultivars have been used widely in the Beef Industry of subtropical Australia. However, the large number of cultivars already commercially available and their narrow range of adaptation suggest that development of new cultivars is a low priority. Both species are considered to be adapted to soils of higher fertility and their long-term persistence under heavy grazing is frequently poor.

Possibilities for providing new cultivars from native species are limited. One grass which does have potential is Queensland bluegrass (*Dichanthium sericeum*). This grass is found naturally on heavy-textured soils in semi-arid Queensland. It is a species which is easily established on such soils and wild-harvested seed of various ecotypes is marketed already. It is also less competitive than alternative exotic cultivars such as *Setaria incrassata* cv. Inverell, so may combine better with sown legumes. However, given the large natural variation in various attributes which has evolved within the species (W.S. Scattini, personal communication), the development of a widely adapted cultivar may prove elusive.

Dairy Industry

The Dairy Industry in northern Australia is located in humid and subhumid environments and frequently on higher fertility soils. Grasses for use in the Dairy Industry must be persistent and productive under the intensive grazing management systems usually imposed by farmers. One of the most important grasses available to the subtropical Dairy Industry is kikuyu (*Pennisetum clandestinum*). The most commonly used cultivar, cv. Whittet, is affected by kikuyu yellows virus disease in some regions and the only resistant cultivar, cv. Noonan, is not considered to be a viable agronomic alternative. This disease is a serious threat to the Dairy Industry and a program to develop a productive, disease-resistant

cultivar is seen as a high priority (Fulkerson 1997). Such a program would require the acquisition of new germplasm and possibly a plant breeding program (Reid 1997).

Other important Dairy Industry grasses include 5 cultivars of setaria (*Setaria sphacelata*), 4 of panicum and 3 of rhodes grass. These grasses are widely used in southern coastal dairying regions of Queensland. Providing no serious disease or pest problems arise, further cultivar development in these genera is seen as a low priority.

As well as being potentially important grasses for the north Australian Beef Industry, *Digitaria* and *Paspalum* need to be examined more closely for dairy pasture opportunities. *P. atratum, P. notatum, P. nicorae* and related species, all have the potential to provide cultivars for the coastal and subcoastal subtropical regions where the northern Australian Dairy Industry is concentrated. The increased use of *D. milanjiana* cv. Jarra in mesic regions of Queensland and results from early evaluation of stoloniferous *D. eriantha* germplasm (B.C. Pengelly, unpublished data) suggest that palatable, persistent, higher quality cultivars might be derived through selection within these species.

Mine site rehabilitation

Grasses to be used in mine site rehabilitation often must be adapted to extreme soil characteristics. There are indications that forms of *U. mosambicensis* may play an important role in rehabilitating central Queensland mine spoils which are typically of a clayey nature with high pH, high salinity and low contents of phosphorus and nitrogen (Coaldrake and Russell 1978). In general, however, we know very little of the potential of grasses held in the ATFGRC for mine site rehabilitation and other land stabilisation uses. If this topic is to be addressed more fully in the future, it will be necessary to study the current grass collections to determine their adaptation to these environmental extremes.

Horticulture

The use of tropical forage germplasm as amenity grasses or as ground cover remains a largely untapped resource. Grasses such as Japanese millet (*Echinochloa utilis*) are used frequently as nurse crops in the development of sports grounds and parks. An accession of the annual species *E. frumentacea* (cv. Indus) was released in 1993 for use as a quick ground cover and for land stabilisation. However, plant collectors have not targetted species with potential as fast growing plants for these purposes, so the present collections probably have limited potential in these roles.

However, some perennial grasses held in the collection may provide plants for lawns and sports fields. Grazing-tolerant stoloniferous species such as *Bothriochloa pertusa, Digitaria swazilandensis* and *Dactyloctenium* spp. clearly have potential in these roles. However, as these species have been identified as a by-product of plant evaluation aimed at producing forage cultivars, the full potential of the genetic resource collection in these roles will not be realised until evaluation studies designed to identify amenity grasses as such are carried out. Further plant-collecting activities will certainly be necessary if developing grasses for amenity use becomes a priority.

Overseas uses

There are increasing requirements for grasses for use in cut-and-carry systems in Asia and in Africa as populations increase their consumption of meat and milk. In addition to being adapted to the climate and soils of a region, grasses for cut-and-carry systems need to be highly productive, have an erect habit conducive to hand harvesting and be tolerant of frequent cutting. *Paspalum atratum* and *Panicum maximum* are likely to be important in the humid environments. Although extensive collections of *Panicum maximum* already exist both in Australia and in genetic resource centres overseas, *Paspalum atratum* is poorly represented and, with allied species such as *P. guenoarum* and *P. regnellii,* offers exciting possibilities. Other grass genera which could be further developed in these situations are *Brachiaria, Andropogon* and *Urochloa.*

Communal grazing is common in many regions of the tropics and is frequently practised on less fertile soils. Grass cultivars developed for use in such areas will need to be tolerant of heavy grazing and of frequent burning. While few grass species palatable to livestock can be expected to persist under such a regime, some of the stoloniferous grasses adapted to northern Australia

(such as *Bothriochloa* spp., *Digitaria* spp. and *Urochloa* spp.) may be worth evaluating. In some countries, communities are beginning to realise the benefits of imposing control of grazing on communal land and this opens up further opportunities for selecting appropriate grasses for grazing.

