Survival of the New Zealand herbage seed industry: quality is the answer

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Abstract

Herbage seed has been grown in Canterbury since 1852. The industry supplies seed for the pastures which cover 6.5 million ha of New Zealand as well as sporting grounds and golf courses. Thus the herbage seed industry underpins our agricultural economy, and our leisure and tourism industries; together they account for over 70% of foreign exchange earnings. Herbage seed is, however, a low value product, and the area in herbage seed has decreased from 80,000 to 35,000 ha in the last thirty years. Furthermore, the industry is facing increasing non-tariff barriers to trade in export markets.

This paper reviews trends in herbage seed area, yields, and cultivar number over the last 15 years and discusses reasons for changes. The contribution made by herbage seed crops within a cereal rotation is outlined, and gross margin data are presented. The latter show that when treated as a specialist, quality crop, herbage seeds can be lucrative; over the last decade ryegrass and white clover gross margins have increased ten- and five-fold, respectively. The importance of quality (purity, germination and vigour, the latter two components incorporating pre- and post-harvest treatment) is emphasised. Only by maintaining its reputation as a supplier of high quality seed will the New Zealand herbage seed industry survive.

Additional key words: *export, seed vigour, technology transfer*

Introduction

Six and a half million hectares of New Zealand's green and pleasant land are classified as 'improved pasture'. Another 1.5 million hectares are in some sort of pasture with scrub. In all, over a quarter of New Zealand has had pasture species introduced for the purpose of increasing the yield and quality of agricultural products, to boost our export earnings. Primary production still accounts for more than half (54%) of our export dollars, most of it based initially upon pastures sown with herbage seed. Many New Zealanders are still wedded to their 'quarter acre, pavlova paradise' and perfect lawns; lawn seed is in demand in autumn and spring. Increasing emphasis on leisure activities within our culture has resulted in a burgeoning of parks, sports fields and golf courses, all requiring specialised grasses, and hence grass seed, to suit their purposes. Agriculture, gardens and sports are important components of the image of New Zealand which attracts millions of tourists each year. Tourism accounts for 19% of total foreign exchange earnings, and is increasing; herbage seed underpins sections of this industry as well.

The New Zealand herbage seed industry has been equal to all the challenges it has been given so far. This paper outlines the history of herbage seed production, discusses the challenges we are likely to meet in the future and suggests the strategies we must adopt in order to be able to overcome them.

The Past

Since 1851, when William 'Cabbage' Wilson ordered 2 hundredweight of cocksfoot seed, plus other seed such as ryegrass, from England (Coulson, 1979) and sowed it in what is now central Christchurch, the seed industry in New Zealand has been through four distinct phases.

During the first phase, which lasted until 1930, pasture on the Canterbury Plains was considered secondary to cropping, and pasture seed was taken only to save the expense of buying it (Slater, 1948). Paddocks were sown down only to give them a break from cropping, lime was considered unnecessary, and superphosphate was widely perceived not to be required for crops. Pasture was sown with a cereal or brassica,

along with ryegrass and clover. Ryegrass seed was harvested the following year, and the year after that white clover could be harvested, or red clover taken after an early hay crop.

The introduction of a seed certification scheme, announced in 1929 (Hadfield 1929), and the sowing of Hawke's Bay ryegrass under contract, marked the beginning of the second phase (Slater, 1948). The area in herbage seed production began to increase. In 1930, over 2800 ha of ryegrass and over 800 ha of white clover were harvested, and the comment was made that this area could easily be extended (Hilgendorf, 1933). By 1938, 7000 tonnes of herbage seed were being produced in New Zealand (Rolston *et al.*, 1990) and production quadrupled in the next decade. However, since no nitrogen, superphosphate or lime were used, yields were unpredictable and highly variable. Furthermore, there was an emphasis on return per pound, not per acre - quality was forgotten in what was described as the 'mad rush for buried treasure of small seeds, a treasure which only a few ever found' (Slater, 1948).

