INTERNATIONAL GRASSLAND CONGRESS OUTLOOK – AN HISTORICAL REVIEW AND FUTURE EXPECTATIONS

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Abstract

Features of the history of the International Grassland Congress are mentioned. Aspects of a number of failed themes in grassland science are described with respect to molecular biology, intensive systems of ruminant production, carbohydrate use in plant growth, plant succession and range condition, and stocking method. Future expectations are focused on meeting a balance of objectives, maintaining reductionist science, taking new initiatives in plant improvement and in the development of animal production systems, and reducing barriers to international trade. The adoption of grassland science depends upon the growth of new learning, especially through cyclical interaction between scientists and farmers.

Keywords: International Grassland Congress, history, failed themes, expectations, learning, plant improvement, animal production systems, sustainability.

An Historical Review

George Santayana (1905) wrote: 'Progress, far from consisting in change, depends on retentiveness ... Those who cannot remember the past are condemned to repeat it.' Scientists benefit from developing perspectives about the ground from which the component disciplines of grassland science have emerged and interacted, and which now shape its future directions. Cultural memory and traditions may provide a basis for contemporary science; concurrently we need to examine these traditions and discard a large body of garbage.

Our first International Grassland Congress (IGC) met in 1927 at the Leipzig Zoo. The first truly international meeting, with 37 countries represented, was held in 1937 in Wales at Aberystwyth, for many the cradle of grassland science. Sir George Stapledon (1937) dominated the Congress; he recognized the primacy of the soil-plant-animal interface and said: 'Grass ... properly used ensures soil fertility, grass marries the soil to the animal and the solid foundation of agriculture is the marriage of animal and soil.' The availability of nitrogen, the key nutrient in the control of grassland production, arose from the legume: 'No grassland is worthy of the name ... unless a legume is at work. Find or breed the right legume for every corner of the world and you have tolerably good grassland in every corner of the world. Make the conditions suitable for the legume and manage the sward to favour the legume as well as to feed the animal, and everything else will be easy – the battle will be won'. The expansion of industrial capacity after World War II led to the availability of cheaper fertilizer nitrogen and to higher expectations for the level of sward production.

In 1937 much attention in plant improvement was directed to the superiority of bred varieties over regional ecotypes but by 1952 this was counted unnecessary, and I think the main theoretical and technical bases for the subsequent advances were laid down: novel germplasm, selection procedures, modes of reproduction, male sterility and compatibility, quantitative inheritance, induced polyploidy and interspecific hybridization.

When I analysed the main themes which have occupied five representative International Grassland Congresses over the period 1937 to 1993 (Humphreys, 1997) I found a remarkable homeostasis of disciplinary content; plant genetic base, plant physiology, plant ecology and soil science contributed 52 to 57 per cent of the subject matter. Animal nutrition and systems of animal production arising from the study of the animal-plant-soil interface were the other key preoccupations. Over the history of the IGC we have been fortunate to come to Brazil twice; there have been eight Congresses in western Europe, two in eastern Europe, one in Asia, three in Australia and/or New Zealand, and three in north America. Many areas of the world have been poorly represented at Congresses, and three regions out of eleven – north America, Australia and New Zealand, and western Europe – account for 75 per cent of scientist participation.

Gradually a wider agenda of debate has evolved at the Congresses. Systems papers emerged from 1966; the strength of tropical pasture science was evident by 1981; socio-economic themes and environmental science continued to receive more attention; the management of natural grasslands has always been featured. I envisage the central role of Grassland Congresses as that of assisting scientists working in specialist areas to conceptualize their work in wider inter-disciplinary contexts.

Failed Themes in Grassland Science

It is not enough to build further upon the existing structure of grassland science; we need to discover new foundations and underpin the whole structure afresh. I begin by enumerating a number of failed themes which had a negative impact, either directly on farm or environmental welfare or indirectly in terms of the faulty allocation of resources to bad or inapplicable science. All experienced grassland scientists here, including myself, are culpable in following at some stage inappropriate scientific fashion.

Molecular biology

There has been a gross misdirection of resources to molecular biology which has slowed progress in other techniques of grassland improvement. We welcome (1) the knowledge that the structure of plant variation can be understood in the new terms of its basis in the molecular biochemistry of gene action and (2) the introduction of truly benign foreign codes. However the impact on pastures of 20 years of research is negligible. Perhaps gene markers may be less valuable as the complexity of the genetic architecture of the desired trait and the range of environments in which it is expressed increase. There may be a niche market in disease resistance, the breakage of lignin and in the marginal improvement of widely traded species such as *Lolium perenne* and *Trifolium repens*.

