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HERBAGE SEED: TOWARDS THE YEAR 2000

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ABSTRACT

In New Zealand, herbage seed production has been static for 25 years with an annual production of 20-25,000 tonnes. In this period clover production has doubled to 6000 t while species other than ryegrass have declined in volume. In the 1980/84 period the percentage of each species produced was perennial ryegrass 48%, hybrid and annual ryegrass 13%, white clover 29%, other species 10%. New Zealand is the world's largest producer of white clover seed. About 40% of seed produced is exported to 33 countries, and the most important markets are the EEC 36%, Australia 20%, and North America 19%.

Future markets are examined by regions. Australia will expand as a market because New Zealand cultivars perform well there and Australian pasture plant breeding efforts are minimal. The high altitude, subtropical zones of South America, Asia and Africa are all areas where large scale pastoral industries are being developed and are potential new markets. Thirty six species are discussed as prospective species for fertile soils, alternatives to ryegrass, processed forages, species for stress environments (acid, infertile soils, saline soils, dryland regions), amenity use and multiplication for re-export. White clover, lotus, prairie grass, tall fescue, cocksfoot and amenity browntops have the potential for significant increased production and export.

To remain competitive in the international market the New Zealand herbage seed industry must meet market requirements, produce appropriate cultivars at competitive prices, maintain high quality standards backed by seed production research, good market intelligence, marketing and promotion.

Additional Key Words: herbage grasses, herbage legumes, seed production, seed exports, marketing, new species.

INTRODUCTION

New Zealand's herbage seed production has remained static over the past 25 years (Table 1), with an average annual volume of 22,900 t, of which 15,000 t is certified seed (Hampton and Scott, 1984). Although a range of species and cultivars are grown (Lancashire, 1985), perennial ryegrass and white clover account for 80% of certified seed produced. Of the other species, only five (hybrid and annual ryegrass, cocksfoot, red clover, prairie grass) had annual volumes for the 1982-86 period exceeding 100 t (MAF, 1987). Production of hybrid ryegrass, cocksfoot, red clover, other grasses (particularly crested dogstail) and other legumes (particularly lucerne) has declined (Table 1), and only for clover has there been a significant production increase.

The farm-gate value of herbage seed produced is currently $NZ40 million, with seed exports returning $14-$16 million annually (MAF, 1987). For 1982-86 an annual average of 7500 t seed was exported; this included 4000 t white clover returning $11.2 million and 2600 t ryegrass returning $2.7 million. Herbage seed exports increased to 14,000 t for 1986/87 with large sales of ryegrass to the USA. Europe, Australia and USA respectively are presently the major markets for these species. Seed in amounts of more than 100 kg was exported to 33 countries in 1985/86. Of the seed exported, the EEC took 36%, Australia 20%, USA 19%, South America 7% and Japan 6% in 1985/86 (MAF 1987).

Within New Zealand around 3% (300,000 ha) of grassland is renewed annually (Lancashire, 1985), and although this rate of reseeding is considered low, domestic demand for seed is unlikely to increase. However a considerable shift in the species used is likely particularly as drought tolerant, summer growing species and special purpose species are adopted by farmers.

Lancashire (1985) considered that the future challenge to the New Zealand seed industry was to enlarge and diversify both the internal and external demand for seed. In this paper we examine the potential of 36 species that may be important components of the industry by the year 2000.

EXPORT MARKETS FOR NEW ZEALAND CULTIVARS

Australia

Australia is already a significant market and is likely to remain an important one (J. Hay, Grasslands Division, DSIR, pers. comm) because:–

i) Plant Variety Rights legislation was recently introduced,
ii) the pastoral base for the industry is large and diverse,
iii) plant breeding efforts within Australia for temperate perennial herbage species are minimal,
iv) New Zealand is closer to Australia than other competitors such as producers in Oregon, USA; Denmark, EEC,
v) success of New Zealand cultivars in Australian pastoral systems.

Europe

Europe is our largest market, primarily for white clover. New Zealand cultivars perform best in southern Europe (France, Spain, Portugal) where winter hardiness is not a required attribute. New Zealand's continued dominance of this market will depend on either having appropriate NZ bred cultivars, or on the multiplication and re-export of European bred cultivars that the market demands. For example, in the United Kingdom a kilogram of seed of the small-leaved UK cultivars S.184 and Kent costs four times that of Grasslands Huia.

