Tropical pasture plants as weeds

T. LOW
Chapel Hill, Brisbane, Queensland, Australia

Abstract

Introduced pasture plants are a serious threat to Australia's ecosystems. Five of Australia's worst environmental weeds are tropical pasture grasses and 2 are shrubs introduced for shade and fodder. The paper documents cases where exotic tropical grasses and legumes introduced for sowing pastures have invaded national parks and natural ecosystems. The effects of vigorous exotic grasses in altering the fire regime, thus adversely affecting biodiversity, are discussed. Exotic grasses used in ponded pastures eliminate habitat for native fish. Woody legumes and twining legumes also pose a grave threat.

Sown pastures frequently decline or fail because of run-down, marginal land, pest attack, or overgrazing. In these situations, new exotic pasture plants are wrongly promoted as the solution. Lower grazing pressures are likely to be more sustainable in the longer term.

Because of the deleterious effects of exotic grasses, and twining and woody legumes, there is no justification for further introduction. Research should be directed towards developing native legumes and grasses, as a resource for the grazing industries.

Introduction

Until recently, the weed problems created by pasture plants had received little attention. In 1991, a major Federal Government report (Humphries *et al.* 1991) warned that weeds pose dire threats to native habitats and concluded: "Some serious and very serious environmental weeds are intentionally planted; among the country's most easily dispersed and damaging species are several grasses presently being promoted and planted for pasture." The authors presented a list of Australia's 18 worst environmental weeds, of which 5 are tropical pasture grasses, and 2 are woody legumes, planted in the past as shade and fodder trees (Table 1).

Table 1. Tropical pasture grasses, and shade and fodder trees, listed by Humphries *et al.* (1991) as among Australia's worst weeds.

Pasture grasses
Buffel grass (*Cenchrus ciliaris*)
Aleman grass (*Echinochloa polystachya*)
Hymenachne (*Hymenachne amplexicaulis*)
Mission grass (*Pennisetum polystachion*)
Para grass (*Brachiaria mutica*)
Shade and fodder trees
Prickly acacia (*Acacia nilotica*)
Mesquite (*Prosopis* spp.)

More recently, Lonsdale (1994) found that 463 exotic grasses and legumes were introduced to northern Australia as potential pasture plants between 1947 and 1985, and that 60 of these had become weeds. Most significantly, only 21 of the introductions proved useful, and all but 4 of these were also agricultural or environmental weeds.

In fact, Lonsdale's methodology underestimated the number of weeds. Of the 4 pasture plants he excluded as weeds, 3 are widely naturalised in Queensland (Queensland Herbarium 1993), and 1 of these — *Setaria sphacelata* — is a serious weed of wallum heathlands and coastal wetlands (Paul Grimshaw, Queensland Herbarium, personal communication). There is thus only 1 successful pasture introduction from 1947–1985 that is not yet a weed — the recently released *Centrosema pascuorum*.

These reports have raised public concerns about pasture plants, although problems have

Correspondence: Mr T. Low, 6 Henry Street, Chapel Hill, Qld 4069, Australia

been evident for some time. Kleinschmidt and Johnson (1977), in "Weeds of Queensland", featured more than 25 introduced pasture species as weeds of farms, gardens or roadsides, including siratro (*Macroptilium atropurpureum*), phasey bean (*M. lathyroides*), burr medic (*Medicago polymorpha*) and kikuyu grass (*Pennisetum clandestinum*). They stated that buffel grass (*Cenchrus ciliaris*) is naturalised over the major part of central inland Queensland and is also encountered as a weed of cultivation.

Documenting the problem

Pasture plants cause enormous problems as weeds, but the scale of the threat is difficult to document, for several reasons. Most pasture plants are relatively recent introductions, and a species may take a long time to reveal itself as a problem. Athel pine (*Tamarix aphylla*), introduced to inland Australia as an ornamental tree early this century, was not highly invasive until the wet year of 1974 (Humphries *et al.* 1991). Giant sensitive plant (*Mimosa pigra*), introduced in the nineteenth century, was not a major weed until the 1960s. Buffel grass was introduced last century and is still spreading (Walker and Weston 1990; Humphries *et al.* 1991).

It may take as long as a hundred years after introduction before weed status can be assessed accurately. This allows time for possible genetic selection in the new environment, geographic spread, and time for pests to target the weed, which may lead to reduced numbers, as happened dramatically with Townsville stylo (*Stylosanthes humilis*) (Walker and Weston 1990).

Even when a weed has proliferated, its impact can be difficult to measure. There is no list of national parks invaded by buffel grass, and no way to put a price tag on the environmental degradation, which may include extinction of rare herbs (see Humphries *et al.* 1991).

