Summary of Sessions in Theme B

Grasslands/Rangelands Production Systems

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The Theme 'Production Systems' ranged widely from papers on plant gene function to animal production and food quality. While organisationally it was inevitable that the Congress be divided into themes, the overlap between the themes emphasises the continuum in subject matter covered by the Congress.

To give an indication of the scope within the theme the number of poster papers accepted in each session were:

B1 Livestock Production Systems	155
B2 Integration of Crops, Forage and Forest Systems	89
B3 Amenity and Conservation Turf and Turf-grass	25
B4 Developing Improved Plants	99
B5 Domestication of Native Grasslands/Rangelands	89
B6 Seed Science and Technology	84
B7 Forage Quality, Conservation and Utilization	132
B8 Integrated Management of Harmful Organisms of Grasslands/Rangelands	41

As the papers of theatre presentations (invited and offered) and posters are fully reported in the two volumes of the Congress, I'll attempt draw out points made by the presenters which may not be immediately apparent when reading the texts. Main discussion points and a brief summary of the scope of the posters are also included

Livestock Production Systems

In Session B1 the two invited papers provided contrast between temperate grassland and subtropical savannah in Uruguay. Fabio Montossi explained that combining grassland and cropping in a well structured rotation in ley farming was the most sustainable option for farming in Uruguay but due to continuous cropping offering higher short-term profit, grassland had been pushed out to the more marginal areas. He described the technology challenges this poses and demonstrated a technology gap as research stations can produce 1000 kg LWG/ha while the best farmers are producing only about half of that. Peter O'Reagain described his longterm (10 years) stocking rate experiment in a Eucalypt savannah in northern Australia. Under these semi-arid conditions where annual rainfall is highly variable he found that a constant moderate stocking rate over years (despite widely varying scarce annual rainfall) was more profitable, was botanically superior and suffered less soil erosion than that which was at a fixed high stocking rate (set to take advantage of the 'best' years). The most productive treatment produced an average of 21 kg/ha/year! Despite the differences in conditions, both papers emphasised the economic competitiveness of the most sustainable systems appropriate to the conditions they were describing. However, short term gain often wins over long term stability. In discussion the issues raised included the limits to applying the northern Australian findings to other semi-arid regions e.g. Africa, the possibility of introducing rest periods (spelling) into the grazing treatments, and concern about the apparent paradox in Uruguay between exporting produce from organic farming or promoting a clean green image and openly embracing the benefits of GMOs and agrochemical usage. Two offered papers presented different aspects of temperate grassland systems. Marta Lourenco presented information from a literature review on the effect of species composition in grazed grassland on polyunsaturated fatty acid (PUFA) content in milk and meat, clovers and biodiverse grassland tending to produce higher PUFA in animal product than perennial ryegrass. Emmer Kennedy described possibilities of extending the grazing season to maximise intake of grazed grass by allowing cows restricted access to grazing when weather is inclement at the extremities of the season.

Posters in this session covered a wide range of topics: from maximising primary production yield and quality, through grazing animal behaviour, comparisons of grazing systems, whole systems, and animal breeds, economic appraisals, animal health to the impact of forage type and animal breed on quality of food. Despite wide diversity many reflected the focus of the two main papers on the importance of sustainability in grass/rangeland livestock production systems whether it be identifying indicators of sustainability on Canadian dairy farms (Belanger *et al*.), advocating the environmental and economic benefits of reintroducing a locally adapted breed of cattle in southern Africa (Bayer *et al*.) or developing a system of winter housing for sheep to reduce pasture degradation and soil erosion in Gansu province in China (Ma *et a*l.).

The poster by Allen *et al*. presented evidence in support of grassland experiments running longer than 3-5 years (the usual timeframe imposed by funding bodies). Derner *et al*. concluded that, from a re-analysis of literature comparing continuous and rotational grazing of rangeland, animal or plant production is not overall higher in rotational than continuous grazing systems

Integration of Crops, Forage and Forestry

In Session B2 case studies were reported in both invited papers. Neil MacLeod described a participatory technology development project integration of forage and cropping systems by small holders in Indonesia while Yu-Ying Shen. described how alfalfa was integrated into a traditional system of pig-grain farming in the western Loess Plateau in China. In discussion Neil MacLeod considered that the success of the Indonesian example was mainly due to identification of a genuine need, avoidance of the 'night market' approach (project mentality) and so ensuring meaningful follow-up and continuity to build up confidence, and making available a complete system in which the farmer is helped to make a decision. The Loess Plateau example was considered to have been successful mainly due to the system and its components having been well understood, supportive government strategy and taking account of operational/sociological factors. 'On-ground teams' were critical to the scale out phase of the Indonesian project and enthusiastic local undergraduates had a role to play. There was some discussion about the role of stakeholders in successful adoption. It was stressed that, of course, local services needed to be involved so institutional support was essential for continued success.