I contrast this with the tremendous advances resulting from plant introduction programmes, now reduced in scope. I think of *Brachiara decumbens* cv Basilisk covering millions of hectares in Brazil. This introduction from Uganda was popularized by Bert Grof, working at a small, underfunded field station in north Queensland. I think of *Stylosanthes hamata* cv Verano, collected by W.T. Atkinson in Venezuela, and now found over vast areas of northern Australia, Asia and Africa. Both these cultivars require replacement. I consider the excellent germplasm collections amassed at CSIRO in Brisbane and at CIAT in Cali, collections which die unless used. The global evaluation programmes which used to be so vigorous are now curtailed.

I also consider the truncation of regular plant breeding programmes, and the shortage of plant breeders with an understanding of agriculture, are unfortunate. Certainly there are technicians who know about the site of a gene, but how are they to place it in the agronomic context of the role of the plant in a grassland ecosystem?

Intensive systems of ruminant production

This Congress included extensification of grasslands as a theme. We have to recognize that highly intensive systems of ruminant production which either incorporate grain feeding or high levels of nitrogen fertilizer are inherently inefficient. These systems in north America, in Europe and in Japan depend for their survival on (1) heavy transfer of resources from other sectors of the national economy and (2) heavy subsidies of support energy (Wilkins, 1982); they also generate persistent problems of environmental pollution for their communities. Students from tropical countries who seek training of relevance to their own farming systems from countries which have failed so dismally to produce self-sufficient and sustainable livestock production have their disappointments.

Carbohydrate use in plant growth

We seek to manipulate the leaf surface to optimize the sustained harvesting of herbage nutrients and the maintenance of a protective cover of the soil. For many decades a dominant paradigm was the need to accumulate non-structural carbohydrate as ‘reserves’ to ensure growth and persistence (Weinmann, 1961). We now know these ‘reserves’ accumulate when growth demands are low, perhaps because of nutrient shortage, and may even be indicative of plant ill-health. The allocation of regrowth carbon to leaf leads subsequently to a better root system. I may add that my student Wong Choi Chee (1993) has proved me wrong about the growth of pastures shaded in plantations where reserves may have a role.

A new light on the horizon was the Leaf Area Index (Brougham, 1958), which related growth to the degree of interception of radiation. It took us twenty years to learn that the objective was to maximize utilization and not growth, and that growth at low LAI minimized senescence and enhanced nutritive value (Parsons and Penning, 1988).

Plant succession and range condition

Clementsion succession used to work in the tall grass prairies of northern America, but we now think that seral stages are more productive than the disclimax, and that the ‘State and Transition’ model has more utility in manipulating the ecosystem (Westoby, Walker and Noy-Meir, 1989). It is difficult to sustain an evangelistic piety in favour of certain range condition classes in the light of studies which showed they bore no relation to animal production (Wilson and Leigh, 1967; Robards, Michalk and Pither, 1978; Hatch and Tainton, 1993). The homeostastis in the ecosystem is indicated by a north Queensland study which showed that a grassland Stage with a history of heavy grazing has a higher nutritive value and rate of liveweight gain than a lightly grazed Stage, until the feed runs out (Ash *et al*., 1995). Clearly we need a deeper understanding of the processes which drive change in grassland communities.

Stocking method

At the 1960 Congress that great grasslander, G.O. Mott, whose spirit is probably hovering around this Brazil which he loved, proposed a model of the relations of animal production to stocking rate, the prime factor in grazing management (Mott, 1960). We know that the synchrony of available forage with the demand of the animals grazing the pasture requires seasonal adjustment of grazing pressure, and great gains in animal production and in sustainability have then emerged. By contrast why, over seventy years of research, have scientists foolishly directed so many resources to studies of stocking method, where the gains from rotational, time control, short duration and cell grazing have been at best marginal (O'Reagain and Turner, 1992), often negative and certainly negative in an economic sense? These systems have lacked scientific bases. There may be gains from rationing forage and from more even utilization across the farm, and degraded pastures often recover after rest, but animals will never benefit from being presented with aged feed of inferior nutritive value and from reduced opportunity for selection, especially if grazing C_4 grasses.