Nitrate levels in drinking water are increasing and legislation is being developed to reduce the use of nitrogen fertiliser, and this may increase the use of white clover. Also, sowing rates of white clover are often low (1.0 kg/ha) compared with 3.0 kg/ha in New Zealand and any increase in sowing rate would significantly

increase the amount of clover sold. With a few exceptions (prairie grass and ryegrass in France), grasses bred in New Zealand are unlikely to have a large place in European pastures.

North America

This is a large variable market supplied by Oregon. Temporary shortfalls in domestic production, such as that caused either by poor weather harvest or increased consumption by the federally funded Programme which encourages farmers to sow pastures to remove land from cropping, provide opportunities for New Zealand seed, as in 1986/87 when 5900 t of ryegrass was exported to the USA. The market for amenity species is large, and there is a trend to using bentgrasses (*Agrostis* sp.) instead of bluegrass (*Poa pratensis*) on golf courses (Chaltas, 1986) which may provide an opportunity for New Zealand seed.

South America

New Zealand cultivars have been trialled successfully in the temperate zones of Chile and Argentina, the high altitude areas of Ecuador and Peru and the subtropical zones of Colombia, southern Brazil and Uruguay. *Lotus spp.* and serradella *spp.* have proved particularly successful in the acidic, low fertility soils of the subtropical zone (Ritter and Sorenson, 1984). The world oversupply of cereals has prompted a move to increase beef production in Argentina, creating a strong demand for herbage seed which Argentina cannot supply (Julian Mulville, Argentina, pers. comm.).

Asia and Africa

Apart from Japan this is an unknown market. There are millions of hectares of high altitude hill lands above 1000 metres with climates suitable for New Zealand species. In Iran, the Himalayan states, China and Japan, cultivars from New Zealand have performed well in trials (D. Charlton DSIR, pers. comm.) but their performance in the African highlands is unknown.

SPECIES

A. For Fertile Soils

Ryegrass and white clover are expected to remain the dominant species used in seed mixes for moist, fertile, lowland soils both in New Zealand and overseas.

1) *Ryegrass* (*Lolium perenne*; *L.* × *boucheanum*; *L. multiform*)

The world market for this major temperate grass species is highly competitive, and shipping costs of up to 40 cents/kg (20% of the FOB price) reduce New Zealand's competitiveness. One advantage New Zealand has is that a part of the crop harvested in January can be cleaned, tested for quality and shipped by the end of March to reach the northern hemisphere in time for June/July sowings. Storage and interest costs are minimal compared with those for seed from the northern hemisphere which is stored for 12 months, and this helps to compensate for the cost of shipping seed from New Zealand.

New Zealand ryegrass cultivars are unique in that they have been developed under grazing regimes rather than cutting regimes. They have performed well in France and southern Europe and South America. Better tolerance to crown rust (*Puccinia coronata*) is required if the present Australian market is to expand. Future developments with perennial ryegrass may depend on market demands for the presence or absence of the seed-borne lolium endophyte fungus *Acremonium lolii* (Fletcher, 1983; Gaynor and Hunt 1983). Fungal viability must be maintained during storage and shipping (Rolston *et al.* 1985).

Recent research fundings on management (Brown 1980), fungicide use (Hampton 1986) and use of the growth regulator chlormequat chloride (Hampton 1987) in ryegrass seed production are being applied by growers and consistent yields obtained. Yields of up to 1800 kg/ha for perennial ryegrass have been recorded by the best New Zealand growers, and these yields are comparable to those obtained by the best Oregon growers.

2) White Clover (*Trifolium repens*)

New Zealand is the world's largest producer of this important forage legume, and the market is dominated by one cultivar, 'Grasslands Huia'. Better understanding of plant growth and reproductive development has led to improvements in management and harvesting efficiency, resulting in high seed yields of 700-1000 kg/ha (Clifford, 1985; Clifford and McCartin, 1985). The recent development of methods for maintaining the purity of white clover cultivars (Clifford *et al.* 1985; Hampton *et al.* 1987a), the successful production in New Zealand of seed of European cultivars, and the release of the small leaved 'Grasslands Tahora' and the large leaved 'Grasslands Kopu' add diversity to the range of white clovers available in New Zealand and the rest of the world. Demand for white clover seed in Europe and Asia is expected to increase, particularly as the role of white clover as a pasture component and in biological nitrogen fixation is being re-evaluated in many European countries.

3) Ryegrass Alternatives

There is considerable interest in alternative species to ryegrass for lowland areas, especially where insect pests and summer drought reduce ryegrass persistence, or where animal disorders such as ryegrass staggers occur. Few species have the nutritive quality of ryegrass, or are as easy to manage or establish.

Table 1. Quantities of machine dressed herbage seed produced in New Zealand* 1000 tonnes/year.