Some of the 89 posters were concerned with studies quantifying the inter-relationship between forage and crops or trees in integrated systems, including the role of manure or fixed nitrogen from the livestock components on crops, and the use of models to determine optimum combinations of grass and crops. Although not covered in the invited papers, 17 of the posters dealt with varying aspects of the integration of trees or coppice with pasture, the majority relating to Central or South America.

Amenity and Conservation Turf and Turf Grass

Just as for forage grasses, Bob Shearman explained how amenity grasses are continually being improved by breeding and introducing new species to be more stress tolerant, pest resistant, and of higher quality (albeit that the criteria of quality differ for amenity and forage use!). In amenity grasses greenness and resistance to wearing and tearing continue to be improved. The challenges to turf growth and maintenance in modern football stadiums, especially in Northern Europe, due to their structure (excluding light and restricting air movement) and the demands placed on their playing surface were highlighted by Steve Baker. Mathematical models are now used to identify the most vulnerable areas of the turf at different times of the year so that preparations can be made to remedy the environmental constraints. Special rooting media have been developed to increase wear resistance and maximise drainage, and artificial air circulation and winter lighting have been introduced to protect the turf. From a trial conducted to determine the most effective nitrogen fertilisation management to maintain greenness on a lawn, Golinska concluded that the optimum was a moderate total annual rate (160 kg N/ha) applied fortnightly

Issues raised in discussion included the likelihood of release of genetically modified varieties of amenity grasses and the environmental impact of heavy fertilizer usage on turf grasses. It was considered unlikely that a genetically modified herbicide resistant *Agrostis stolonifera* variety would be released soon due to the danger of gene flow into the natural population. Steps are being taken to use agrochemicals more responsibly on amenity turf, e.g. on golf courses, taking account of the potential impact they can have on surface and underground water quality.

About 40% of the posters were concerned with evaluation of species, varieties or breeders' selections for specific conditions, often related to a particular environmental stress. Molecular techniques featured in a few such as in the use of microsatellite fingerprinting, Agrobacterium-mediated transformation and cloning of drought resistance genes.

Developing Improved Plants

The requirement for more appropriate species and improved varieties of currently used species is becoming a priority in areas in which circumstances have changed, e.g. in southern Australia, due to increasing salinity and in Uruguay where, productive forage species are required for marginal land. Serita Bennett explained that rising water tables and increasing salinity in southern Australia are rendering existing forage species (mainly annuals) unsuitable for agriculture. Although perennial legumes, grasses and herbs have been sourced in other Mediterranean-type climatic regions and evaluated for southern Australian conditions, material from more arid

regions of the world has been acquired for the driest areas of southern Australia. Development of core collections of germplasm is an important feature in this type of project. Ghamkhar *et al*. described the use of state-of-the-art technology, e.g. DNA markers and eco-geographical data, in the development of collections of bladder and subterranean clovers.

The benefits of interdisciplinary international research programmes in plant improvement were espoused by Monica Rebuffo. She described the interdisciplinary project LOTASSA involving researchers in Europe and South America and includes molecular biologists, biochemists, microbiologists, plant physiologists, plant breeders and agronomists. The aim is to improve agronomicaly useful Lotus species to cope with drought, salinity and low pH, by exploiting knowledge of the genetics of the model species *Lotus japonicus* in molecular-assisted breeding. It was stressed that in such a programme consideration has also to be given to the most appropriate strain of rhizobium.

Two papers on manipulation of fructan content in perennial ryegrass were presented. The paper by Jensen *et al* described the characteristics of transgenic perennial ryegrass lines with higher expression of fructan biosynthesis genes than controls. The genetically modified lines maintained higher levels of fructan than controls throughout the growing season and had greater drought tolerance. The paper by Hisano *et al.* described their results on mapping the genes involved in fructan biosynthesis, invoked by conditions during cold acclimation, results of which are likely to lead to cold hardy transgenic perennial ryegrass.

Stimulated by offered papers on genetically modifying grass species to increase their water soluble carbohydrate content, discussion was centred on criticism of European Union opposition to the release of genetically modified organisms. Merit of placing emphasis on *Lotus* spp. was questioned, claiming that members of the genus are not widely used and they usually lack persistence. However, the potential of Lotus spp. was defended due to the use of *Lotus corniculatus* in some parts of South America, its promise in the Australian evaluation trials and its tolerance generally to low soil P status.

Posters covered breeding (conventional and transgenic), quantifying genetic diversity, evaluation of species, varieties and breeders' lines (mainly under specific environmental stress) and physiological mechanisms involved in stress tolerance. The majority of posters were concerned with application of molecular methodology, emphasising the increasing importance of molecular genetics in forage improvement programmes.

