

Potential for seed production of non-traditional herbage species in New Zealand

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Abstract

The New Zealand herbage seed industry is looking to diversify and reduce its almost complete dependence on ryegrass and white clover. This review examines some opportunities and constraints to achieving this industry goal. In the near future, low input sustainable agriculture is likely to create a demand for seed of species such as alsike, Caucasian, zigzag and suckling clovers, crown vetch, velvet grass, white sweet clover, hairy canary clover, birdsfoot trefoil, perennial lupin, yarrow, tagasaste, wheat grass, oat grass, phalaris, paspalum, dogstail and sheep's burnet. There is also potential for export of herbage legumes such as annual medics, berseem clover, vetches, sainfoin, sulla, lotus and sweet clover, particularly to the Mediterranean region and Australia. The New Zealand seed industry has the strengths required to meet these challenges, and areas of lower fertility and free-draining irrigatable soils such as parts of Canterbury are likely to be highly suitable for non-conventional herbage legume seed production. At present there are important constraints, including lack of seed supply and therefore little demand, very limited seed production information, lack of available financial resources, and competition from overseas producers. These problems are discussed. However, they can be overcome, and by 1995 New Zealand could expect commercial seed production of birdsfoot trefoil, sulla, perennial lupin, serradella, Caucasian and zigzag clovers, velvet grass, smooth and upland bromes, phalaris, paspalum, dogstail, dryland bent, yarrow and sheep's burnet. Brief seed production information for some of these species is appended.

Keywords herbage legumes and grasses, pasture herbs, forage shrubs, seed production potential, export, research, marketing

Introduction

New Zealand's herbage seed industry continues to be dominated by ryegrass and white clover. During 1987-89, 68% of the 18475 t of certified herbage seed machine dressed annually was ryegrass (*Lolium* spp), 25% was white clover (*Trifolium repens*) and only 7% was of other species (A.A. Johnson, pers. comm.). Of this total production, 65% was from just two cultivars, 'Grasslands Nui' perennial ryegrass and 'Grasslands Huia' white clover. Much of this production was to fill an opportune commodity market in North America (ryegrass) and traditional markets in Europe (white clover).

The dangers inherent in relying almost entirely on single cultivars and species are recognised, and the industry is slowly beginning to diversify, e.g. in 1988, 310 t seed from 15 European white clover cultivars was produced in New Zealand for re-export. Also, certification entries for chicory (*Cichorium intybus*), cocksfoot (*Dactylis glomerata*), fescues (*Festuca* spp.), lotus (*Lotus uliginosus*) and phalaris (*Phalaris aquatica*) have increased significantly each year since 1987-88 (Anon. 1989), although in 1989 production was > 100 t only for cocksfoot. In addition, in 1989, 3000 ha of US turf tall fescue cultivars were sown in New Zealand for multiplication-and-re-export.

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, and Rolston *et al* (1987) predicted that the herbage seed industry of the future would have a greater diversity of species, a greater emphasis on legumes, particularly for stress environments, and an increased export trade. The present and future place of species such as cocksfoot, tall fescue, prairie grass, browntop and red clover was discussed by Rolston *et al.* (1987). In this paper we examine further opportunities and constraints to achieving these industry goals.

Opportunities

Within New Zealand

In recent years there has been increasing interest in plant species adapted to drought-prone, low to moderate fertility soils that will grow with minimal fertiliser input. For example at low to moderate soil