Period	Total	Ryegrass perennial	Ryegrass hybrid	Ryegrass annual	Cocksfoot	Other** grasses	Clover white	Clover red	Other*** legumes
1960-64	23.4	11.66	3.49	1.29	0.96	1.30	3.12	0.99	0.58
1965-69	23.3	9.21	5.77	1.67	0.84	1.43	2.57	1.15	0.63
1970-74	26.0	11.16	4.26	3.79	0.90	1.72	2.94	0.75	0.51
1975-79	20.7	8.62	2.45	2.35	0.51	0.93	4.57	0.86	0.38
1980-84	21.4	10.33	1.02	1.82	0.61	0.58	6.21	0.55	0.32

* Source NZ Agricultural Statistics – includes certified and uncertified seed

** In descending order of importance; crested dogstail, timothy, browntop, chewings fescue, prairie grass

*** In descending order of importance – lucerne, suckling clover, subterranean clover

However three species are gaining acceptance as alternatives to ryegrass.

a) Cocksfoot (*Dactylis glomerata*)

Cocksfoot has traditionally been used in pasture mixtures for drylands, but from the mid 1970's its use in seed mixes began to decline because of its poor persistence and susceptibility to rust. The recent development of two rust tolerant cocksfoots, 'Grasslands Kara' and 'Grasslands Wana' (Rumball, 1982) combined with the dense tillering habit of Wana which is persistant under severe grazing has renewed farmers interest in cocksfoot. Autumn sowing of Wana can produce seed (Brown & Rolston, 1983), and commercial yields of up to 900 kg/ha have been recorded. Steady growth in seed production of cocksfoot can be expected both within New Zealand and in overseas markets such as southern Europe, South America, and high altitude Asia.

b) Tall fescue (*Festuca arundinacea*)

Tall fescue has long been recognised as a species tolerant of drought, heat and saline conditions and is a major component of pastures in south-east USA and Australia. Poor animal health, common when grazing tall fescue, is associated with the seed borne fungal endophyte *Acremonium coenophialum* (Welty *et al.*, 1986). Tall fescue cultivars are variable in their nutritive quality but trials with no-endophyte 'Grassland Roa' tall fescue, selected for low-leaf strength (Anderson, 1982) have demonstrated the value of this cultivar for beef production (Goold & van der Elst, 1980), sheep production in Canterbury (deLacy, 1987) and dairy production (Wilson, 1975), particularly where summer droughts restrict the growth of ryegrass.

Seed yields of tall fescue in NZ have been generally variable and lower than those of ryegrass. Recent trials have shown that tall fescue should be closed earlier than ryegrass (Brown *et al.*, 1988) and seed yields of up to 1000 kg/ha have been reported by farmers. Future useage of tall fescue in NZ will be considerable and there is a potential market of 1000 t per year.

c) Prairie grass (*Bromus willdenowii*)

Prairie grass is a self pollinating species with high growth rates in autumn and winter and good persistence in droughts (Rumball 1974). The species is sensitive to overgrazing and mismanagement.

Problems initially encountered with seed production of prairie grass included head smut (*Ustilago bullata* Berk.); and the presence of a long lemma and awn that made seed cleaning and seed handling at sowing difficult; reductions in germination during shipment,-'Germination collapse'. Head smut has been successfully controlled by fungicide seed treatment (Falloon & Rolston, 1986) and strict standards for seed certification. Handling problems during cleaning can be reduced by drying seed to less than 14%, which reduces blockages (Rolston & Hare, 1984), while a flame de-awning method developed for prairie grass is used to produce "Easy drill Matua". Germination collapse is associated with seed lines of low vigour, and an accelerated ageing test can be used to identify seedlines with high vigour which are suitable for export (Hampton, 1985).

Recent research on management of seed crops (Brown & Rolston, 1985; Brown & Archie, 1986) and the use of the plant growth regulator chlormequat chloride at 0.75 kg/ha (Hampton *et al.*, 1987) have resulted in seed yields of up to 5000 kg/ha. With the development of "Easy drill Matua" the potential of prairie grass is considered to be 1000 t per year, with major markets in the EEC, USA, Australia, Africa and South America.

Table 2. Quantities of herbage seed by major production areas and major species (1984-86).