The impact of pasture plants when they occur as weeds in crop farming is also impossible to measure. For example, sugar cane farms are often invaded by para grass (*Brachiaria mutica*), green panic (*Panicum maximum*), centro (*Centrosema pubescens*), setaria, siratro and rhodes grass (*Chloris gayana*) (BSES 1989), but there is no way to measure their total cost to farmers.

Nor is it possible to measure the cost incurred by local councils in controlling weed grasses. For example, 42 km of Hervey Bay foreshore has been invaded by green panic, and more than half of this length is heavily infested, but the Hervey Bay Parks Manager, Ms Joanne Lambden (personal communication), has no estimate of the cost of control, nor of the loss of scenic amenity.

Ecology of invasions

Both legumes and grasses are introduced for the purpose of improving pastures. Unfortunately, both of these plant groups are among the most invasive of all plant families.

Legumes

Cronk and Fuller (1995) note that, of all environmental weeds: "The Leguminosae appear to have the highest number of invasive species ... Many of the leguminous invasive species are rapidly-growing shrubs or trees, with copious production of seeds which often have a high ability to remain dormant and which are effectively dispersed by birds or water."

Legumes contribute to other weed problems by increasing soil nitrogen, which encourages invasion by nitrophilous weeds such as annual grasses. This process led to a rapid decline of stylo pastures in the Northern Territory in the 1960s (Torssell 1973, cited in Mott 1986), and it is likely to be a problem wherever large numbers of legumes, especially woody legumes, invade natural habitats.

The legumes released into Australia include shrubs, vines and herbs. The shrubs and vines are of particular concern. Humphries *et al.* (1991) warn that introduced shrubs in northern Australia are "causing broadscale destruction or gross modification to hundreds of square kilometres of native grassland, woodland and wetland." Most of the shrubs they mention are legumes, including *Mimosa pigra, Acacia nilotica, Prosopis* spp. etc. None of these species has reached anywhere near its maximum range.

Leucaena (*Leucaena leucocephala*) is the only fodder shrub that has been promoted widely in northern Australia, and it is spreading rapidly. Shelton *et al.* (1991) state that leucaena can form thickets along creeks and can dominate natural ecosystems if no ruminant grazers are present. It infests 1000 ha of disturbed ground in the Northern Territory, and extends along 100 km of

waterways around Rockhampton. It is a declared weed in Darwin and Rockhampton (Shelton *et al.* 1991). It is also a weed in Kenya, Tanzania, Florida, West Indies, Brazil, Hawaii, Vanuatu and Japan (Cronk and Fuller 1995).

Introduced vines are a major threat to rainforest remnants in Queensland and New South Wales, which they destroy by smothering. The most invasive vines in Australia are escaped garden plants, not pasture legumes, but some legumes appear to be spreading rapidly, and may become major weeds soon. Glycine (*Neonotonia wightii*), calopo (*Calopogonium mucunoides*), centro, axillaris (*Macrotyloma axillare*) and siratro are all behaving as weeds

The weediness of herbaceous legumes is difficult to assess, as the most invasive species, Townsville stylo (*Stylosanthes humilis*), suffered a dramatic decline from anthracnose infection (Walker and Weston 1990). Other herbaceous legumes have been less invasive in the relatively short time since their introduction, although phasey bean has become a widespread weed of disturbed land (Kleinschmidt and Johnson 1977).

One species of concern is round-leafed cassia (*Chamaecrista rotundifolia*), which has all the characteristics necessary to become a naturalised species (Partridge and Wright 1992). It was released only in 1984, yet as early as 1990, could be found along roadsides and was showing signs of naturalisation (Hacker 1990).

Grasses

Two of the most outstanding problems associated with introduced pasture grasses are: (a) when they burn, the intense fires produced by the large fuel mass cause habitat changes; and (b) semi-aquatic species cause changes in wetland structure.

Tropical pasture grasses burn hotter and often later in the season than native grasses, destroying nearby native plants and animals, and altering forest structure. They regenerate quickly, replacing the native plants they have killed. In this way, they can become dominant over large areas. Grasses that behave like this include: mission grass (*Pennisetum polystachion*), buffel grass, gamba grass (*Andropogon gayanus*), green panic and guinea grass (*Panicum maximum*), feather-top rhodes grass (*Chloris virgata*), *Pennisetum pedicillatum*, para grass and probably molasses grass (*Melinis minutiflora*).