fertility sites in South Island hill country Scott *et al* (1985) suggested that species such as alsike, Caucasian, zigzag and suckling clovers (*Trifolium hybridum*, *T. ambiguum*, *T. medium*, *T. dubium* respectively), crown vetch (*Coronilla varia*), velvet grass (*Holcus lanatus*), white sweet clover (*Melilotus alba*), birdsfoot trefoil (*Lotus corniculatus*), perennial lupin (*Lupinus polyphyllus*), yarrow (*Achillea millefolium*), tagasaste (*Chamaecytisus palmensis*), pubescent wheatgrass (*Agropyron trichophorum*), tall oat grass (*Arrhenatherum elatius*) and sheep's burnet (*Sanguisorba minor*) all have particular features appropriate for these environments. Wills *et al.* (1989) also reported that hairy canary clover (*Dorycnium hirsutum*) had the ability to establish and grow in low fertility soils under cold dry conditions. Both phalaris (*P. aquatica*) and tall fescue (*Festuca arundinacea*) are suitable for use on drought-prone areas. Production data are being accumulated for a number of these species (e.g. Wills *et al* 1987; Daly & Mason 1987; Fraser *et al.* 1988; Scott 1989; Wills *et al.* 1989). If pasture species are chosen firstly to meet the constraints of the environment, and secondly to utilise best the fertiliser rates able to be used, there will be a demand for supplies of seed of many of these 'non-conventional' species.

For export

Rolston *et al.* (1987) suggested that Australia and subtropical Asia were most likely to become important for New Zealand herbage seed exports, but there is also potential in much of the Mediterranean region. For example, Cocks (1988) reported that of 20 West Asian and North African countries, only two produce more than 10% of their existing requirements for herbage seed. The species required include forage legumes such as annual medics (*Medicago* spp), berseem clover (*Trifolium alexandrinum*), vetches (*Vicia* spp.), sainfoin (*Onobrychis viciifolia*), sweet clovers (*Melilotus* spp.) and sulla (*Hedysarum coronarium*) (Mansat 1988). Portugal imports seed of *T. alexandrinum*, *T. incarnatum*, *Lotus* spp. and *Medicago* spp. (Dordio 1988), and Iran imports *T. alexandrinum* (Rolston *et al* 1987). Demand for seed of *Lotus corniculatus* exceeds supply in many Mediterranean countries.

In Australia, seed supplies of annual medics are variable, while in the North American market, interest in ecologically balanced lawns could lead to demands for New Zealand yarrow (*Achillea millefolium*) and possibly strawberry clover (*Trifolium fragiferum*) (J.G.H. White, pers. comm.).

Why New Zealand?

The strengths of the New Zealand herbage seed industry as discussed by Rolston *et al.* (1987) include climate, quality assurance, industry infrastructure, promotion, research and training. To those must be added farmer initiative and increasing expertise.

Research has provided the technology to produce consistently high yields of temperate herbage legumes through manipulating the limitations of the environment, particularly soil moisture and fertility (Rolston & Clifford 1989). It is significant that white clover seed production research in Europe is now focusing on the Mediterranean region where seed yields are generally higher than those of northern Europe (Marshall & Hides 1988) because of more reliable weather and the ability to manage water availability through irrigation. Many of the species suggested for New Zealand stress environments and required in southern Europe and northern African are Mediterranean in origin. Although the Canterbury climate does not match the typical Mediterranean climate (Lorenzetti 1988), the lower-fertility, free-draining irrigatable soils (Rolston & Clifford 1989) are likely to be highly suitable for herbage legume seed production other than white clover.

Constraints

Species adoption

Daly & Mason (1987) noted that "a constraint is the present lack of commercial seed supplies" (for *T. ambiguum* and *T. medium*), and in 1990 seed of only 4/34 potential new species is freely available (Table 1). Certified seed production in 1989 was 127 t for dogstail, 14 t for velvet grass, 12 t for serradella, 7 t for phalaris (A.A. Johnson pers. comm.), and small quantities of upland and smooth brome and paspalum were also produced.

In many ways the quantity of seed available is a reflection of market demand. Use of many of these alternative species is at present limited to MAF and DSIR research trials, and the adoption of such species into commercial farming practice will require time, effective extension and good marketing. Until this happens and a demand for seed arises, it is likely that herbage seed producers and seed firms will move only cautiously and carefully. However, the economic reality of farming on lower fertility and/or drought prone land may well produce a more rapid adoption of new species than was the initial response for species such as 'Grasslands Roa' tall fescue and 'Grasslands Matua' prairie grass (Lancashire 1985).