By 1945, a third phase in production was apparent. The relationship between seed production and arable farming had stabilised with the realisation that catch cropping was risky, and that the whole farm should not be devoted to seed production. In 1948, production was down to 15000 tonnes (Rolston *et al.*, 1990). The most common production system was to sow ryegrass with white clover. Ryegrass was harvested in the first year and clover in the second. The area was then grazed for at least one year before returning it to a cropping rotation. Emphasis was on high seed yields with good germination, low disease and high purity. To achieve good yields farmers were advised to sow the ryegrass-white clover seed in to a 'rising plane' of fertility; that is, as ryegrass was thought to be a depletive crop, fertility should be medium, such as that achieved after a cereal crop. High fertility was not advised as it was known to cause excessive vegetative bulk (Slater, 1948).

In this third phase, the results of scientific research on seed production (in contrast to publications based on 'best grower management practices') began to be published. In 1952, for instance, trials in cocksfoot (Lambert and Thurston, 1952) showed yield increases from 290 to 750 kg/ha with the addition of 190 kg/ha nitrogen as sulphate of ammonia.

By the mid 1950s, the production of small seeds, with the 3-4 year benefit from one sowing, was seen to be integral to the management of many mixed cropping farms (Smith, 1956). Catch-cropping meant flexibility for the farmer. Falling prices for wool during the 1950s put more emphasis on seed, and a generally buoyant economy allowed farmers to make capital inputs. demand for seed increased due to breeding of improved forage plants, addition of lime and superphosphate, and more efficient pest control (Whatman, 1968). The availability of efficacious pesticides was a by-product of war research.

A decade later, the area had increased to 80,000 ha (Hebblethwaite, 1980) and the industry was worth $8 million at the farm gate, and $4 million in export earnings (Shillito, 1968). South America, identified earlier (Calder, 1934) as having potential, had become an important market, and the possibility of providing an 'out of season' multiplication service for other countries was being hotly debated. Unsolved problems for seed production were identified as being sowing dates, sowing rates, nitrogen application timing and amount, and drying (Shillito, 1968).

During the 1970s and 80s, research addressed many of these issues. The New Zealand Seed Technology Centre was established at Massey University to enhance research and education in seeds. It worked closely with scientists at DSIR Grasslands and the Ministry of Agriculture and Fisheries Official Seed Testing Station to address problems faced by seed growers. Seed yields increased (Table 1), within the vagaries of climate, reflecting increased availability of new technology.

By 1980, however, only 50,000 ha were being grown, and in the 1990s it had decreased further to an average

Table 1. National average seed yields of Grasslands Nui ryegrass and Grasslands Huia white clover, 1971-1997 (Seed certification statistics, MAF).

Year	Grasslands Nui (kg/ha)	Grasslands Huia (kg/ha)
1971-75	533	153
1983	497	230
1984	512	201
1985	568	206
1986	575	100
1989	608	440
1990	688	408
1991	865	383
1992	808	384
1993	816	283
1994	699	244
1995	893	295
1996	1002	303
1997	989	343