Buffel grass is perhaps the most destructive. It has spread widely through inland Australia, forming dense monocultures that displace native plants, including in national parks such as Uluru. It is a grave threat because it does best in the moist fertile places where biodiversity is concentrated. It causes more extensive fires than native grasses, thereby reducing habitat variability for fauna. It triggers more frequent fires, destroying seedlings and seed stores (Humphries *et al.* 1991). It seeds prolifically but the seed is not available to seed-eating birds, and the numbers of finches and parrots decline (Bruce Thompson, Department of Environment, personal communication). In Western Australia, buffel grass is replacing spinifex (*Triodia* spp.). Aborigines in the Rudall River area regard it as a major threat to their food plants (Keighery 1991).

In Queensland, buffel grass is naturalised over 200 000 ha of inland Queensland, and it is still spreading (Walker and Weston 1990). It is a particular threat to dry rainforest remnants, as it grows along the edges and within the remnants, carrying successive hot fires that progressively destroy the rainforest (Fensham 1996). It is encroaching upon Carnarvon National Park, Palm Grove National Park, Expedition Range National Park, and several other parks (J. Edair, personal communication).

In Epping Forest National Park in central Queensland, the area of buffel grass has increased from 13% in 1987 to 54% in 1994. This park is the last refuge for the Northern Hairy-nosed Wombat (*Lasiorhinus krefftii*), probably Australia's rarest animal, with a total population of about 65. Many wombat burrows are now engulfed by buffel grass. National Parks rangers have been very concerned by the buffel invasion, but the grass is eaten by the wombats and now comprises 40–50% of their diet (Alan Horshup, Department of Environment, personal communication).

Mission grass, rated as one of the world's worst weeds (Holm *et al.* 1977), was introduced in the 1970s, but proved useless. It burns with flames up to 5 m tall, and is largely blamed for a 60% decline in monsoon rainforests around Darwin (Panton 1993). Mission grass also invades woodlands, and in Kakadu, it is considered by Braithwaite (cited in Humphries *et al.* 1991) to pose as serious a weed threat as *Mimosa pigra*. There is concern that gross alteration to the fire regime will have a severe impact on the fauna and flora of the wet-dry tropical open forest and

woodlands. It has been declared a noxious weed in the Northern Territory.

Grasses that grow or trail in water are another source of concern. Hymenachne (*Hymenachne amplexicaulis*), a recently released ponded pasture grass, is spreading rapidly in catchments just south of Cairns. There are fears that it could become a weed as serious as para grass, the only ponded pasture grass that has been established in Australia for a long time.

Para grass is estimated to cover 100 000 ha of swampy land in Queensland, with the potential to invade twice this area (Walker and Weston 1990). In the Northern Territory, it infests 40 000 ha of land. It is a major weed on the Townsville Common, where it displaces water chestnut (*Eleocharis dulcis*), a major food of magpie geese and brolgas. Attempts to control it with sprays, burning and mechanical extraction, have been unsuccessful.

Para grass is also displacing water chestnuts in Kakadu National Park. If the para grass invasion proceeds unchecked, Kakadu could lose one of its major tourist and ecological spectacles — the large flocks of magpie geese. Para grass is rated a category one, major environmental weed of northern Australia, defined by Humphries *et al.* (1991) as a "species capable of grossly and irreversibly destroying the structure and function of an ecosystem".

Para grass has become a dominant plant along streambanks around Brisbane, where its impact upon stream ecology has received some attention. Arthington *et al.* (1983) found that grass-infested pools were avoided by 6 native fish species, and only 1 native fish, the carp gudgeon (*Hypseleotris compressa*), favoured it. Yet 2 exotic fish that thrive in Brisbane streams, the mosquitofish (*Gambusia affinis*) and swordtail (*Xiphophorus helleri*) associate with para grass. The mosquitofish is implicated in the decline of several native fish species. Mosquitofish and para grass are both very widespread in coastal Queensland, and the same impacts on native fish are probably occurring over a wide region.

Para grass is also a major economic weed. It is a serious pest in supply and drainage channels, an aggressive weed of sugar cane (Kleinschmidt and Johnson 1977; Sainty and Jacobs 1981), and an unsightly weed in urban parks.

Para grass will not grow in water deeper than 0.5–0.6 m, and this has provided the impetus to introduce 2 new ponded pasture grasses — hymenachne and aleman grass (*Echinochloa polystachya*) — to colonise deeper waters. There are grave fears that these new grasses will prove as invasive and ecologically destructive as para grass (Humphries *et al.* 1991). Hymenachne seeds are readily dispersed by birds, and it has already invaded 1000 ha of land in the wet tropics, including Eubenangee Swamp National Park, south of Cairns.