Seed production information

The adoption rate of any new cultivar or species will also depend on the successful production of quality seed at an appropriate price. Of the 34 species (Table 1), some seed production information is available for sulla, birdsfoot trefoil, serradella, berseem and zigzag clover, smooth and upland brome, paspalum, phalaris, dogstail, velvet grass, sheep's burnet and tagasaste (see Appendix). For many of the other species, little published information is readily available, even internationally.

Seed production research for non-traditional species has begun at DSIR Grasslands Palmerston

Table 1 Potential new **herbage** species for seed production in New Zealand

Species		Cultivar status ^a	Seed availability ^b
1. Herbage legumes			
<i>Coronilla varia</i>	crown vetch	2	3
<i>Dorycnium hirsutum</i>	hairy canary clover	3	3
<i>Hedysarum coronarium</i>	sulla	1	2
<i>Lotus corniculatus</i>	birdsfoot trefoil	1,2	2
<i>Lotus tenuis</i>	narrow leaf trefoil	2	3
<i>Lupinus polyphyllus</i>	perennial lupin	2	3
<i>Medicago</i> spp	annual medics	3	3
<i>Melilotus alba</i>	white sweet clover	3	3
<i>Onobrychis viciifolia</i>	sainfoin	2	3
<i>Ornithopus sativus</i>	pink serradella	1	1
<i>Ornithopus sativus x compressus</i>	hybrid serradella	2	3
<i>Trifolium alexandrinum</i>	berseem clover	3	3
<i>Trifolium ambiguum</i>	Caucasian clover	1	3
<i>Trifolium dubium</i>	suckling clover	3	2
<i>Trifolium fragiferum</i>	strawberry clover	2	3
<i>Trifolium hybridum</i>	alsike clover	3	1
<i>Trifolium incarnatum</i>	crimson clover	3	3
<i>Trifolium medium</i>	zigzag clover	2	3
<i>Vicia</i> spp	vetches	2,3	3
2. Herbage grasses			
<i>Agropyron cristatum</i>	crested wheat grass	3	3
<i>Agropyron trichophorum</i>	pubescent wheat grass	3	3
<i>Agrostis castellana</i>	dryland bent	1	3
<i>Arrhenatherum elatius</i>	tall oat grass	3	3
<i>Bromus inermis</i>	smooth brome	1	2
<i>Bromus sitchensis</i>	upland brome	1	2
<i>Bromus stamineus</i>	grazing brome	2	2
<i>Cynosurus cristatus</i>	dogstail	1,2	1,2
<i>Holcus lanatus</i>	velvet grass	1,2	1
<i>Paspalum dilatatum</i>	paspalum	1	2
<i>Phalaris aquatica</i>	phalaris	1	1
3. Pasture herbs			
<i>Achillea millefolium</i>	yarrow	3	2
<i>Plantago lanceolata</i>	plantain	2	3
<i>Sanguisorba minor</i>	sheep's burnet	2	1
4. Forage shrub			
<i>Chamaecytisus palmensis</i>	tagasaste	2	2

^a New Zealand cultivar status: 1 = named cultivar(s), 2 = unnamed new selection shortly to be released as a cultivar, 3 = no known cultivars or possibly imported cultivars.

^b Availability of seed: 1 = freely available, 2 = limited quantities available, 3 = only experimental quantities available.

North and Lincoln, and at both Massey and Lincoln Universities, and problems typical of **all herbage** legumes have been encountered, i.e. indeterminacy, protracted flowering periods, pollination problems, poor seed set, abortion, uneven ripening, pod shatter, harvesting difficulties and low harvest indices. For example, Cocks (1988) found that potential seed yield in *Medicago rotata* was around 2.4 t/ha, but actual yield was often low because up to 90% of all flowers formed failed to develop mature pods; seed yields of perennial lupin should be from 0.5-2 t/ha, but pod shatter is prevalent and seed is presently obtained by handpicking (Scott 1989); seed

set in *Trifolium medium* is low because of poor pollination, and seed recovery is difficult because of the large amounts of vegetative dry matter produced (C. Mtolera, pers. comm.); only one in every 10 florets of *Holcus lanatus* supports a seed through to physiological maturity, and further losses then occur through seed shedding (Hampton unpub. data).

