GRASS SPECIES : INTRODUCTION IN CENTRAL OTAGO

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MOST ADVISORS of tussock grassland development frequently recommend the sowing of a few pounds of grass seed, usually cocksfoot, with clover seed mixtures for oversowing. With changes taking place in tussock grassland fertility, owing to successful clover growth and more intense grazing, it appears an appropriate time to assess critically the place of grass oversowing and more particularly the emphasis on cocksfoot as the grass to sow in the tussock grassland environment.

Historical

Throughout tussock grassland areas, about 160 different grass species have been sown in nursery and field trials. The approach has been to try to find a grass which would revegetate the denuded area under the existing fertility conditions. In the semi-arid areas, the basic factor governing the growth of a plant is undoubtedly climate, particularly rainfall, and therefore the testing of grass species under the existing conditions is probably a reasonable guide to their productive ability. However, in the subhumid and humid areas of tussock grasslands, it is questionable whether soil fertility does not surpass the climatic influence in importance. This suggests that the early species testing in these areas was biased towards plants capable of existing under low fertility conditions. In the last fifteen years, the soil fertility build-up from successful clover growth and more intensive grazing has probably in many instances reached a level which would support high fertility demanding grasses. It was not until the late 1950s that Hercus (1956) and O'Connor (1959) were assessing the growth of grass species 'under conditions of added nitrogen.

From early trials (see Appendix) it is evident that the widespread use of cocksfoot (*Dactylis glomerata* L.) in the tussock grassland environment is well founded. Tall oat grass (*Arrhenatherium elatius* L.) and tall fescue (*Festuca arundinacea* Schreb.) have also been successful. One point of interest is that perennial ryegrass (*Lolium perenne* L.) has not been widely tested outside the semi-arid region.

The success of cocksfoot is probably in part the result of its ability to survive under low fertility conditions (O'Connor, 1958). It is common practice to oversow cocksfoot seed with clover mixtures at the onset of a development programme, and, while the grass seedlings make little growth for 2 to 3 years, it has been shown that many of the seedlings survive and become productive once the soil nitrogen levels have built up (Cullen *et al.*, 1966). Nevertheless, particularly in fescue tussock areas, many workers have reported difficulty in establishing over-sown grasses (Dick, 1952; Sewell, 1952; Hercus, 1954; Dingwall, 1955; Sievwright, 1956; Lobb and Bennetts, 1958).

Details of Investigations

The establishment and early growth of six cocksfoot cultivars, Grasslands "Apanui", S26, S345, S143, Scotia and Brignoles were measured at three sites representative of the scabweed, the fescue tussock, and bracken fern zones of Central Otago (Douglas, 1966). Seed was broadcast by hand at a rate of 6 lb per acre with 3 cwt of superphosphate per acre on to plots in the autumn and spring of 1964. No clovers were sown. All sites were unimproved; on the bracken fern plots, the top growth was burnt off in February, 1964.

No differences were found in the seedling growth of the individual cultivars, but overall there were large site and time of sowing differences in the growth of the plants. The means of the measurements recorded are shown in Table 1.

In the scabweed zone, cocksfoot was successfully established by broadcasting the seed in the autumn. Autumn sowing has previously been recommended by MacPherson (1913) and Cockayne (1922). Early work by Cockayne (1920) showed cocksfoot would spread naturally on this

TABLE 1: SEEDLING COCKSFOOT MEASUREMENTS AT MAY, 1965, FROM SOWINGS IN MARCH AND AUGUST, 1964

	Rainfall 1964 (in.)	No. of Plants sq. ft		No of Tillers per Plant excluding Main Shoot		Wt. per plant (g)	
		Autumn	Spring	Autumn	Spring	Autumn	Spring
Scabweed	8.29	0.49	0.14	2.20	0.00	0.26	0.01
Fescue tussock	25.0	1.00	2.25	0.14	0.19	0.02	0.02
Bracken fern	40.97	Not recorded	0.70	177.00	11.85	294.00	2.19

