CHAIRS' SUMMARY PAPER: Forage and Grassland Management

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The plenary papers from Theme 22 covered two major problems found commonly in forage production: persistence under cold and drought (King et al) and persistence of legumes in grass-legume mixtures (Hoveland). In both cases, management (cutting or grazing and their timing relative to climatic and physiological factors) places an added pressure on the plant or mixture component, resulting in a weakening of the plant or disappearance of the component from the managed or natural plant community.

King et al. contrasted factors affecting winter survival of forage crops under cold, snow covered conditions of Canada to survival under frequent drought conditions of Australia. The response of plants to cold and drought in both regions is not identical, but there are similarities. In both cases stored carbohydrates, primarily water soluble carbohydrates, stored in crowns, stem bases and stolons act as a buffer, providing energy at maintenance levels, while current photosynthate is in limited supply. However, it is not always true that carbohydrate is the most limiting. For example, carbohydrate levels were not affected by drought and defoliation to the same degree in different seasons in which drought occurred. Drought affected water soluble carbohydrate content and survival more than defoliation under Australian spring conditions, but defoliation was the more critical to survival under fall conditions (Boschma et al., 414). Water soluble carbohydrate can be a compensatory effect of other factors associated with survival.

Other traits, even within the carbohydrate fraction, may be more critical to survival and are specific to species and environmental stress. Specific root storage proteins were cited as having a cause and effect relationship with winter survival and regrowth in alfalfa (King et al.). Also, Nadeau et al. (1473) found that water soluble carbohydrate levels *per se* were not as closely associated with winter survival as high molecular weight fructosans of *Lolium perenne* L. grown in Quebec, Canada. Morphological traits can also be associated with survival under specific management conditions. Stolon density was critical to survival and productivity of white clover strains grown under grazing in New York, USA (Karsten and Fick, 862).

Hoveland reviewed several of the advantages of mixtures of forage species. The advantages, including greater nutritional quality, reduction in legume bloat and reduction in risk of stand failure are particularly evident when legumes are used in mixture with grasses. For example, in this Congress Koch and Yun (1446) reported that lamb gain per ha was doubled with an alfalfa or sainfoin mixture with Russian wildrye compared to a Russian wildrye monoculture. They attributed this response to the high nutritional value of the legumes. Eerens et al. (572) in New Zealand also showed that pasture yield was greater for a white clover-ryegrass pasture than from a ryegrass pasture fertilized with N.

Recognition of the importance of legume-grass mixtures has resulted in specific management strategies to achieve and maintain them. Considerable efforts have been made to determine the most efficient legume-grass mixtures. For example, in this Congress there are reports of testing mixtures of perennial grasses with birdsfoot trefoil in Wisconsin (Grueb and Undersander, 907), with alfalfa in Mexico (Alvarez and Ramirez, 1205) and with white clover in Slovakia (Zimkova, 1714). Likewise, strategies to enhance alfalfa, red clover, or birdsfoot trefoil or white clover establishment through interseeding and overseeding were reported for Argentina (Colabelli and Mazzanti, 248), and Uruguay (Risso and Beretta, 328).

Mixtures of legumes and grasses are inherently unstable to difference in plant competitiveness for light and water, to tolerance to environmental stress such as temperature, flooding, and soil conditions, and response to harvest management. Legumes are generally less persistent than adapted grasses. Enhanced persistence of legumes can be achieved by adaption to environmental conditions. For example, *Arachis pintoi* is a new tropical legume evaluated under grazing for mixtures (Barcellos et al., 462) in the tropics, while Caucasian or Kura cover is being evaluated in New Zealand (Lucas et al., 462), and white clover is being developed under grazing in the USA (Karsten and Fick, 862). Grazing tolerant species of alfalfa have also been developed.

New grass species and varieties also provide an opportunity to increase forage productivity in new environments. A new variety of tall fescue, "Grasslands Advance", provided greater year round forage production in New Zealand. (Hay et al., 828) while "Georgia 5" tall fescue was recently released as the first persistent tall fescue cultivar for winter grazing in the lower southeastern USA. In other areas, species such as winter rye (Botha and Rethman, 1114); bahiagrass (Muchovej and Mullahey, 782) and crabgrass (Dalrymple, 720) are being evaluated.

Technologies and methods are still being sought to renovate and establish legumes in warm and cool season grass stands and cool season grasses in warm season grass stands to improve forage quality and improve distribution of dry matter (Rouquette et al., 714; Josifouich and Scheneiter, 1250; Kuneilius and Carter, 1522; Papadopoulos et al., 1584), indicating the difficulty and the desire to keep legumes in grass stands.

The discussion confirmed the need for improved persistence of forage crops, especially for legumes grown in mixtures. Comments were made to the effect that selection for improved genetic material must occur under the climatic and management regime specific to end use, if progress is to be made. Choice of species or selection of genetic material for a specific management system should be based on traits providing the greatest projected resistance to stresses observed under that system. It was suggested that a lack of long term multi-disciplined research limits improved persistence to cold, drought and competition. An international reporting system for tolerance to specific stresses may be useful in improving persistence in forage crop species.