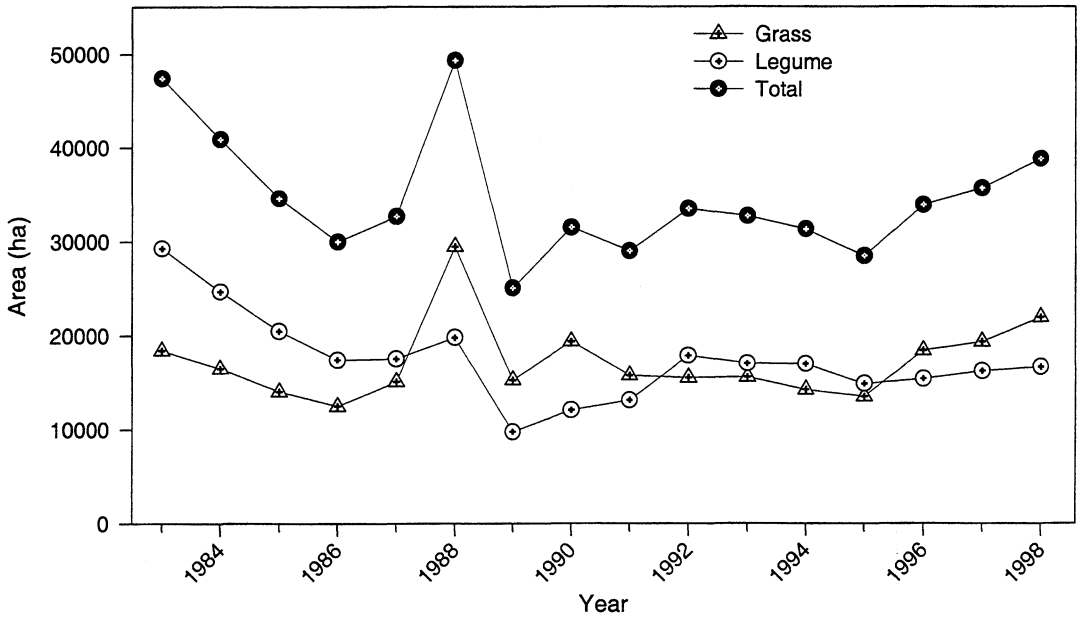

Figure 1. Area in herbage seed production, 1983-1998.

of 30,000 ha (Fig. 1). The failure of the American seed crop in 1987 caused a marked, but short-lived, increase in area in 1988, mostly in ryegrass seed production. From 1950-1990, average production was just over 20,000 tonnes, varying from 14,000 to 34,000 depending upon climate and market opportunity (Rolston *et al.*, 1990).

In 1987 the certification standards were changed and the 'permanent pasture grade' was removed. This meant the demise of catch-cropping (Rolston *et al.*, 1990), the increased prevalence of specialist cropping, and an increase in gross margins (Table 2) - the fourth phase in seed production in New Zealand had begun.

The Present

Herbage seed production now occupies approximately 35000 ha of prime arable land, most of which (96 - 98%) is in Canterbury and North Otago (Table 3); data indicate that the industry is becoming increasingly centred upon mid-Canterbury. Ryegrass and white clover still account for most of the area (47 and 41%, respectively) and 73 and 17% of production (Table 4), but there are now 14 grass species, 7 legumes and 2 herbs entered into the certification scheme. Furthermore, over the last decade cultivar numbers, particularly in ryegrass and white clover, have increased dramatically (Fig. 2).

Approximately 25000 tonnes of herbage seed is produced annually, worth about $50 million at the farm gate. Over half is exported each year (almost 17000 T in 1997, of which two thirds was ryegrass and a quarter was white clover; Table 5), to more than thirty countries around the globe. Principal export markets are Australia, the Economic Union and South America.

Seed production is now the role of the specialist, who recognises the importance of thorough cultivation and weed control of seedbeds, weed control during winter and spring with appropriate herbicides, good insect and disease control methods, close monitoring of flowering/anthesis and seed development, and harvesting techniques to overcome shattering.

Seed production is not only an end in itself, contributing valuable dollars to farm income, but it also plays an important part in the rotation: the fibrous roots of grass seed crops increase structural stability (Haynes and Francis, 1990), both clover and ryegrass crops

Table 2. Gross margins for ryegrass and white clover[1]

Year[2]	Yield	$/kg	Gross margin ($/ha)	Yield	$/kg	Gross margin ($/ha)
1988	na[3]	na	na	350[7]	2.25	178
1990	850[4]	0.90	68	350[7]	2.90	370
1991	na	na	na	350[7]	3.20	443
1992	na	na	na	300[8]	4.20	346
1993	na	na	na	400[8]	4.00	562
1994	1000[5]	1.20	98	400[8]	4.00	448
1995	1250[6]	1.40	610	400[8]	4.00	526
1997	1250[6]	1.60	850	400[8]	5.50	1023
1998	1250[6]	1.70	980	400[8]	5.00	870

[1] From Financial Budget Manual, Lincoln University
[2] Data for 1989 and 1996 not available
[3] Not reported
[4] cv. Grasslands Nui
[5] cv. Concord
[6] cv. Embassy
[7] cv. Grasslands Huia
[8] cv. Grasslands Kopu

Table 3. Geographical distribution of herbage seed growing area (Seed Certification Statistics, MAF).

