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Environmental and Management Factors as Determinants of Pasture Diversity and Production of North Island, New Zealand Hill Pasture Systems

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ABSTRACT

Hill pasture systems are inherently variable due to both environmental (e.g. rainfall, temperature, altitude, slope, aspect and microtopography) and management (e.g. stock type, stocking rate, grazing behaviour and soil fertility) factors. Fertiliser application and grazing pressure are the two main tools used for hill pasture management, as hill pastures are non-arable and the success of oversowing into existing pastures has been limited. One aim of pasture management is to increase the percentage of desirable species (e.g. *L. perenne* and *T. repens*) by changing composition rather than the addition of new species. Pasture botanical composition affects production directly through the productive capabilities of species present, but it is hypothesised that the number of species present play a role in pasture productivity and stability of hill pasture systems.

A field survey and two glasshouse experiments were performed on hill pasture swards to identify the effects of imposed management and environmental factors on botanical composition. The relationship between species diversity and productivity was also investigated.

Ten field survey data sets were collected from two research farms. These data sets reflected different management history, climate, season and time (28 year time lapse). Information collected for each data set included botanical composition, Olsen P, hill slope, standing green biomass, and species growth rate over a one month period. The results of the survey indicated that the same species were present on all sites surveyed, but the abundance of those species changed. For example, *L. perenne*, *A. capillaris* and *T. repens* were most abundant on the high fertility sites, *A. capillaris* was the dominant species on the low fertility sites, flatweeds were more abundant on the dry sites, and *Muscii* spp. were more abundant in spring than summer. There was no direct relationship between species diversity and pasture production, but factors such

as hill slope, fertility and season appeared to play a role in a more complex, undefined relationship between species diversity and productivity.

The first glasshouse experiment involved the application of two simulated management factors (i.e. defoliation height and treading) to hill pasture turves. The turves were removed from three hill country farmlets that had different management conditions imposed on them for 20 years. The abundance of *A. capillaris*, *L. perenne*, *A. odoratum*, *Poa* spp. and *T. repens* increased with the tall defoliation height, which was a positive effect, as was the increase in abundance of *T. repens* with treading. *L. perenne* and *H. lanatus* abundance decreased whilst treading was occurring, which was a negative effect.

The second glasshouse experiment involved the application of a simulated environmental factor (i.e. moisture deficit and excess moisture) and its interaction with a management factor (i.e. treading) on the same turves. The abundance of *H. lanatus*, *Poa* spp., *T. repens* and other legumes decreased under the moisture deficit treatment. *L. perenne* abundance was unaffected. The abundance *of C. cristatus*, *A. odoratum, F. rubra* and *L. perenne* decreased under the excess moisture treatment, all others increased. *T. repens* abundance was increased with a combination of treading and excess moisture.

Functional groups were developed as part of the objectives of this research programme, to simplify the system being studied. In response to the management and environmental factors applied to the turves, the functional groups were described as being increasers, decreasers or static. The results of the turves experiments were used to validate the definition of the functional groups. For example, the high fertility responsive grass functional group was more abundant on the high fertility turves and *L. perenne,* which is also responsive to high fertility conditions, was found to be in a functional group of its own because of its ability to recover from treading. *A. capillaris*, which like low fertility tolerant grasses was abundant on low fertility sites, was separated

into a group of its own because of its great abundance and dominance of the sward.

No definitive relationship between species diversity, production and stability of production was observed in the turves experiments. That *A. capillaris* was particularly dominant in all swards may have significantly influenced the relationship. As with the field survey, however, all species were observed on all turves, and just the abundance of those species changed.

The results of this experimental work showed that pasture composition can be altered to a more desirable (leafy green with legumes and adapted to the environment in which they are occurring) form with the use of management factors such as fertiliser application, defoliation height and treading. That composition was changed without a change in the number of species present, suggested that such composition changes are reversible. The work also highlighted the importance of an environmental factor, that cannot be controlled by land managers (i.e. soil moisture), and its interaction with management practices in maintaining a desirable and stable pasture composition.

"Real generosity towards the future lies in giving all to the present."

Albert Camus (1913-60), French-Algerian philosopher, author.

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