Legumes

Beef Industry

In large areas of northern Australian, soils are light-textured and low in phosphorus, and rainfall is highly seasonal and also very variable. Sown pasture species need to be adapted to these conditions. Undoubtedly, the most important legume genus in the northern Australian Beef Industry is *Stylosanthes.* However, a number of species and cultivars within species of this genus are susceptible to the disease anthracnose, caused by the fungus *Colletotrichum gloeosporioides.* The fungus exists in a number of races, with different specificities and pathogenicities.

The three cultivars *S. scabra* cv. Seca and *S. hamata* cvv. Verano and Amiga make up >90% of the commercial seed production of *Stylosanthes.* All are largely resistant to anthracnose. The most important priority is to protect this investment in these species by maintaining vigilance against new severe races of anthracnose.

There are also opportunities to commercialise other stylo species. Yield and seedling regeneration data suggest that *S. mexicana* might play a useful role in the southern speargrass region. *S. fruticosa,* a shrubby species similar in habit to *S. scabra,* has been collected from near Pretoria, South Africa, where minimum temperatures are frequently lower than 5°C. This species has the potential to provide a cold-tolerant shrubby stylo for use in southern inland Queensland. However, the 6 accessions of *S. mexicana* and 10 of *S. fruticosa* tested have been affected severely by anthracnose, and overcoming this susceptibility will be necessary if cultivars of these species are to be developed.

S. macrocephala, a perennial Brazilian species, also offers opportunities to the semi-arid regions of the northern Beef Industry. Evaluation studies in north and central Queensland have shown that the species is drought-tolerant, productive, persistent, and resistant to anthracnose. While further development of this species is limited by the availability of suitable root-nodule bacteria (RNB), it should be considered for further study. Recent successes in developing RNB for caatinga stylo ("Stylosanthes seabrana") (Date 1997) indicate that this is not necessarily an insuperable obstacle.

In 1991, 3 cultivars of *Desmanthus virgatus* were released for use on heavy-textured soils in southern Queensland and seed of these cultivars is now available as a mixture, cv. Jaribu. It is too early to assess the contribution of these cultivars to the Beef Industry, but their performance to date, together with reports of the tolerance of this species to heavy grazing at the sites of collection, indicates that the genus *Desmanthus* has much to offer. A taxonomic revision of the genus has been published recently by Luckow (1993), who has subdivided *D. virgatus* into a number of different species. Further collections of the genus have been made recently from Paraguay (Hacker *et al.* 1996) and Argentina (B.C. Pengelly and B.G. Cook, unpublished data), from regions which experience frequent frosts. Passport data from these collections also indicate that the use of *D. virgatus sensu lato* might not be limited to heavy-textured soils and that the species could provide cultivars for use on light-textured soils of the southern speargrass region. This extension of the edaphic range of *Desmanthus* also opens up the possibility of finding commercially viable alternatives to *Stylosanthes* spp. in northern Australia.

The genus *Zornia* is well adapted to light-textured soils throughout the tropics, although the percentage biomass it contributes in grass pastures is frequently low. However, a study currently being conducted by the ATFGRC has shown that some species have attributes which may make them useful as forages. Evaluation of elite accessions is warranted.

Dairy Industry

Legumes used in the Dairy Industry need to be compatible with the highly productive grasses used in the industry and tolerant of high grazing pressures. In recent years, a number of cultivars have been released for use in the industry. These included *Arachis pintoi* cv. Amarillo, *Vigna parkeri* cv. Shaw and *Aeschynomene villosa* cvv. Kretschmer and Reid. Since the release of *A. pintoi* cv. Amarillo, further germplasm of *A. pintoi* has become available and it is likely that an

improved cultivar of this species will be forthcoming. The opportunities for new cultivars of *Aeschynomene* spp. will depend upon the success of cvv. Kretschmer and Reid, but there may be a place for an early-flowering *Ae. americana* accession in south-eastern Queensland. Opportunities might also lie in examination of further germplasm of *V. parkeri* and its close relatives *V. gracilis* and *V. hosei*. Presently available collections of these species are very restricted. Cultivars are also likely to come from the genus *Teramnus*, especially *T. labialis*. This species has many of the attributes of *V. parkeri* cv. Shaw and, as such, has some potential in heavily grazed, mesic environments used by the Dairy Industry. Similarly, *V. oblongifolia* and related species have performed well in initial evaluation trials and may have a role in these regions.