TABLE 2: MEAN PERCENTAGE ESTABLISHMENT OF COCKSFOOT SEEDLINGS FROM SOWINGS OF 61 SEEDS/SQ. FT (6lb/acre) *

Site	Date of Measurement	% Established
Autumn-sown, March 1964		
Scabweed . . .	. . . . June 1964	4.3
	May 1965	0.8
Fescue tussock	. . . . August 1964	1.4
	May 1965	1.6
Spring-sown, August 1964		
Fescue tussock . . .	,,,, May 1965	3.7
Bracken fern ,,,,	. . . . May 1965	1.1

*Germination of all cultivars over 80%

country if protected from stock and rabbits but later work by Hercus (1954) and Ludecke (1962) suggested that sod-seeding was advantageous for plant establishment. This result indicates that on country unsuitable for sod-seeding broadcasting of seed may be worth while.

In the bracken fern zone, the cocksfoot grew particularly well. Although the autumn-sown cocksfoot was the better, the time of sowing was probably not as important as sowing soon after a fire. At Te Anau, Cullen (1966) found time of sowing did not significantly affect grass establishment in bracken fern.

In the fescue tussock zone, spring sowing proved the better, which is in agreement with the general recommendation (Cullen 1964; Anon., 1964).

The cocksfoot establishment at each site was only a small percentage of the seed sown (Table 2). More seed-

lings survived on the fescue tussock trial area than on the other more exposed sites. At Te Anau, Cullen (1966) showed the presence of herbage cover was important for seedling survival.

On the fescue tussock site, it appears that much of the autumn-sown cocksfoot seed did not germinate till the spring.

Discussion

Despite the low percentage establishment in the bracken fern and scabweed zones, the growth and vigour of the surviving plants were excellent and the sowing of grasses into the unimproved conditions is recommended.

While the percentage establishment was higher in the fescue tussock zone, the growth under the low fertility conditions was poor and it is questionable whether grasses should be included with the initial sowings of clovers in this type of vegetation. Waiting until there had been a build-up in soil fertility would not necessarily improve results as competition from the existing vegetation is likely to be increased. Cullen (1966a) has shown competition from the resident sward is an important factor in oversowing. Thus, by putting grasses in initial sowings when the sward competition is lowest, a nucleus of plants should be formed to provide a basis for the ensuing high productive sward.

On the other hand, O'Connor (1963) obtained better establishment of cocksfoot oversown into dense fescue tussock when the nitrogen level was high. He suggests that in humid tussock grasslands the building of soil fertility was probably the most important factor in preparing for the establishment of improved grasses.

One advantage of sowing into high fertility conditions is that good production is obtained much more quickly from the sown species.

In the fescue tussock trial, the spring sowing produced 2.25 cocksfoot seedlings per sq. ft from a sowing of 6 lb of seed. Consequently in practice, if only 2 to 3 lb of seed is sown, the low seed rate could probably account for the apparent failure of the oversown grasses. Therefore, in sowing grasses with clovers into unimproved conditions, it appears that to be more assured of success the seeding rate of the grasses should be increased,

From a soil fertility viewpoint the environment of an improved sward is better equipped to maintain seedling growth. If good grass establishment can be obtained from sowing less seed at this stage than into the low fertility sward, then the delayed oversowing of grasses is to be recommended. Under conditions of improved fertility at Te Anau, Cullen (1966) found seedling mortality of oversown grasses was reduced. While more research evidence is required, if greater use is to be made of the ryegrasses then the pendulum is swung more in favour of delayed sowing of grasses.

Arising from these problems of establishing productive grasses, the question might be asked: Why oversow grasses? The main reason is to improve winter grazing either by establishing cool season active grasses, such as the ryegrasses, or by letting the autumn production stand as foggage, as with cocksfoot. For summer production, O'Connor (1960) has shown that the naturalized grasses, browntop (*Agrostis tenuis* Sibth), sweet vernal (*Anthoxanthum odoratum* L.), Yorkshire fog (*Holcus lanatus* L.) and Kentucky bluegrass *(Poa pratensis* L.), give good production under conditions of improved fertility. Thus, if an area has these grasses in the unimproved state, it is not necessary to add grasses to the clover seed mixtures for summer production. Exceptions are areas which are deficient in palatable grasses such as the scabweed, the bracken fern and many depleted areas of the fescue tussock zone.