There are production constraints because of an information deficit, but compounding this are problems associated with funding for further research. At present, research is of necessity piecemeal and opportunistic, rather than working towards well planned long term goals.

Competition

The world is not sitting back waiting for New Zealand to become suppliers of herbage seed. Although there are major problems, in for example many of the Mediterranean countries, in establishing local seed industries (Cocks 1988), they are being slowly overcome, and Mansat (1988) considered that a production capacity in the Mediterranean region may find markets in more northern latitudes, particularly with the encouragement of generous EC research funding.

At present New Zealand does not have good market intelligence from potentially new importing countries, and information on seed supplies, trends for production and consumption, precise cultivar requirements and species preference is poor. Failure to obtain such information will result in lost opportunities. As Smith & Mather (1985) noted, "we must listen to the market signals from our (present and potential) offshore consumers" and have our seed industry "move in positive fashions to the challenges in the future".

Conclusion

To increase and expand in internal and international markets, the New Zealand seed industry must continue to produce seed yields at relatively low costs per kilogram, and produce seed of the species and cultivars required by consumers. Can we do this for non-traditional species? Our assessment is as follows:

1. Commercial seed production operational by 1995: *Hedysarum coronarium*, *Lotus corniculatus**, *Lupinus polyphyllus*, *Ornithopus sativus*, *Agrostis castellana* *, *Bromus* spp. *Cynosurus cristatus*, *Holcus lanatus**, *Phalaris aquatica*, *Paspalum dilatatum*, *Achillea millefolium* *, *Sanguisorba minor*.
2. Commercial seed production ready to begin by 1995: *Coronilla varia*, *Lotus tenuis*, *Medicago* spp*, *Onobrychis viciifolia*, *Trifolium alexandrinum**, *Trifolium hybridum*, *Trifolium incarnatum*, *Trifolium ambiguum*, *Trifolium medium*, *Agropyron* spp ., *Chamaecystis palmensis*, *Plantago lanceolata*.
3. Little progress by 1995: *Dorycnium hirsutum**, *Melilotus alba**, *Trifolium dubium*, *Vicia* spp., *Arrhenatherum elatius*.

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* species with export potential.

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Appendix: Sked production notes

