Drought recovery of temperate perennial pastures on the northern tablelands

J.F. Ayres, A.D. Turner and P.G. Kamphorst

NSW Agriculture, Agricultural Research & Advisory Station, Glen Innes, NSW 2370

Seasonal drought in Australia is a regular event that has a pervasive influence on the adaptation and performance of pastures in dryland environments. The occurrence of severe episodic drought events, although infrequent, can be potentially catastrophic for the pasture community. Moisture stress during an episodic drought can be both extreme and prolonged and will typically combine with intense and continuous defoliation as the feed resource for grazing livestock progressively diminishes. The additional stress of declining plant nutrition through omission of fertiliser application during drought imposes an additional stress on persistence of introduced species.

A previous report (Ayres *et al.* 1996) described the impact on an introduced temperate perennial pasture community of a two year drought event (1993 - 1995) considered to be the worst drought experienced on the northern tablelands this century. This drought comprised low rainfall in autumn 1993 followed by low rainfall in five of six seasons from autumn 1994 to winter 1995 (Figure 1). The pastures under study suffered loss of introduced perennial legumes (white clover, lotus) to trace levels and ingress of annual grasses and broadleaf

weeds. However, a significant population of introduced perennial grasses persisted. Drought was followed by above average rainfall over spring and summer 1995 and average rainfall conditions in subsequent seasons to summer 1996, constituting a recovery phase. Opportunity was taken to observe the recovery of these pasture communities following this severe drought.

Methods

Location. The trial site was located at Glen Innes (latitude 29°42'S, longitude 151°42'E, altitude 1057 m) on the northern tablelands of New South Wales. Average annual rainfall is 853 mm with summer dominance (36% incidence between December and February inclusive). The annual temperature range is ~ 25°C; the mean maximum and minimum temperatures in the warmest month (January) are 25.8 and 13.1°C, respectively; the mean maximum and minimum temperatures in the coldest month (July) are 12.3 and 0.2°C. The soil type is a self mulching dark brown clay Ug 5.15 (Northcote 1974). The trial site had a fertiliser history of ~ 2500 kg superphosphate/ha applied during the past 20 years (1976 - 1996); molybdenum and sulphur fortified superphosphate were used periodically. Soil test results from sampling in September 1996 show that soil pH(1:5 $CaCl_2$) was 5.1 and available soil phosphate (Bray -1 test) was 23 mg/kg.

Pasture Establishment. Pastures were established on four adjacent unreplicated blocks in autumn 1990; block size was four hectares. Each pasture comprised the same companion grasses (tall fescue, phalaris) but differed in the legume component, being either cv. Grasslands Huia white clover, cv. Grasslands Tahora white clover, cv. Haifa white clover or cv. Grasslands Maku lotus. Seeding rates were according to Lowien *et al.* (1991); 6, 1.5 and 0.75 kg seed/ha for cvv. Au Triumph fescue, Uneta phalaris and Sirosa phalaris respectively, and 2 and 1 kg seed/ha for white clover cultivars and lotus respectively. Planting was undertaken with a conventional disc seeder into a cultivated seed bed. The fertiliser program included 125 kg/ha Starter 15® (15% N, 13.1% P, 10.3% S) at planting and 250 kg/ha single superphosphate as an annual topdressing during 1992 - 1996 inclusive.

Grazing management. Each block was independently grazed by sheep or cattle to maintain pasture biomass availability of 2500/1500 kg DM/ha; *i.e.* grazing was imposed when pasture biomass increased above 2500 kg/ha and grazing ceased when pasture biomass fell below 1500 kg/ha. From 1996, pasture biomass availability was maintained in the range 3000/2000 kg DM/ha.

Measurements

Plant frequency for the legume component was assessed in November each year by recording the presence or absence of the notional legume in a 1 x 1 m^2 quadrat and expressed as a percentage from 100 estimations obtained randomly along four transects.

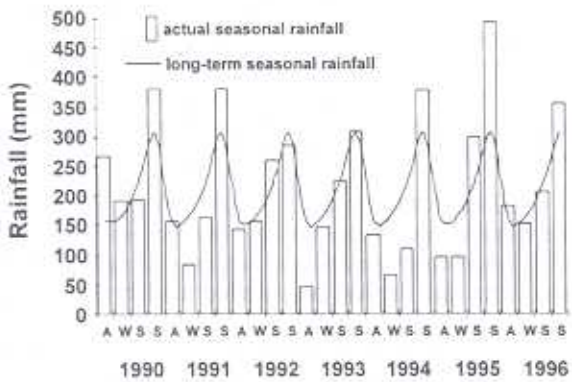

Figure 1. Seasonal rainfall at Geln Innes during 1990-1996.

Botanical composition was assessed in December 1995 and December 1996 using Botanal procedures (Hargreaves and Kerr 1978). Data are presented (Table 1) for dominant and subdominant species detected by the Botanal procedure and also for species aggregated into the following categories; perennial legumes, perennial grasses, annual legumes, annual grasses and annual weeds (Table 2). A sward *stability index* was calculated as the ratio of perennial grass: annual grass (Hutchinson 1992).