	Area (%)			
	1987/1988	1992/1993	1995/1996	1997/1998
Manawatu	6.0	1.4	1.8	1.6
Blenheim and Marlborough	2.2	1.2	0.8	1.1
North Canterbury	23.7	22.4	21.0	21.1
Canterbury	43.1	48.9	53.8	57.6
South Canterbury and North Otago	23.5	24.9	21.1	17.8
Southland	1.5	1.1	1.5	0.7

increase soil N by over 100 kg/ha (compared with only 48 kg/ha from a ryegrass-white clover pasture) (Williams and Wright, 1997; Williams *et al.*, 1998), and the crops provide an opportunity for weed and pest control for sensitive crops in other parts of the rotation. Furthermore, they can provide useful grazing during some months of the year.

The Future

Global herbage seed exports are worth US$ 419 million; the international movement of seeds is increasing steadily, and faster than the domestic markets, due not only to general globalisation of trade, but also to reasons specific to the seed industry, such as counter-season growing and agro-climatic adaptation to seed production (Le Buanec, 1997).

Globally, however, herbage seed is an undervalued product (Rowarth *et al.*, 1997), and land use for herbage seed production in New Zealand is under threat from higher value products, such as vegetables, life-style farming operations and the continued expansion of dairying (Burgon *et al.*, 1997; Rowarth, 1997).

The future, the fifth phase, of the New Zealand herbage seed industry, depends on the ability to secure production contracts at a price which will provide an economic return for the grower. New Zealand growers are very willing to produce for export markets (Burgon *et al.*, 1997), but prefer crops that offer long-term consistency in production. Consistency in production requires some stability in seed supply and specialised producers. The presence of the latter in the New Zealand seed industry has tended to produce the former, although the effects of the vagaries of climate cannot be

Table 4. Area and quantity dressed of different species[1] entered for certification in 1996 (Seed Certification Statistics, MAF).

Species	Area (%)[2] 1996	Quantity dressed (T) 1996	Area (%) 1997	Quantity dressed (kT) 1997
Legumes				
Lotus	0.8	15.8	0.6	23.6
Red clover	3.4	153.7	3.1	232.4
White clover	41.4	4070.9	39.2	4996.8
Grasses				
Brome	0.8	187.2	0.8	411.4
Browntop	1.1	83.3	1.3	85.5
Cocksfoot	2.8	822.0	1.0	578.3
Crested dogstail	0.2	56.9	0.0	18.5
Fine fescue	0.1	24.6	0.0	14.4
Phalaris	0.0	20.5	0.2	14.8
Prairie grass	0.8	997.7	0.6	557.6
Ryegrass	47.2	17619.7	50.9	16947.1
Tall fescue	0.9	96.7	1.54	150.0
Timothy	0.3	43.5	0.3	24.5
Yorkshire fog	0.1	13.6	0.0	5.7
Totals		24205.9		24110.0

[1] Area of some species is extremely small and is therefore not entered on this table.
[2] Based on total area for 1996/1997 of 35680 ha.
[3] Based on total area for 1997/1998 of 38812 ha.

ignored. However, the ability to meet market demands is obviously also of prime importance, the major factors being seed quality, species/cultivars, and price.