One necessity for winter feed production is high fertility; apart from providing a suitable environment for ryegrass growth, it enables cocksfoot to produce a bulk of feed in the autumn. The contribution of cocksfoot to winter feed is mainly autumn-saved foggage, so if it were sown in unimproved fescue country it would be a number of years before it made any worthwhile impact on winter feed supply.

At Invermay Research Station, K. R. Drew (1966, unpubl. data), measured the digestible organic matter of frosted and non-frosted cocksfoot by in *vitro* digestion in samples taken at Tara Hills on August 1, 1966. The results were 50.2% for frosted as against 74.75% for non-frosted, the cocksfoot at the time comprising 82% of the frosted herbage.

Frosting has caused a change in feed value from a feed of good digestibility to one which would be submaintenance for an animal fed solely on it (K. R. Drew, pers. comm.). Nevertheless, while the winter feed from cocksfoot is near or below a maintenance diet, it is still considerably higher than what had been offered on this type of country before any improvement had been carried out. In this experiment it was noticeable that the most severely frosted cocksfoot was that which had regrown after an autumn grazing.

Conclusion

At present, grass introduction into tussock grasslands is centred on cocksfoot which, for the critical winter feed period, is producing a bulk of grass of relatively low quality feeding value. The frosting and the digestibility of the cocksfoot would be affected by its autumn management and growth, but, there does seem a place for testing of more winter active cocksfoot cultivars as well as other grass species which stand as foggage with a high percentage digestibility.

It is evident that the introduction of cocksfoot for winter feed in Central Otago is only partly the answer. While this grass has ably filled the gap between the transition of these grasslands from a low fertility to a high fertility status, it appears that more emphasis could now be placed on grasses more useful under high fertility conditions. The saving of autumn growth is only one facet of winter feed production and it seems desirable to mix this form of fodder conservation with the greater use of cool season active grasses.

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APPENDIX

GRASS SPECIES SOWN IN FIVE OR MORE OF THE TEN MAJOR TRIALS IN TUSSOCK GRASSLANDS

o indicates which species was sown
X signifies it showed promise

Species	1	2	3	4	5	6	7	8	9	10*
Agropyron cristatum			x	0	0		x	x	0	0
A. dasystachum			0	0	0		0	0	x	
A. elongatum			0	x	0		0	x	0	
A. inerme			0	0	0			0	0	0
A. inter-medium			0	x		0	0	x	x	0
A. scabrum	0		X	o	o		0		x	X
A. smithii			0	x	0			0	0	
A. spicatum			0	0		0	0	0	0	0
A. trachycaulum			0	0	0			0	0	0
Agrostis tenuis		0	x	x	0					x
Arrhenatherium elatius	x	x	x	x	x	0	x	0		x
Bouteloua gracilis			0	0	0			0	0	
Bromus carinatus			0		0		0	0	x	0
B. inermis	x		0	x	x		x	x	0	0
B. marginatus				0	0			0	x	0
Buchloe dactyloides	0	0	0		0			0	0	
Cynosurus ***cristatus***	0	0			0		o		0	0
Dactylis ***glomerata***	x	x	x	x	x	x	x		x	x
Danthonia pilosa	0		0	x	0	0	x			
Ehrharta calycina				0	0		0	0	0	
Elymus *canadensis*				o		o	0	0	0	
E. glaucus				0	0	0	0	0	0	
E. virginicus				0	0	0	0	0	0	
Eragrostis curvula				0	x	0	0	0	0	
Festuca arundinacea		x	X	x	x	x	0		0	x
F. rubra	x		x		X		0	0		o
Holcus ***lanatus***		0		0		x	0			x
Lolium perenne		0	x	0		0	x			x
Phalaris *tuberosa*			x		x	0	o			o
Poa ampla			0	0	0			0	0	
P. pratensis	x	x	x	x	o	o	o		0	0

*The result of the research work shown under each number is in some cases the added recommendation of more than one author. The trial site and person involved are given below.

