PERENNIALS IN THE PASTURE ZONE

DOMESTICATION OF NATIVE PERENNIAL GRASSES - PROBLEMS AND POTENTIAL

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Abstract. *Domestication of native grasses for use as sown pastures is becoming increasingly common. A number of domestication programs are underway in Australia. There are however numerous problems to contend with, particularly with respect to harvesting and sowing the seed. Some of these problems are caused by very small or fluffy seed; plants which shed seed rapidly once it is ripe; and with some there is an inherent dormancy mechanism to contend with. However the value of native grasses for pastures in the marginal areas of Australia is enormous and these problems are slowly being overcome.*

DOMESTICATION

To Domesticate - "to tame" or "to bend to our will" (Oxford Dictionary).

Obviously this is a long term process, needing time and money.

Domestication of native grasses is a relatively new concept in Australia. For many years Australian native grasses were considered inferior for grazing, being regarded as having low yields and low nutritive value. However the enormous benefit of persistence through periodic droughts is now considered their greatest asset. As well they may often yield equal to introduced species in some situations.

Although a number of domestication programs are now underway in Australia there are as yet no cultivars registered for use. In contrast, in the USA 45% of the 82 species of forage plants commonly seeded in range and perennial pastures are of native origin (Lodge and Groves, 1990). The trend towards the use of native species in Australia is increasing.

Harlan (1960) indicated that seedling vigour, establishment and seed production were critical for domestication and commercial viability. Domesticated grasses need seed that lacks dormancy, can be sown mechanically and established using existing methods.

Mechanical harvesting must be possible and cost effective (Bowman, 1990). A domesticated species should produce even stand height when sown, have seed retention, relatively constant seed size, longevity of stored seed.

So why bother to put time into domesticating native species when there are numerous exotic pasture grasses, and legumes, available that are already domesticated?

WHY USE NATIVE GRASSES ?

There are many uses for native grasses - in particular amenity use is becoming increasingly common such as for parks and roadsides (Sindel and Groves, 1990) and soil conservation applications. However I will confine this talk to native grasses for use in sown pastures for grazing purposes.

Why bother with natives in these situations ?

What we are really talking about is pasture species for areas more marginal than Orange where unreliable rainfall and extremes of temperature are common.

In these environments there are few, if any, suitable exotic plants. Some such as buffel grass are extremely useful and are sown on a large scale.

However, erratic rainfall is a common feature of such environments and native species are well adapted for survival through recurrent wet/dry periods. This ability to survive periodic droughts is an important

advantage natives have over many of the introduced species that are available.

PROBLEMS WITH NATIVE GRASSES

There are four main problems associated with the use of domesticated native grasses in sown pastures:

- Seed harvesting
- Seed production
- Sowing
- Plant establishment

SEED HARVESTING

Seed dissemination is an essential process to wild plants and this is one of the first processes that must be inhibited if a species is to be domesticated. Seed shedding and inflorescence shattering are major problems to contend with but the prevention of seed dissemination can increase harvestable seed yield by two to three fold.

Most native grasses have efficient seed dispersal mechanisms. Individual seeds are usually dispersed (shed) as they ripen and it is often impossible to harvest the entire crop of seed in one pass. Also a lot of immature seed may be obtained in the harvested sample. One of the main selection requirements in domestication of these species is to restrict this problem.

A domestication program therefore usually involves detailed studies of the dispersal mechanisms and the breeding systems of species, and in some cases selection for seed retention may be required. This took approximately 50 years for *Phalaris aquatica* (McWilliam, 1960). However the occurence of such genes is rare and it may be better to select for suitable seedhead architecture (Lodge and Groves, 1990).

Harvesting seed from many native species is only partially effective. *Astrebla lappacea* (curly Mitchell grass) is one species that can be harvested easily using a conventional wheat header with very little modification. There have also been developments by QDPI for a brush harvester to harvest seed of species such as *Dicanthium sericeum* (Queensland blue grass) and *Thyridolepis mitchelliana* (mulga Mitchell grass) (Robotham and Loch, 1990).

BIOLOGICAL SEED YIELD

Seed yields of long lived perennial grasses are often low and flowering may be spread over a long period. Usable seed yield can also affected by three major post harvest problems:

Fluffy seed for example, *Dichanthium* (Queensland blue grass). It can be overcome mechanically by threshing or by seed coating however in both cases adding to the cost of the seed.

Dormancy is often less strongly developed in perennials than annuals but still can be a problem. Often seed of perennial grasses needs to be stored for up to 12 months before germination is high enough to make sowing feasible.

Genetic stability: many native grasses have two stages of seed production. During good growing conditions most seeds have the same genotype as their female parent, whereas at the end of the growing season highly variable offspring are produced sexually.

SEED SOWING

The seeds of most grass species are very small. However most can be handled by modern sowing equipment or seed size can be modified by technology such as seed coating.

ESTABLISHMENT

For many grasses requirements for germination and establishment under natural conditions are unknown, and knowledge is not yet available regarding the sequence of climatic events that are required for seedlings to appear in natural stands. Such information would be a guide to the most appropriate commercial sowing times for such species.

Data on the expected seedling recruitment levels and times for successful sowing have been collected for curly Mitchell grass although no major effort has yet been made to domesticate this grass. Such information on emergence is essential for successful establishment and the development of management techniques for native grasses.

A succesful domestication program for native grasses depends heavily on the discovery of mutations or naturally occuring ecotypes which prevent seed shedding and inflorescence shattering to increase total harvestable seed production, and on reducing major limitations such as excessive seed fluffiness and dormancy.