Region	Total production(t)	Major species(t)	
Oregon, USA	163,500	annual ryegrass	72,700
		perennial ryegrass	28,800
EEC	110,000	perennial ryegrass	52,600
		annual ryegrass	20,200
New Zealand	21,600	perennial ryegrass	8,500
		white clover	6,220
Australia	14,600	subterranean clover	5,390
		perennial ryegrass	2,990

4) Processed Forages

Specialist forages for use as processed crops (hay, chaff, pellets) have a long history of use in New Zealand. Species used include lucerne (*Medicago sativa*), red clover (*Trifolium pratense*) and timothy (*Phleum pratense*). The development of live sheep exports to the Middle-East, expansion in equine breeding, deer farming and the export of beef breeding cattle requires processed forages and suggests possible expansion in these markets. Sainfoin (*Onobrychis viciifolia*) and sulla (*Hedysarum coronarium*) also have potential as processed forages. In New Zealand seed yields of lucerne have been low by USA standards, but the use of the leaf cutter bee (*Megaachile pacifica* Panzer) as an effective pollinator, improvements in pest control, and stands of lower population have increased yields (Dunbier *et al.*, 1983). There has been a strong demand for the tetraploid red clover 'Grasslands Pawera', but poor pollination has resulted in low seed yields. Domestication of long tongue bumble bees (*Bombus ruderatus, B. hortorum, B. subterraneus*) (MacFarlane *et al.*, 1983) and managed bumble bee pollination has the potential to improve seed yields but the costs of establishing colonies are high and variable colonisation rates and/or failures of nests leave many questions unanswered.

Markets for red clover are likely to expand to 750 t per year, while growth in lucerne is dependent on higher yields which should result in competitively priced seed. Seed production of sainfoin and sulla has not been studied in detail in New Zealand but initial observations show that seed yields of sainfoin are often reduced by sucking insects.

B. Stress Environments

A stress environment is defined as a site where there are major limitations to plant growth. In New Zealand the stress environments and species adapted to them include (Scott *et al.*, 1985):

(1) acid soils, often with high Al^{+++}: *Lotus pedunculatus, Lotus corniculatus*; serradella (*Ornithopus sativus*).
(2) low fertility soils: browntop (*Agrostis capillaris*), mountain brome (*Bromus sitchensis*); Yorkshire fog (*Holcus lanatus*); lotus species; suckling clover (*Trifolium dubium*).
(3) saline soils: strawberry clover (*Trifolium fragiferum*); tall fescue.
(4) drought-prone soils: phalaris (*Phalaris aquatica*); browse shrubs including tagasaste (*Chamaecytisus palmensis*); chicory (*Cichorium intybus*); subterranean clover (*Trifolium subterraneum*).
(5) high temperature (+ 30°C): paspalum (*Paspalum dilatatum*).

(6) higher altitude sites which often have a combination of cold winters, low rainfall and low fertility: alsike clover (*Trifolium hybridum*); crown vetch (*Coronilla varia*); sheep's burnet (*Sanguisorba minor* ssp. *muricata*); Caucasian clover (*T. ambiguum*), zigzag clover (*T. medium*), smooth brome grass (*Bromus inermis*), Russell lupin (*Lupinus polyphyllus*).
Honey production can often be integrated with forage or soil conservation in these environments e.g. blue borage (*Echium vulgare*).

With the exception of subterranean clover and browntop, seed of the species listed above is not readily available, and is expensive. There is little published research on seed production of most of these species.

a) *Lotus* 'Grasslands Maku' lotus is a tetraploid *L. uliginosus* bred for acid, infertile soils and evaluated initially on peat soils and tussock high country. The present major use is for agro-forestry systems because of its good tolerance of shade, and in subtropical pastures where good performance has been recorded in southern Brazil (Ritter & Sorrenson 1984); Colombia and Queensland, Australia (Cook & Jones 1985). Annual seed production is low (50 t) but the potential market is estimated to be 1000 t per year. Low seed yields have occured because of problems with weeds and insect pests, pod shattering and high plant populations (Lancashire *et al.*, 1980; Rolston & Henderson, 1981; Hare, 1984; Clifford *et al.*, 1983). However these problems are now largely understood, and acceptable yields of 200 to 400 kg/ha can be obtained.

(b) *Chicory* Chicory is a herb species. 'Grasslands Puna' is a high yielding forage crop which produces up to 25,000 kg DM/ha/yr, has excellent summer growth, high mineral contents, especially in K^+, N^+ and Zn^{++} and gives high growth rates in lambs (Rumball, 1986; Hare *et al.*, 1987). Initially seed yields of 250 to 300 kg/ha were obtained, but, following studies on closing date and seed development, yields of 550 kg/ha have been otained. The potential demand for chicory seed is unknown. However, Argentina uses 1000 t per year (L. Sojo, Argentina, pers. comm.) and there is strong interest in chicory as a summer forage and in 'organic' farming systems in New Zealand.