Results

Perennial legumes. The recovery phase was characterised by a regeneration of white clover from trace levels (1 - 6% biomass) during drought to dominant status (28 - 44% biomass) in the first year of recovery (Table 1). Although lotus content in the Maku sward remained at a low level (2% biomass), frequency data taken at the same time as biomass data show that lotus presence increased during recovery; lotus presence was 7, 70, 46, 28, 18 and 35% for the years 1991, 1992, 1993, 1994, 1995 and 1996 respectively.

Introduced grasses. The biomass content of introduced grasses on a botanical content (%) basis appeared to be less in the recovery phase compared with the drought phase but this was because the white clover component expanded so substantially (Table 1). Phalaris persisted as a major sward component and tall fescue recovered to minor yet significant biomass levels in three of the four swards.

Invading perennial grasses, native grasses. The invading perennials cocksfoot and paspalum retained presence at low levels. Native grass (principally red grass- *Bothriochloa macra*) remained at trace levels (0 - 2% pasture biomass) in the recovery phase other than an expansion to 14% biomass in the Maku sward (Table 1).

Table 1. The botanical composition (%) of temperate perennial pasture based on alternative legume cultivars (cv. Grasslands Huia white clover, cv. Haifa white clover, cv. Grasslands Tahora white clover, cv. Grasslands Maku lotus) during severe drought and following drought, northern tablelands of New South Wales.

	Drought				Post-drought			
	Huia	Haifa	Tahora	Maku	Huia	Haifa	Tahora	Maku
White clover	5	5	1	6	31	28	36	44
Lotus	-	-	-	1	-	-	-	2
Medics	4	1	-	1	2	-	-	-
Phalaris	35	60	54	44	12	19	15	10
Fescue	9	1	-	5	12	3	-	8
Cocksfoot	2	1	32	21	-	-	19	5
Paspalum	1	3	1	4	2	12	4	10
Native grasses	2	-	1	1	2	-	2	14
Annual grasses	22	19	7	14	11	17	12	6
Weeds	19	11	4	3	30	20	10	1

Table 2. Sward components and stability index (perennial grass:annual grass) for temperate perennial pasture based on alternative legume cultivars (cv. Grasslands Huia white clover, cv Haifa white clover, cv. Grasslands Tahora white clover, cv. Grasslands Maku lotus) during drought and following drought, northern tablelands of New South Wales.

	Drought				Post-drought			
	Huia	Haifa	Tahora	Maku	Huia	Haifa	Tahora	Maku
Perennial legume	5	5	1	7	31	28	36	46
Perennial grass	49	65	88	75	28	34	40	47
Annual legume	4	1	-	1	2	-	-	-
Annual grass	22	19	7	14	11	17	12	6
Annual weed	19	11	4	3	30	20	10	1
Perennial/annual grass	2.2	3.4	12.6	5.4	2.6	2.0	3.3	7.8

Annual grasses, broadleaf weeds. Annual grasses (annual ryegrass, vulpia, annual setaria) and broadleaf weeds (plantain, flatweed, dandelion) maintained significant presence in the recovery phase; annual grass content ranged from 6 - 17% biomass and broadleaf weed content ranged from 1 - 30% biomass depending on sward type (Table 1).

Stability index. The data show that the stability index remained largely unchanged from drought to recovery phase and it is noteworthy that two of the swards remained below the threshold level of 3:1 proposed by Hutchinson (1992) as indicative of species resilience and sward stability.

Conclusions

1. Severe drought reduced all four swards to sub-optimal presence of introduced perennial grasses. In the recovery phase, three of the swards showed partial recovery of the sown perennial grass base; introduced species comprising white clover, lotus, sown grasses and invading exotic grasses comprised 60 - 80% of pasture biomass. The stability index was little different in the recovery phase compared with the drought phase thereby indicating that the pastures remained partially degraded. However, the critical mass of perennials persisting following drought would seem sufficient to promote ongoing recovery.

2. The major observation in the recovery phase was a dramatic increase in white clover. However, this occurred through the annual habit mechanism (seedling recruitment) rather than perennation (stolon survival). A major germination and seedling recruitment event occurred in January 1996 followed by unseasonal mild/moist conditions over the subsequent summer/autumn.

3. The significance of these data is that they show a trend of pasture recovery following severe drought in the presence of adequate phosphate nutrition and without overgrazing - the experimental site was topdressed regularly with superphosphate to maintain medium P status and grazing management maintained sward biomass at a level exceeding 1500 kg DM/ha.

References

Ayres, J.F., Turner, A.D and Kamphorst, P.G. (1996). The persistence of introduced pasture species through severe drought on the northern tablelands of New South Wales. *Proceedings of the 11th Annual Conference of the NSW Grasslands Society*, pp. 137-139.

Hargreaves, J.N.G. and Kerr, J.D. (1978). BOTANAL - a comprehensive sampling and computing procedure for estimating pasture yield and composition. 1. Field sampling. CSIRO Australian Division of Tropical Crops and Pastures. Tropical Agronomy Technical Memorandum No. 8.

Hutchinson, K.J. (1992). The grazing resource. *Proceedings of the 6th Australian Society of Agronomy Conference*, pp 54 - 60.

Lowien, J., Duncan, M., Collett, I. and McDonald, W. (1991). "A Guide to Better Pastures on the Northern Tablelands". NSW Agriculture Agdex 131/10.

Northcote, K.H. (1974). "A Factual Key for the Recognition of Australian Soils". (Rellim Technical Publications: Glenside, S.A.).