PROGRESS IN THE SELECTION OF NATIVE GRASSES

Most of the current programs in Australia for selection and domestication of native grasses, with the exception of *Astrebla*, have involved the collection of material and assessment of within species genetic variation. This variation has been used to select types that have a higher level of seed retention and harvestable seed yield than most naturally occurring ecotypes. Selective breeding or crossing has not yet been used.

As mentioned previously seed shedding or inflorescence shattering is common in many native grasses. In the *Danthonia richardsonii* (wallaby grass) program for example the problem has been overcome by the selection of types with seed head characteristics

(*eg.* compact seedheads with large glumes) that allow for physical retention of the seed (Lodge and Groves, 1990).

In Queensland there have been substantial developments in the technology of seed harvesting machinery for use with grasses such as *Dichanthium* and *Bothriochloa* (red grass). In these programs the emphasis is on harvesting seed from existing native grasslands rather than on selection.

The main programs underway in Australia are:

***Danthonia linkii* and *Danthonia richardsonii* (wallaby grasses)**

A winter- green native perennial grass which provides valuable forage, particularly in winter and early spring.

A program commenced in 1985 with plant collections. These collections were evaluated to determine the amount of genetic variability and to identify superior individuals. It was found that the key to the successful domestication of *Danthonia* was seed retention and production. Seed of two cultivars will be available by 1993.

***Microlaena stipoides* (weeping grass)**

This is a relatively frost tolerant grass which predominantly grows in summer. It is classified as a year- long green perennial.

Collections began in 1986 on the Northern Tablelands and are still being evaluated.

***Elymus scaber* (wheat grass)**

Again a species from the Northern Tablelands which is sparsely distributed in native pastures but produces some green material during winter.

Work with unselected plants has shown that it is both responsive to nutrition and productive. Selection is now being carried out for productivity, persistence, seed yield and seed retention.

***Astrebla lappacea* (curly Mitchell grass)**

Work on this species took a different approach. The overall aim at the beginning of the program was to supply Mitchell grass seed and establishment guidelines to farmers who wished to sow it.

The species has seed retaining plants and seed had always been harvested in northern NSW and Qld after wet summers from naturally occurring stands. It is resown by throwing spikelets out of a vehicle or off a horse. It was rarely sown conventionally.

Subsequent studies have shown that clean seed could be obtained by mechanical threshing. These caryopses had a higher germination percentage and more rapid germination rate than the spikelets. Caryopses also had the advantage of flowability allowing sowing through conventional seed boxes.

Guidelines relating to sowing depth, time and rate have been established (Bellotti, 1988). The next stage of this program will be to select for superior types. Little has been done on assessing genetic variations within the *Astrebla* genus and a detailed assessment of such variability would identify suitable types for multiplication, registration and commercial seed production. Alternatively seed production may continue from natural stands. Both approaches have advantages and disadvantages in that seed harvested from the wild retains inherent variability while a fully domesticated species would have little variability, which is more conducive a to controlled seed industry.

PROGRESS IN APPROPRIATE MANAGEMENT TO ESTABLISH NATIVE GRASSES AT WALGETT

Establishment in semi-arid environments will always be risky however these risks can be minimised by understanding the rainfall variability and soil surface dynamics. Although some guidelines have been developed more information is needed, particularly the relationships between specific rainfall sequences and seedling emergence and survival need to be monitored (Bellotti *et al.*, 1990). Sowing guidelines for Mitchell grass on the cracking grey clay soils have been developed and there are other species where investigations are at early stages of looking at similar problems [Grice, Bowman and Toole (1990) and Waterhouse (pers. comm., 1990)].

With Mitchell grass there is no real technical limitation to harvesting and cleaning seed. Ignorance of all the establishment requirements of Mitchell grass is still our greatest limitation to domestication as the success of sowings will always be strongly reliant on subsequent rainfall.

In such variable environments the cost of such a risk could be minimised by a cheap seed supply. The cost of the failure is then reduced. Techniques which have the ability to place seed quickly to take advantage of favourable conditions also need to be evaluated.

As most grass species have small seeds and are slow to establish competition from weeds can be crucial. Although there are no registered herbicides for use with many of these species preliminary work done at Narrabri by Agriculture and Fisheries has shown that broadleaf herbicides such as Ally$^{(R)}$ can be used on seedlings and mature plants.

Also field observations have shown that winter weeds, such as annual grasses, can be controlled with low rates of glyphosate at times when the perennial grasses are dormant. However further studies and chemical registration are crucial to using herbicides for successful establishment of native grasses.

INFORMATION STILL REQUIRED

The adaptability of the grass or cultivar to climatic areas and soil types other than those in which it originated.

- Effect of environmental stress on seedlings and mature plants, particularly in relation to seed production.
- Effect of management strategies (*eg.* fertilizer rates, time and method of sowing, herbicide rates *etc.*) on production and persistence.
- Seed characteristics *eg.* weight, size, dormancy and how they are affected by environmental factors.

CONCLUSION

All of the above information is essential if native grasses are to be used on a commercial scale. At present the demand for seed of species such as Queensland blue grass and Mitchell grass cannot be met. Producers with natural areas of these species that can be harvested can have returns that are more than worthwhile. Scientists must provide the means to increase the supply of seed of such species but also supply establishment guidelines for those who will use them.

The potential of native species as sown pastures in the marginal environments of Australia is enormous but the use of any species with conventional techniques for establishment in such environments can be risky. Scientists' other role is to decrease that risk. Native grasses have not been selected for production and so it is unlikely they will out-yield domesticated exotic species in many areas. However they are persistent and in marginal environments this is the essential criteria for a pasture species.

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