1. **Sulla (*Hedysarum coronarium*)**
 - responds best to mild winters and warm summers; warm dry summers essential for optimal seed production.
 - grows well on any well-drained soil with **pH** of 6-8. Does not like heavy or sandy soils.
 - sow late summer-early autumn, using pre-sowing weed control (trifluralin); seed-bed should be deeply worked, compacted and fine surfaced. Correct P and K deficiencies if below moderate levels.
 - seed benefits from **dehulling** and scarification; inoculate with **NZP5410** rhizobia.
 - drill or broadcast at **5-10 kg/ha** (dehulled) or 15-20 kg/ha (hulled); harrow and roll after broadcasting.
 - weed control post emergence necessary (metribuzin, dinoseb, propyzamide).
 - do not cut or graze autumn sown crops before seed harvest; established stands can be grazed during winter and early spring.
 - peak flowering occurs late spring-early summer; honey bees are good pollinators.
 - harvest 7-8 weeks after peak flowering when **50-60%** of hulls have turned brown; mow with sickle bar or rotary disc mower, leave in **windrow** for 3-5 days before harvesting.
 - yield potential over 1000 kg/ha, but typical yields range from 150-500 kg/ha of **unhulled** seed.
2. **Birdsfoot trefoil (*Lotus corniculatus*)**
 - will persist under low fertility, but for seed production moderate soil fertility and **pH** 6-7 required.
 - early autumn sow at 3-5 kg/ha depending on hard seed content (often around 30%); slow to establish; inoculate seed prior to sowing, 30 cm row spacing.
 - trifluralin presowing, and **2,4-DB** in early winter for weed control; **interrow** cultivate in early spring before **new** crop growth begins; in established crops **use** paraquat plus atrazine (0.5 + 1.0 kg **a.i./ha**) for weed control.
 - an insecticide (e.g. Mavrik Aquaflo) may be required to control sucking insects before and after flowering.
 - do not graze in the establishment year; in subsequent crops close in late September.
 - a long **flowering period** leads to uneven ripening and losses through pod shatter; plant growth regulators may help to overcome this problem.
 - cut the crop 35-38 days after peak flowering (**70-80%** of pods light brown) and thresh as soon as the fleshy stems have dried sufficiently to feed through the combine without 'wrapping'.
 - seed yields of 300 kg/ha are considered good, but yields of over 600 kg/ha have been obtained; seed can be harvested for up to six seasons.
3. **Berseem clover (*Trifolium alexandrinum*)**
 - requires well drained, fertile, loamy soils; light, sandy and acidic soils are unsuitable.
 - autumn sow at **20-25 kg/ha**; inoculation with appropriate **Rhizobium** bacteria essential.
 - grazing or cutting available in early spring, but must cease by mid October to allow at least **10** weeks for reproductive growth and seed maturation.
 - swath harvest by cutting when **65-70%** of pods are brown; field dry for 3-4 days before combining.
4. **Zigzag clover (*Trifolium medium*)**
 - perennial which spreads readily by rhizomes; resembles red clover.
 - sow at 2 kg/ha in 30-60 cm rows.
 - in established-crops, white clover can be **controlled** with **metribuzin**.
 - cross pollinated, primarily by long tongue bumble bees, as corolla tube too long for pollination by honey bees.
 - seed yields low because of **genetic** factors (highly **polyploid**), clover seed chalcid damage, long flowering period, large vegetative mass and **'burial'** of seed heads within the canopy.
5. **Smooth brome (*Bromus inermis*)**
 - a rhizomatous species adapted to dry environments and cold winters.
 - requires free draining soils of moderate fertility.
 - sow in spring at 5 kg/ha in IS-20 cm rows.
 - graze once established and 10-15 cm tall; apply 40 kg N/ha in autumn and continue to graze until winter growth stops; do not graze below 3 cm.
 - apply 40 kg N/ha in late September.
 - seeds brown when mature and very light so that airflow within the combine must be reduced to a minimum
 - after harvest **balé** or burn off straw; hard graze in early autumn, apply 40 kg N/ha in autumn and continue grazing until closing.
 - seed yields of 200 kg/ha have been obtained.
6. **Upland brome (*Bromus sitchensis*)**
 - resembles prairie grass (*B. wildenowii*) but less winter growth and lower fertility requirements, **ph** 5.5-6.5.
 - autumn sow **de-awned**, fungicide-treated seed at 5-10 kg/ha in 15-30 cm rows.
 - lax graze down to 5 cm during winter, close later September.
 - apply 80-100 kg N/ha at closing and cycocel (CCC) at 1.0 **litre/ha** in early October to reduce lodging.
 - cut at **45-48%** seed moisture content and thresh at 14% SMC; further dry to **10-12%** SMC.
 - provided head smut does not occur, a second year crop can be taken.
 - yields range from **1000-1500 kg/ha**.