Domestication of Native Plants for Regional Use

Collaboration between US rangeland plant collectors in need of more varied germplasm and those from an area with abundance (Mongolia) was described by Doug Johnston. These collections have been lodged where seed is readily available for the development of improved cultivars which will be resistant to grazing pressure on rangelands for wider use. The search for and development of suitable germplasm to restore degraded arid rangelands in Russia and Central Asia was covered by Dzyubenko. Concentrating on halophytes he considered that there were more than 100 native species suitable for domestication and use in restoration and outlined the process of collecting, maintaining genetic variation, assessing agronomic value and breeding. He described an interesting study in which the original route taken by Vavilov in 1916 was recently retraced. A high proportion of the species collected by Vavilov could not be found suggesting that genetic erosion had been considerable in the intervening 80 years.

Topics of posters included development of native grasses and legumes in US, China and Australia, with over 60% of the posters relating to native species in China. Assessment of genetic variation accounted for more than a third of the posters from China. Collecting and domesticating species from the Middle East and Canary Islands (described earlier) for use in southern Australia was described. In Discussion concern was expressed about introductions becoming weeds. The danger was widely recognised and it was stressed that its importance should be taken into account in the early stages of evaluation. In conclusion there is no single solution to sourcing germplasm for pasture or amenity plant improvement as the genetic variation within native populations may not always be sufficiently wide to cope with the degree of change in conditions.

Integrated Management of Harmful Organisms of Grasslands/Rangelands

Invited papers in this session comprised a series of four by range scientists from the US on invasive plants. These papers highlighted the vulnerability of native grasslands to invasion (e.g. Great Basin and Great Plains in the US) (Mack), methods to remedy invasion including biological control and targeted grazing management (Wilson) or use of herbicides as catalysts for vegetation change (Sleugh). The potential danger of mutual ingression of species from US and China due to similar habitats and increased traffic between the two countries

was highlighted by Brock. Theories on why cheat grass is so invasive in the US but not in its native range, and optimum quarantine arrangements for introductions were the main topics of discussion.

Posters were more wide ranging than the specialised topics covered by the invited papers. While almost half of the posters were concerned with the ecology or control of weeds invading grassland or rangeland, a further third were concerned with pest damage and control in grass and rangeland (mainly insects but also including rodents).

Seed Science and Technology

Seed production of native grassland and of bred commercial forages was compared by Phil Rolston. Seed production of native grasses can be difficult as problems have not been selected out in a breeding programme. However there is evidence that native seed crops are improving due to better understanding of their agronomy. Regulations for marketing native seed are not yet developed. A successful village-based project in Thailand is described in which seeds of new grasses and legumes were produced resulting in improved incomes. Christian Huyghe explained, in a thought-provoking paper, the rational for sexual reproduction in grasses and its implications for sward dynamics and the sward's response to management and renovation. Discussion centred on optimum fertiliser requirements for grass seed crops and suggestions for methods to quantify seed banks.

Posters ranged from factors influencing pollination and seed set to fertilizer management for seed production. The most common category was studies on factors, including stress such as salinity, affecting germination.

Forage Quality, Conservation and Utilization

The importance of conditions in silage, e.g. its content of dissociated acids and its anaerobic conditions, influencing the prevalence of undesirable micro-organisms e.g. mycobacteria and mycotoxins was covered by Nishino. He developed his paper to consider the probiotic effect of silage. In contrast Nissio, basing his experience of silage-making in the tropics in Brazil, described the relative ineffectiveness of inoculants in the tropics, although acid additives usually have a positive effect on fermentation, at least under experimental conditions. Moisture absorbents seem to offer some promise as additives. During discussion the benefit in nutritive value terms of using mixtures as opposed to monocultures was discussed. The possible beneficial effects of growing mixtures (or natural vegetation) in which secondary metabolites from some components protect the high N content of other components (e.g. legumes) in the rumen was discussed. The theory that ease of cell damage limits the amount of biohydrogenation of grasses, due to fast rate of passage out of the rumen, resulting in preservation of polyunsaturated fatty acids (PUFA) was tested (Lee et al.). Tall fescue cells are more easily damaged than those of timothy and perennial ryegrass, and some of the PUFAs in tall fescue were more protected than in the other 2 species when they were fed to dairy cows.

Almost a quarter of the posters were concerned with management, especially time of harvesting, on herbage or silage quality. The next most common category was effects of inoculants and additives on fermentation and silage quality. The beneficial and adverse effects of secondary metabolites (e.g. condensed tannins and saponins) were also covered in a few posters.

Conclusions

From an IGC perspective, over the past 20 years or so, sustainability has increased in prominence in production-based papers. This has been particularly obvious at this Congress and may have been, at least in part, a consequence of joining with the IRC. An encouraging number of papers reported successful adoption of technology or whole systems, some making a significant contribution to poverty alleviation. There are, nevertheless, technology gaps still to be filled. State-of-the-art technology, e.g. molecular genetics and mathematical modelling, continues to be applied to systems and systems component research. Although only a few papers on the potential importance of the role of forages in the human food chain were presented, their impact signals a research and development area which is likely to become increasingly important. Lastly, a commendable number of posters in Theme B are the fruits of international collaboration; hopefully more co-operative partnerships have been formed as a result of this Congress.