The Secretary of the Ponded Pastures Steering Committee, Mr John Grimes, says (personal communication) that on present evidence, hymenachne is behaving very badly. This high-risk species should be declared a noxious weed, but instead is being promoted by the Queensland Department of Primary Industries. Aleman grass is not as yet spreading as a weed, but nor is it proving very palatable in pasture trials.

Pasture grasses are causing many other ecological and economic problems; for example, green panic and rhodes grass are invading dry rainforest, and kikuyu grass is invading the natural grasslands of Bunya Mountains National Park (R. Fensham, Queensland Herbarium, personal communication).

Scale of future problems

The weed problems created by pasture plants are likely to worsen. Most future introductions are likely to be legumes, of which Shelton (1990) says: "The potential for discovery of productive new species from wild germplasm is enormous. It is estimated that 3800 species of the family Leguminosae may have the potential for forage and much of this material has yet to be evaluated."

Given that nearly all pasture plants become weeds, it can be said that the potential for introduction of new weeds is enormous, with a pool of 3800 species available.

New cultivars of existing pasture plants are also cause for concern. They may increase the climatic tolerance and disease resistance of existing problem species. Agronomists point out that many, or most, of the weedy populations of leucaena belong to an accidentally introduced population, not the deliberately introduced cultivars. The cultivars, by hybridising with wild populations, introduce greater genetic variability, increasing vigour, pest resistance and ecological amplitude.

Limitations of pasture plants

In sown pastures, productivity frequently soon declines (Myers and Robbins 1991). This decline may translate into massive failures of pasture systems. For example, of new pasture systems adopted on the humid tropical coast of Queensland in the early 1970s, well over half died out by the late 1970s (Teitzel 1992). Pastures of Townsville stylo in northern Australia declined enormously following anthracnose infection.

There are several reasons why pasture systems decline or fail, and 4 are considered here: run-down, unsuitable land, losses from pests and diseases, and overgrazing.

Run-down

Run-down is well known to graziers (Cavaye *et al.* 1989); after several years of establishment, a pasture becomes markedly less productive. The major cause is nitrogen deficiency (Cavaye *et al.* 1989; Myers and Robbins 1991). Run-down is not a consequence of pasture composition, and Myers and Robbins found that pasture age is more important than grass species in determining cattle growth.

Myers and Robbins (1991) suggest management options for run-down pastures, the most practical of which is a reduced stocking rate. They warn: "the benefit that N-fixing legumes pass on to associated grasses is usually less than commonly believed. Seldom can they completely prevent productivity decline." Most importantly, Myers and Robbins conclude that the run-down condition is the normal equilibrium state of the pasture. The higher rates achieved in newly established pasture are due only to a transient boost in nitrogen and water. They are not sustainable.

Cavaye *et al.* (1989) warn that this can affect perceptions of pasture productivity: "... there is a run up in pasture growth after development and this can give an unrealistic expectation of production. Some graziers become worried when pasture production returns to a more sustainable level. However, pasture decline is normal and predictable. Perhaps expectations should be based on a lower level of production, since it is unrealistic to expect pasture production to continue at run up levels."

These unrealistic perceptions can lead to pressure being applied to introduce new pasture plants, when the proper solution is to accept lower stocking rates.

The same problem can arise when pasture plants fail to establish on marginal lands. As Silcock and Johnston (1993) state: "If sown pastures prove difficult to grow, 'wonder' plants or novel pasture establishment methods are sought. However, such perceived needs are often due to unrealistic expectations of the land, either environmentally, or economically."

Pests and diseases

Pests are another problem leading to failure. The notable examples are psyllids on leucaena and anthracnose on Townsville stylo. An active search is now underway to replace these legumes. Several shrubs are being trialled to replace leucaena (Shelton *et al.* 1991), and most of these, if promoted, are likely to become weeds. *Albizia lebbeck* has already established naturalised populations (there are also native populations) (Shelton *et al.* 1991). A legume of particular concern to the Queensland Department of Natural Resources as a potential weed is *Acacia boliviana*, currently under trial by the Department of Primary Industries (central region) (S. Csurhes, personal communication).

The development of pest problems on legumes may be almost as inevitable as run-down. Australia has a vigilant quarantine system, yet new pests routinely reach our shores; we also have many native and naturalised insects and diseases potentially able to adapt to new legumes. Is it realistic to expect a new legume to survive indefinitely without being targetted by pests? If not, the pasture industry should temper its enthusiasm for new legumes, or it will be locked into a cycle of new introductions, none of which will live up to initial expectations, but most of which may become weeds.