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7. **Phalaris (*Phalaris aquatica*)**
- requires deep but free draining soils, pH 6-7, moderately fertile.
 - sow early autumn at 3-5 kg/ha in 30 cm rows.
 - early weed control (*Poa annua* and other weeds) essential for good tiller development.
 - lax graze down to 5 cm during winter; close late September and apply 80-100 kg N/ha.
 - a fungicide spray between ear emergence and anthesis may be necessary; crops grow 200 cm tall!
 - harvest when most seeds are fawn-brown; olive or white seeds are immature; direct head or mow and thresh after 4-5 days' drying.
 - burn or bale straw, graze regrowth but watch for phalaris staggers; autumn fertilise with NPK, and late autumn spray with atrazine, simazine or diuron.
 - seed yields of 600 kg/ha possible, but more commonly 300-400 kg/ha.
8. **Dogstail (*Cynosurus cristatus*)**
- requires well drained average fertility soils with pH 5.8-6.
 - usually late spring sown (November/December) by broadcasting at 18 kg/ha, often with a turnip cover crop (0.25 kg/ha).
 - pre-emergence weed control with MCPA or MCPB.
 - graze lightly in late summer/autumn, and again in following spring, but close in mid October; autumn nitrogen (20-30 kg/ha) should be applied to encourage tillering before winter.
 - harvest around 5 weeks after flowering by windrowing when seed is 'biscuit brown' combine 5-7 days later; alternative direct head at 35% SMC and dry to 12% SMC.
 - burn or bale straw and provided stand is weed free, a second year crop can be harvested.
 - yields of 1000 kg/ha have been recorded, but the average is from 350-500 kg/ha.
9. **Velvet grass (*Holcus lanatus*)**
- grows on a wide range of soil types, prefers pH 5-7.5, but will tolerate lower pH.
 - autumn sow at 1-3 kg/ha in 30-45 cm rows; correct P and K deficiencies if necessary, but autumn N not required.
 - winter graze if required, but close in early September; apply 50-90 kg N/ha at closing.
 - very prone to seed shedding and wind can cause large losses; cut at 40% SMC and swath dry to 14% SMC before combining; alternatively direct combine at 35% SMC and rethresh 2-3 days later to remove all seeds; dry to 14% SMC.
 - yields range from 250-800 kg/ha; most losses are associated with harvest.
10. **Sheep's burnet (*Sanguisorba minor* spp. *muricata*)**
- likes light, well drained fertile soils, pH 5-6; moderately warm dry climate, water in spring; shelter from wind during harvest will help prevent seed shatter.
 - autumn sow in frost free areas, or spring sow if risk of frost heavy, preceded by effective autumn-winter cultivation to eradicate potential weed species (couch, white clover, yarrow, sorrel); incorporate EPTC into soil prior to sowing.
 - requires firm, well-tilled, weed free seed-bed; sow at 4-8 kg/ha at depth at 5-10 mm; emergence may take 3-4 weeks.
 - apply N (50-80 kg N/ha) in early spring at closing.
 - use simazine or chlorozuron post emergence in new stands; MCPA + paraquat will give good weed control in mature crops.
 - do not graze in first seed production season; grazing of mature crops should leave 10-40 mm herbage to ensure vigorous regrowth.
 - an extended flowering period and uneven seed set make correct harvest timing difficult; susceptible to bird damage; harvest when 70-80% of the seed heads become brown and feel firm; direct head or pick up cut swath; yields range from 250-500 kg/ha.
11. **Tagasaste (*Chamaecytisus palmensis*)**
- prefers freely drained soils with pH 5.5-7.5; avoid water logged soils.
 - grows well in most cool temperate environments, but frost sensitive as small plant.
 - autumn sow in mild winter areas, but spring sow in cooler regions; as presently hand harvested, sow < 1 ha; sow at 10-20 seeds/m of row at depth of 2-3 cm; seed requires scarification, and inoculation (use *Lotus uliginosus* inoculant); seed bed should be fine and firm; rolling after sowing aids establishment; seedlings can also be transplanted.
 - metribuzin, pendimethalin and simazine are successful pre-emergence herbicides, and slug and snail bait (e.g. methiocarb) may be required.
 - row spacing depends on farming system and other use (e.g. shelter, coppice, forage - minimum 3 m).
 - 25 g superphosphate/m row beneficial, otherwise only correct soil deficiencies.
 - rabbit protection (netting or electric wires) essential.
 - no grazing or cutting until after first seed harvest.
 - flowering usually starts 2 years after sowing, appearing in winter and peaking in later winter-early spring; often fewer than half the flowers set seed; insect pollination not required.
 - pick pods when brown-black and dry slowly; thresh by rolling tractor over them or belt threshing; single plant may yield 300 g clean seed.
 - after harvest trim plants to 2 m for ease of harvesting in following year.