New Zealand's herbage seed industry has long held a reputation for the quality of its products, and the skills of its growers, processors and traders. The seed quality assurance provided by the Seed Certification scheme and adherence to Plant Variety Rights requirements has generally ensured that this reputation is deserved. A notable exception has been the intermittent problems created by the infection of ryegrass seed lots with blind seed disease (caused by the fungal pathogen *Gloeotinia temulenta*), and the subsequent inability to meet contractual germination standards. Effective control strategies for this pathogen must be achieved. However apart from the effects of blind seed disease, germination of herbage seed lots is not anticipated as a problem area for quality in the future. There is reason for concern about the ability to continue to meet purity standards (both analytical and cultivar), and the lack of knowledge about a seed quality factor of the future, seed vigour.

At present over 5% of all herbage seed lots entered for certification are either downgraded or rejected from certification through failure to meet analytical purity standards (Table 6), that is, they are rejected after all the expense of growing, harvesting and seed cleaning has been incurred. Between 2 and 9% of these downgradings/rejections are due to weed seeds. This is a long recognised problem (e.g., Cockayne, 1912, 1916), and various chemical and cultural strategies have been introduced for weed control. However they rely heavily on the use of herbicides, and for both environmental and economic reasons the number of products registered for use in herbage seed crops is decreasing (Hampton, 1997). Even internationally, the comparatively small size of the herbage seed industry does not support the development of new herbicides specifically for herbage seed crops. Weed control is becoming a major management problem (Mueller-Warrant, 1997) and a lack of effective options could seriously impair the ability of growers to meet the analytical purity standards required, both for certified seed production and export.

The rapid increase in the number of cultivars for which seed is being produced has highlighted one of the most difficult areas of seed quality control, cultivar verification (Hill *et al.*, 1997). The present reliance on

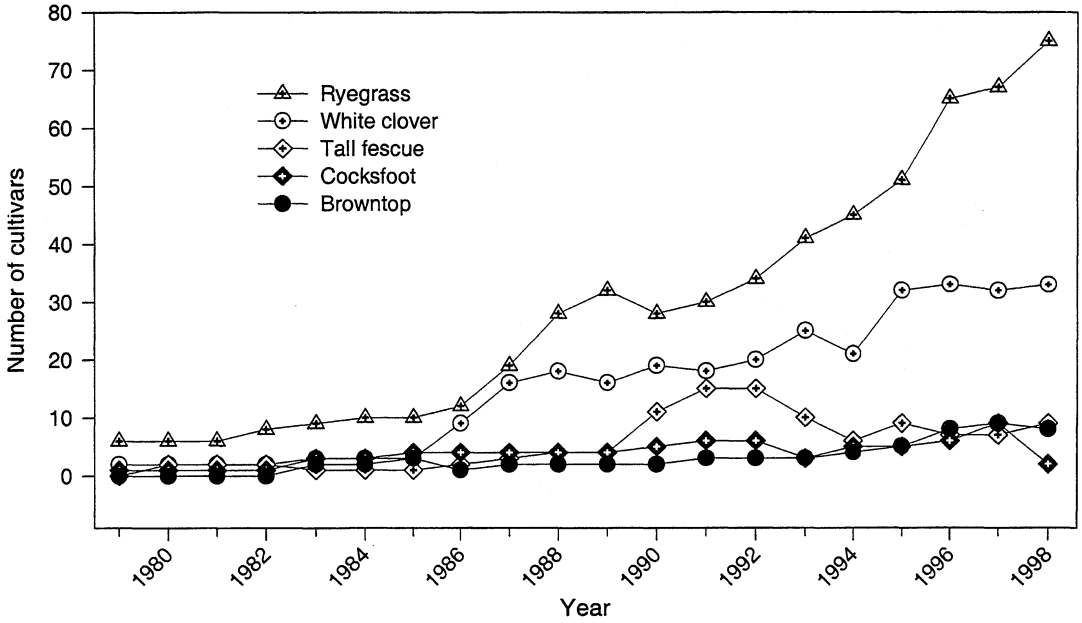

Figure 2. Number of cultivars used in herbage seed production.