Overgrazing

Overgrazing is a similar kind of problem. Many pasture systems fail because stocking rates are too high (*e.g.* Winter 1990), which can lead to calls for new legumes and grasses that "perform better" under the circumstances. The true problem is overlooked, and an additional problem is created when the new pasture plants become weeds.

Under all of the conditions outlined above, new pasture plants are often but wrongly promoted as the solution. There needs to be a better acceptance that new pasture plants are unlikely to provide the 'quick fix' for ecological and economic problems. The industry needs to accept that sustained productivity can come only from lower stocking rates.

The advice of Burrows (1991) should be heeded: "Unfortunately, the enthusiasm which usually goes hand in hand with planting introduced species is rarely matched by plans to deal with their inevitable (?) rundown or changing management requirements. Greater responsibility needs to be taken in this area by both researchers and end users, if we are to avoid the rightful wrath of environmentalists."

Restrictions needed

It is contended that there should be no further introductions of grasses, woody legumes or twining legumes.

Apart from ponded pasture grasses, Australia has an adequate range of introduced grasses, established at a very high ecological cost. Ponded pasture grasses are a very serious weed risk and no further introductions should be contemplated.

Twining legumes have not proved their value. They do not persist well under continuous and moderate grazing (Shelton 1990). Gramshaw *et al.* (1989) admit that: "Siratro, the only twining legume with potential in both the medium rainfall subtropics and wetter environments, has been one of the major disappointments of tropical pasture development". It has, nonetheless, become a weed of extraordinary ecological versatility, invading eucalypt woodlands, beach dunes, lawns, vacant allotments, even the fringes of mangrove wetlands (personal observation).

Woody legumes pose too great a weed risk. Since many are prolific seeders, a single invasive species can dominate enormous areas, as *Acacia nilotica* and *Mimosa pigra* have done. The risks of introducing further pests like these far outweigh any possible advantages. Even Shelton *et al.* (1991), while arguing for more research on exotic fodder legumes, admit that: "Tree legumes have great potential to invade and devastate the productivity of natural grassland communities". Scanlan *et al.* (1991) call for more awareness of the potential for introduced woody plants to become weeds, "both at a general public and government agency level".

Future trials on herbaceous legumes should provide better security so that plants do not escape accidentally, as *Indigofera circinella* has in the recent past. This herbaceous species was recorded by Queensland Herbarium botanists for the first time from Brisbane footpaths in the 1980s. It has the potential to become a significant lawn weed (G. Guymer, personal communication). Its introduction was traced back to pasture trials at Beerwah in the 1970s. It has not been released as a pasture plant, presumably because it has no value.

The native alternatives

The pasture industry should devote its attention to native pasture and fodder plants. Australia has a very rich leguminous flora of over 1800 species.

There is some recognition within the industry that suitable native plants probably exist. Silcock and Johnston (1993) state: "Special plants from overseas have received considerable attention without great success in difficult environments but native plants have received only cursory attention. Current evidence suggests that selection within our native pasture species could produce easily established native species with similar grazing potential to the failed exotics ..."

Silcock and Johnston list 7 plants worth evaluating for marginal subtropical areas: *Astrebla lappacea, A. pectinata, Dichanthium sericeum, Thyridolepis mitchelliana, Monochather paradoxa, Bothriochloa ewartiana* and *Rhynchosia minima.*

There are many other plants worth considering. Hacker (1990) describes Cooper's clover (*Trigonella suavissima*) as "One of the most productive and palatable pasture legumes on black cracking clays" in far south-west Queensland. He rates native lucerne (*Psoralea tenax*) "a very palatable species and a valuable constituent of pasture". There are many native desmodiums closely related to the pasture desmodiums, and Hacker (1990) praises one of these — *Desmodium campylocaulon* — as "a highly palatable species which may be an important component of Mitchell grass pastures during summer." However, evaluation studies of some 80 collections of native herbaceous legumes in northern NSW failed to come up with 1 that was persistent under

grazing (Anon. 1968; Dicker and Garden 1985). More recently, the native *Glycine latifolia* cv. Capella has been shown to have potential on heavy soils, but management guidelines are yet to be defined (Rees *et al.* 1993).

Among woody browse plants, Dann and Low (1988) suggest 18 native species worth considering, and a promising option is *Albizia lebbeck* (Lowry 1991). There is even a native ponded pasture grass — *Hymenachne acutigluma* — in use in north-western Australia (Winter *et al.* 1985).

Silcock and Johnston (1993) conclude: "At least with native species, there is little risk of releasing a new weed, a potential concern with exotic species once they become widespread, *e.g. Eragrostis curvula, Stylosanthes scabra* and leucaena."

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