Future Expectations

The balance of objectives

Grassland scientists have obligations to the farmer producer or grazier, but the disposal of production requires attention to the consumers' tastes and needs, local or overseas. The phrase 'from paddock to plate' encapsulates an emphasis often previously lacking. We also seek to protect our natural heritage and its water quality for the long term or to rescue it from present degradation. In public debate the immense help grasslands give to reducing the threat of global warming through the accretion of soil organic matter (Fisher *et al.*, 1994) has been undervalued, and the dangers of replacing forest with pasture overstated. Continual annual cropping almost inevitably runs soil carbon down, and the incorporation of animals in cropping systems, using pastures or tree crops, is always the best route to salvation. However, alley farming, in which hedgerows are regularly pruned to produce mulch, has not been adopted anywhere in the world; hedgerows to feed ruminants is a better option.

We have to recognize that environmental protection only works where it is married to economic incentives, as occurred with the adoption of minimum tillage. Pragmatic innovations will only emerge if governments and institutions fund long-term grassland research; this also requires that the political will is generated through our effective involvement in public controversy.

Reductionist science

An understanding of the ecosystem and the fidelity of a big picture are gained from hard science; the great advances made through modelling, and the development of decision support systems which work, are underpinned by a hard data base. The growth of programme-oriented, short-term research funding makes it difficult to sustain progress in the component disciplines of grassland science or to develop the working talent of discipline-oriented scientists. Education and research might be seen by the community as a remarkable investment opportunity, and an enrichment to life, rather than as a tax.

Plant improvement

I nominate plant improvement as the area of my greatest hopes for progress in the adoption of grassland science. Farmers readily plant and fertilize new cultivars if their performance meets farmer expectations, if there is a robust technology for their culture, and if seed or planting material is accessible. The global sharing of elite germplasm can lead to better food security and to more stable landscapes.

At this Congress criteria of plant merit have been discussed. New challenges to pest and disease resistance continually emerge. We are gaining a better understanding of anti-quality factors, and the complex, sometimes positive role of tannins. In some areas we can target the specific fertilizer needs or soil adaptation of particular cultivars; we may even be seeking plants which can recover soil nitrate from depth.

Here in Brazil we are amazed at the vast areas now growing selected African grasses but we grieve at the unrealized potential production represented by the relative absence of legumes. Clearly for many regions our legumes are just not good enough. Do we need to rethink the basis of legume adaptation? The development of the trailing tropical legume was a wrong turning in grassland science. In 1989 R.J. Clements (1989) showed us that inaccessibility of growing points to the grazing animal was a positive feature, and this might be extended from creeping legumes to shrub legumes with elevated, inaccessible growing points (Shelton 2001). Perhaps future progress lies with a greater emphasis on shrub legumes, which can overtop companion grasses. An appropriate balance of grass and legume is a primary objective. Can we go further in understanding the adaptive mechanisms for resistance to environmental stresses: climatic, edaphic and biotic? We can evaluate legumes in terms of their resistance to unfavourable soil conditions, or alternatively the efficiency with which they fix nitrogen in response to increased nutrient availability, depending upon the robustness of the rhizobial symbiosis, and the incursiveness, persistence and promiscuity of the associated bacteria. Certainly the increase in soil acidity under long-term leguminous pastures is an area of concern where ley systems are in place.

Constraints to the free flow of germplasm impede our programmes. Certainly we need a code of practice to avoid the movement of unpalatable weeds, but in some countries we have to deal with the parochialism of an environmental lobby with a religious attachment to the preservation of the primitive condition. Local germplasm can survive in gene banks and relict areas; we should not protect the local losers in the ecosystem from successful introductions with superior nutritive value, superior resistance to grazing and drought, and superior contribution to soil carbon balance.

In the tropics the low availability of seed limits development. The physiology of flowering and seed formation, the identification of areas of high potential seed production and the development of efficient crop husbandry require research. High seed yield is an essential criterion for cultivar success. A commercial pasture seed industry has only developed in a handful of tropical countries (Loch and Ferguson, 1999) and intransigent bureaucracies limit the flow of seed to other countries.

Animal production systems

The capacity of species to deliver good quality forage at the seasons of the year when most needed is a significant selection character, and continuity of forage supply remains a central objective. At the 1997 Congress Roger Wilkins (1997) identified two key advances: increased precision in the management and use of inputs, and the increased quality and reliability of grassland feeds to deliver the targeted rate of animal production. Dennis Poppi and his colleagues (1997) produced a robust model of animal responses to changes in intake, digestibility, rumen microbial protein synthesis and the relative rumen degradability of protein. There has been a further sophistication of such production models.