Cropping industries

With the run-down in fertility of heavy-textured cropping soils in central and southern Queensland, the Grains Industry has expressed the need for perennial ley legumes adapted to these environments. Legumes currently commercially available include *Lablab purpureus* and *Vigna unguiculata* (both annuals) and the perennial *Clitoria ternatea*. Studies in *L. purpureus* suggest that the production of a high yielding perennial form might be possible but diversity within the current collection is limited (Liu 1996) and further collections are required urgently. *Macroptilium bracteatum* and *V. oblongifolia* accessions have persisted for 3 years in below-average rainfall on these soils and may provide cultivars to fill the role of a short-term ley legume. While the current collection of *c.* 80 accessions of *M. bracteatum* includes a large degree of diversity (B.C. Pengelly, unpublished data), the collection of *V. oblongifolia* contains only 35 accessions and could not be considered adequate.

Horticulture

The horticultural industries have recognised the need for low-cost control of weeds and of erosion in plantation crops in recent years and see a need for low-growing, non-twining legumes which can tolerate some shading. *Arachis pintoi* cv. Amarillo is currently filling that role in some regions but further studies are underway to identify other legumes, including other *Arachis* spp. which might have a role to play.

Overseas

The potential for developing tropical legume cultivars for use overseas can be divided into 3 main farming systems — cut-and-carry systems; communal grazing; and for erosion control and fertility restoration in cropping systems. The best known tropical cut-and-carry legume is *Leucaena leucocephala* but its use is usually restricted to better drained soils with pH >5.5. Other tree and shrub legumes such as *Calliandra calothyrsus, Gliricidia sepium* and *Desmodium salicifolium* have been evaluated on the more frequent acid, light-textured soils of the tropics, with mixed success. However, these legumes are invariably of lower quality than leucaena. Opportunities in cut-and-carry legume research and development include the acquisition and evaluation of germplasm of species adapted to acid soils to identify those accessions tolerant of defoliation and which have higher forage quality. One genus which possibly has potential (R.J. Jones, personal communication), and which the ATFGRC regards as a high priority for collection, is the American genus *Zapoteca*.

In communal grazing areas, legumes adapted to heavy grazing are required, and in many cases, the types of plants successful in Australia may be of use. In acid soils in tropical mesic environments, species such as *Desmodium heterophyllum*, *Arachis* spp. and *Stylosanthes guianensis* are likely to provide useful cultivars. In arid and semi-arid regions of the tropics and subtropics, *Stylosanthes scabra*, *S. hamata*, *S. hippocampoides*, *Chamaecrista rotundifolia* and *Desmanthus* spp. are likely to be useful. The most productive genotypes may differ from those released in Australia, particularly where the target environment differs in daylength from regions in Australia where Australian cultivars are grown.

In many regions of the tropics, cropping is carried out on land which is susceptible to erosion and deficient in nitrogen. In these situations, the use of ley pastures or ground cover is desirable, as a means of reducing erosion and improving soil nitrogen status. Pastures and ground covers would need to be robust, easily established, drought-tolerant and easily controlled within the cropping system. In some cases, it might even be possible to use a dual-purpose legume — one which

provided a ground cover and produced grain yield. The genus *Arachis* offers a great deal of scope in these farming systems. Other species which have potential are: *Centrosema pascuorum, Macroptilium atropurpureum, M. gracile* and *M. bracteatum.*

Setting priorities

There remain many opportunities for new grass and legume cultivars for use in northern Australia and elsewhere in the tropical world. In the past 10 years, a program of evaluating a wide range of grass and legume germplasm has led to the identification of many promising species. Clearly, the ATFGRC and forage evaluators with whom it interacts cannot address all these opportunities simultaneously and it is up to the user groups such as the grazier and farming communities to identify priorities.

We believe that the maximum impact on the Australian industry is likely to come from:

- improving and maintaining the N status of clay soils receiving over 700 mm annual rainfall;
- providing permanent vegetative cover on degraded areas where native grasses have disappeared;
- providing legumes for the *Bothriochloa/ Aristida* grasslands; and
- providing alternative species to complement stylos and leucaena.

However, the actual priorities for new research will be determined by funding and that is likely to be related to both production and sustainability issues. Current production issues are directed towards meeting the Jap ox specifications and providing suitable store cattle for the feedlot trade or for live export. Sustainability issues such as biodiversity, soil erosion and the potential of exotic species to become weeds are beginning to attract greater attention by the funding bodies. Such priorities and their resolution into R&D components will be developed best in partnership between the user communities, research providers and funding bodies.

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