C. Amenity Species

Amenity species are usually included with herbage seed and include a range of species and useages. Fine leaved perennial ryegrass and dwarf tall fescue are used for hard-wearing sports surfaces (rugby and soccer fields); browntop and related bent grasses (*Agrostis castellana*) and blue grass (*Poa pratensis*) are used on golf courses; and browntop/red and Chewings fescue (*Festuca rubra*) mixtures and crested dogstail (*Cynosurus cristatus*) are used in lawns, Amenity species include roadside species that are slow growing and require low maintenance, or mixtures that include flowering herbs and legumes (e.g. oxeye daisy (*Chrysanthemum leucanthemum*) and Russell lupin).

a) *Browntop* A NewZealand ecotype of browntop has been used for amenity purposes for many years and recently 'Grasslands Egmont' and 'Grasslands Sefton' two purpose bred cultivars were released (Rumball & Robinson, 1982). Browntop is replacing bluegrass in the annual regrassing of golf courses in the USA and is in high demand (Chaltas, 1986). Seed yields of 300 to 400 kg/ha require accurate applications of N fertiliser in spring (Brown & Archie, 1986). While NZ browntop is ploughed after harvest to rejuvenate the stand (Wright, 1980) this practice greatly reduces seed yields of the new cultivars (E.R. Kevern, DSIR Lincoln, *pers, comm.*). The market for amenity browntops is expected to reach 250 tonnes with large exports to the USA.

D. Multiplication for Re-export

The multiplication of overseas cultivars and species for re-export is common in Oregon, but until recently has not been important in New Zealand. Following the development of methods to maintain genetic purity (Hampton *et al.*, 1987), over 100 t of European white clovers will be re-exported in 1987 (D. Scott, MAF, *pers. comm.*) and within 10 years this trade could grow to over 5000 t per year. Opportunities also exist for the multiplication of red clovers and amenity species from Europe, although not all cultivars flower adequately in the latitudes of 37-45° in New Zealand compared with latitudes of 50-55° in their countries of origin. Thus trials to evaluate the potential for seed production of each cultivar are required.

Developing countries use a wide range of species not used in New Zealand and there are often shortages of seed. Berseem, (*Trifolium alexandrinum*) is widely used from India to Morocco and in 1985 Iran tendered for 1500 tonnes of berseem. Other species could include Kenyan white clover (*T. semipilosum*), which has performed well in China (Matheson *et al.*, 1985) and other sub-tropical legumes and grasses. Market intelligence is required to determine which species are in demand and research is required to develop methods of seed production.

CONCLUSION

New Zealand has the potential to increase seed production of herbage species as the industry has the following advantages.

1. Climate: a good climate for seed production, with regions that have mild moist winters and dry summer periods during harvest.
2. Quality assurance: a history of effective seed certification to maintain cultivar purity through a scheme which meets all OECD requirements and is therefore accepted internationally; official seed testing for purity, germination, vigour, disease and the issuing of International Seed Testing Association orange certificates which facilitate international trade.
3. Processing: good seed cleaning and storage facilities.
4. Research and Training: a large group of experienced research scientists (10 full time equivalent) and training is available at the Seed Technology Centre, Massey University.
5. Promotion: Formation of the New Zealand Seed Promotion Council in 1983 (a group involving the industry, grower, and breeder that levies growers for promotional work) and the introduction of Plant Variety Rights allows better international promotion and marketing to occur.
6. Ability to meet spring sowings in the northern hemisphere with minimal costs for storage.

If New Zealand is to meet this potential for growth the herbage industry must remain competitive on international markets. This will require:

1. producing high yielding seed crops which generally have low costs per kg of seed.
2. having seed that is competitively priced. This will be influenced by on-farm costs, off-farm costs such as shipping, and factors such as inflation rates and exchange rates.
3. maintaining high standards for purity of seedlots germination, vigour and genetic purity of the cultivar.

4. producing appropriate cultivars with the agronomic features required by consumers.
5. having cultivars being placed on Recommended Lists and protected by Plant Variety Rights.
6. having effective marketing, promotion by demonstration and on-farm trials, and management packages for each cultivar.
7. receiving market intelligence on seed supplies, trends for production and consumption, and requirments for cultivar and species.

We predict that the herbage seed industry of the future will have a greater diversity of species, more exports, especially to Australia and subtropical Asia, higher production of legumes especially lotus, and more species for stress environments, and by the year 2000, 30,000 tonnes of seed will be produced annually.

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