Table 5. Seed export statistics for 1997 (Statistics New Zealand).

Species	Seed export (kT)	Seed export (%)
Legumes		
Lotus	21.2	0.13
Red clover	49.1	0.29
White clover	4226.0	25.04
Other clovers[1]	54.0	0.32
Grasses		
Brome	3.5	0.02
Browntop	82.7	0.49
Cocksfoot	232.5	1.38
Crested dogstail	125.4	0.74
Fine fescue	44.3	0.26
Prairie grass	472.7	2.80
Ryegrass	11134.3	65.98
Tall fescue	269.9	1.60
Yorkshire fog	1.0	<0.01
Other	152.4	0.90
Herbs		
Chicory	6.0	0.04
Total	16874.3	100

[1] Subterranean, sweet and suckling clovers

morphological characters (Hampton and Scott, 1990) for distinguishing cultivars and assessing cultivar purity poses potential problems, particularly as cultivar numbers increase and the differences among and between them decrease. Laboratory based methods for cultivar identification such as image analysis and biochemical techniques (e.g., protein electrophoresis) exist and are rapidly becoming accepted (Cooke, 1995), but are not as yet in use for ascertaining that the seed certification scheme is continuing to operate satisfactorily. The New Zealand seed industry will need to adopt laboratory based cultivar purity test methodologies to ensure that New Zealand produced seed continues to meet international cultivar purity requirements. Similarly, production practices must ensure that cultivar contamination does not occur - the technology has been developed successfully for cultivar change in white clover (Clifford, 1997), and many growers have been able to diversify into more than one white clover cultivar per farm. Quality control during production must be adhered to rigidly and monitored regularly.

With the exception of blind seed disease, seed-borne pathogens are not at present a major problem in herbage seed crops (Skipp and Hampton, 1996), although this

situation may change if new species are produced. However one present area of concern is the use of seed borne micro-organisms (i.e., not necessarily pathogens) as non-tariff barriers for international trading. This situation has already arisen for herbage seed lots (Hampton, 1997), and has the potential to disrupt the export trade to certain countries seriously.

Seed vigour is a recognised quality component of virtually all types of seed, but one which the seed trade is ignoring in herbage seed production (Hampton, 1997). However vigour differences do exist among herbage seed lots and these differences may lead to reductions in

Table 6. Downgrading and rejection from seed certification of New Zealand herbage seed lots.

a) Percentage of seed lots downgraded or rejected through failure to meet analytical purity standards. (From Rowarth *et al.*, 1993.)

Reason	Cocksfoot	Perennial ryegrass	Tall fescue	White clover
Total due to weeds	2.1	8.4	8.0	9.2
Total due to inert matter and seed of other crops	2.6	3.7	19.8	2.9
Total downgraded or rejected	4.7	12.1	27.8	12.1

b) Weed species occurring in more than 20 % of the seedlots of cocksfoot, ryegrass, tall fescue and white clover submitted for purity analysis at the MAFQual Seed Testing Station, Palmerston North.

Occurrence (%)	Cocksfoot	Perennial ryegrass	Tall fescue	White clover
91-100			soft brome	
81-90				field madder
71-80				
61-70		soft brome		chickweed
51-60	Yorkshire fog			docks, fathen
41-50	soft brome	hair grass		scarlet pimpernel
31-40			annual poa, field madder, hair grass, pansy,	
21-30	docks, hair grass, pansy	annual poa, field madder	docks, speedwell,	

c) Analytical purity standards for seed lots of cocksfoot, perennial ryegrass, tall fescue and white clover[1]

Class		Cocksfoot	Perennial ryegrass	Tall fescue	White clover
Basic	Minimum pure seed	90.0	99.0	99.0	99.0
	Maximum other seed	0.3	0.3	0.3	0.3
First generation	Minimum pure seed	85.0	98.0	98.0	97.0
	Maximum other seed	2.0	0.7	1.0	0.7