1. Macpherson plots at Sawdon, Haldon and Whalesback in the Mackenzie country and at Earnscleugh, Central Otago. Subhumid and semi-arid climates-Macperson, 1912, 1912a, 1913; McGillivray, 1929.

Other species recommended: Agropyrort *repens,* ***Bromus catharticus, Festuca dumetorum,*** and ***Phalaris*** *commutata.*

2. Cockayne plots, Lowburn, near Cromwell, Central Otago. Semi-arid climate-Cockayne, 1922; Tennent, 1935; Lunn, 1951.

3. Pisa Flat Experimental Area, Pisa Flat, Central Otago. Semi-arid climate-Calder, 1944; Lunn 195 1.

4. Tara Hills Research Station, Omarama, North Otago. Semi-arid climate-Soil Conservation and Rivers Control Council Reports 1956 and 1957; Dunbar, 1964 (unpubl. data). Other species recommended: *Agropyron obfusiusculum, Bromus popovii, Dacfylis woronowii.*

5. Ophir Experimental Area, Ophir, Central Otago. Semi-arid climate-Hercus, 1954; Ludecke, 1962. Other species recommended: *Dactylis woronowii.*

6. Ward's plots at Haldon, Mackenzie country and Mt. Possession, Ashburton county. Subhumid and humid climates-Ward, 1923.

7. Sievwright's plots at Holbrook, Mackenzie country. Subhumid climate-Sievwright, 1956.

8. Trials at Molesworth, Marlborough. Humid climate-Moore and Simpson, 1961. Other species recommended: *Dactylis woronowii.*

9. Trials in the Craigieburns and Waimakariri Catchment, Canterbury. Humid climate-Sewell; 1952; L. D. Bascand, 1956 (unpubl. data). Other species recommended: *Bromus popovii* and *Dacfylis woronowii.*

10. Trials in the Craigieburns, Canterbury. Humid climate-O'Connor, 1959, 1960. Other species recommended: *Bromus popovii.*

* * *

A cyclostyled list of the grass species sown in the above-mentioned trails can be supplied by the author.

DISCUSSION

What were the main factors involved in the poor survival of coclcsfoot plants on scabweed country?

The physical forces of the semi-arid climate are the main factors as the soils are naturally fertile (but lack water), and there was no plant competition. From observations, more seedlings survived in the depressions in the ground than on more exposed surfaces, indicating that sod-seeding, where practicable, would give better seedling survival than oversowing. As stated, oversowing and sod-seeding should be done in conjunction with each other.

Is there any merit in using grasses in conjunction with lucerne? In particular, what are the possibilities of the introduction of short-lived winter active species?

Normally lucerne sown alone gives higher production than when sown in a mixture unless the lucerne is subject to invasion by grass weeds in which case the inclusion of a compatible grass would prolong the life of a

lucerne stand and increase production. Greater spread of production is gained by including a grass with the lucerne. Today, lucerne sown alone with short-lived grasses or cereals overdrilled in autumn for winterfeed would probably give the best spread of production compatible with high lucerne yields. As yet no work has been published to confirm this,

In spite of low fertility, would Mr Douglas recommend the use of ryegrass as well as cocksfoot in oversowing?

Yes, perennial ryegrass will give greater winter growth than cocksfoot, under conditions of improved fertility. Ryegrass shows some ability to persist under low fertility conditions and therefore could be included in initial seed sowings. However, since production from the ryegrass would not be gained until an improvement in fertility, it is probably prudent to sow it a few years after the initial clover dressings.

If it is better to put *grass in after a build-up phase, how is this achieved?*

On browntop-dominated country, it may be difficult to lower competition from the invigorated sward by grazing, but, on the majority of fescue tussock country, there seem few reasons why sward competition cannot be lowered sufficiently by grazing to obtain good seedling establishment. The important point is very high stock numbers per acre which come only after adequate subdivision fencing. To be most effective, high stock. numbers are best used in periods of low sward production, *i.e.,* summer or winter, and the grass seed sown shortly before the stock are taken off the block.