[1] Ministry of Agriculture and Forestry Seed Certification Standards 1997-1998

establishment, dry matter production (Hill *et al.*, 1997) and performance in storage (Table 7). While seed vigour *per se* is unlikely to be a problem for seed production in terms of reduced seed yield, the fact that seed lot vigour differences exist is a direct result of the environment in which the crop was grown and management of the crop from the beginning of seed development through to processing and storage (Hampton, 1991). At present there is little consumer demand for vigour information for herbage seed, but this situation is likely to change, particularly as the International Seed Trade Federation (FIS) now accepts that seed vigour is an important seed quality component. A goal for seed growers will be to avoid the production of low vigour seed; achieving that goal will require research and education.

While there has been a rapid increase in the number of cultivars of the commonly grown herbage species, there has been little change in the number of species grown. Hampton *et al.* (1990) reported that during 1987-89, 68% of total certified seed production was ryegrass, 25% white clover and 7% other species. In 1996 the quantity data (Table 7) expressed as a percentage were 73% ryegrass, 17% white clover and 10% other species. Both Rolston *et al.* (1987) and Hampton *et al.* (1990) predicted that the New Zealand herbage seed industry of the future would have a greater diversity of species, and in 1997/98 seven (birdsfoot trefoil, serradella, Caucasian clover, Yorkshire fog, upland brome, phalaris, dogstail) of the fifteen species that the latter authors predicted would be in commercial production by 1995 had cultivars eligible for certification. However the volume of seed produced for any of the species is still very small.

Species and cultivars are produced because of market demand, both nationally and internationally, and this is why ryegrass and white clover still dominate New Zealand's production. Predicting the future is an occupation riddled with pit-falls. However, the strengths of the New Zealand herbage seed industry (climate, quality assurance, industry infrastructure, innovative and experienced growers, research and technology transfer) mean that New Zealand will be in a position to respond relatively quickly to market signals, whether they be for seed of New Zealand cultivars, cultivars for multiplication and re-export, or the production of seed from non-traditional species (Hampton *et al.*, 1990). To be successful in any of these enterprises, the New Zealand seed industry must continue to produce high quality seed at relatively low cost per kilogram. The role of specialist producers will therefore become even more important.

The wide gap between average production figures and those being achieved by top farmers (Whatman, 1968) has been acknowledged for many years (Pyke *et al.*, 1997). Technology transfer has been a focus of various programmes in New Zealand (Rowarth *et al.*, 1993; Rolston, 1995) and is continuing with the aid of the Foundation for Arable Research (FAR). FAR was established in 1995 with the express purpose of funding research identified as necessary by growers, and which could be put into practice by growers within a short time frame (Pyke *et al.*, 1998).

As we enter the new millennium, New Zealand seed growers are facing their biggest challenge of all - that of meeting the requirements of sustainable production, whilst maintaining economic yields, in the face of increased competition as a result of globalisation of the market place and increased climatic uncertainty. The

Table 7. Field and storage performance of herbage seed lots which germination data indicate are of similar quality. (Adapted from Hampton, 1991.)

	Red clover[1]				Italian ryegrass[1]			
Seed lot	1	2	3	4	1	2	3	4
% Germination	90	90	90	90	96	95	92	94
% Field emergence	76	56	78	80	90	67	79	87
	Red clover[1]				Tall fescue[1]			
Seed lot	1	2	3	4	1	2	3	4
Pre-storage % germination	90	90	90	90	90	91	90	88
Post-storage % germination	90	66	71	91	90	73	58	24

[1] Sown in replicated adjacent rows.
[2] Ambient storage for 12 months.

work of the Foundation for Arable Research, scientists and advisers, the establishment of the New Zealand Seed Technology Institute in 1998 at Lincoln University, plus the willingness of the growers to adopt new technologies, means that they are more than equal to facing this challenge. The fifth phase has the potential to be the most exciting yet in the history of the New Zealand herbage seed industry.

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