Most of the problems of production systems in the semi-arid and arid zone grasslands are not susceptible to technical inputs, since abiotic factors exert the predominant control, and the reduction of grassland degradation is a socio-economic problem of population pressure, which in turn controls stocking rate.

Trading grassland products

There will be a continuing long-term world demand for grassland products. How can developing countries benefit from this increased demand, when the trading policies of the West are inimical to their market access?

This whole issue has been greatly clouded by spurious cries about the 'multifunctionalism' of agriculture, that the preservation of rural landscapes and the viability of rural communities can only be sustained by heavy subsidies to the export of animal products. There are other more acceptable ways by which governments can channel resources to rural communities. The CAP subsidies to European beef exports continue to damage the access of other traders, especially in the Asia Pacific region. These are complex issues central to the welfare of both producers and the consumers which suffer from the current economic distortions.

The growth of learning

The global flow of information has improved marvellously, and grassland scientists all over the world have instant access to each other's data and perceptions as these appear on the Internet. The negative aspect of this is the low quality of information. There can be no substitute for independent peer review in scientific journals; may we never come to accept a culture where the interim research report, written to satisfy a funding body, is the final repository of new knowledge.

We have moved away from the linear model of agricultural extension dependent on the 'trickle down' from researchers to extension agents to farmers, and now embrace cyclical models where farmers are involved in the research process, second order cybernetics prevails, and the research scientist is both a contributor and part of the problem. The effective education of a grassland scientist requires the development of close relationships with the farming community, especially in seeking to improve smallholder production systems, where research effort is ineffective and wasted unless there is a joint formulation of objectives.

I have been interested by recent perceptions of Raymond Ison and David Russell (Ison and Russell, 2000) that categorizing farmers as 'information rich' or 'information poor' was inappropriate. The cycle of learning is better driven by the release and identification of enthusiasms. 'Enthusiasm' as a word derives from the Greek 'the god within', a distinction which contrasts with the prevalent notion that a source of understanding arises from 'without'. Enthusiasm is often stimulated by people telling stories of themselves, and the identification of joint enthusiasms which emerge can drive the processes of experiential learning to both the generation and the adoption of new technology.

Conclusion

At this Congress we have all learnt a great deal from each other. This great world movement of Grassland Congresses is giving better managed ecosystems, greater equanimity in rural communities and more efficient production of food and fibre.

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References

Ash, A.J., McIvor J.G., Corfield J.P. and Winter W.H. (1995). How land condition alters plant-animal relationships in Australia's tropical rangelands. Agriculture, Ecosystems and Environment **56:** 77-92.

Brougham, R.W. (1958). Interception of light by the foliage of pure and mixed stands of pasture plants. Australian Journal of Agricultural Research **9:** 39-52.

Clements, R.J. (1989). Rates of destruction of growing points of pasture legumes by grazing cattle. Proceedings XVI International Grassland Congress, pp. 1027-1028.

Fisher, M.J., Rao I.M., Ayarza M.A., Lascano C.E., Sanz J.I., Thomas R.J. and Vera R.R. (1994). Introduced grass-based pastures in the South American savannas – could they be part of the missing global sink for carbon? Nature (London) **371:** 236-238.

Hatch, G.P. and Tainton N.M. (1993). A bioeconomic stocking rate model for the semi-arid savanna of Natal, South Africa. In Proceedings XVII International Grassland Congress, pp. 59-60.

Ison, R.L. and Russell D.B. (2000). Agricultural extension and rural development. Breaking out of traditions. Cambridge University Press, Cambridge, U.K.

Humphreys, L.R. (1997). The evolving science of grassland improvement. Cambridge University Press, Cambridge, UK.

Loch, D.S. and Ferguson J.E. (eds.) (1999). Forage seed production, 2. Tropical and subtropical species. CABI, Wallingford, UK.

Mott, G.O. (1961). Grazing pressure and the measurement of pasture production. In Proceedings VIII International Grassland Congress, pp. 606-611.

O'Reagain, P.J. and Turner J.R. (1992). An evaluation of the empirical basis for grazing management recommendations for rangeland in southern Africa. Journal of the Grassland Society of Southern Africa **9:** 38-49.

Parsons, A.J. and Penning P.D. (1988). The effect of the duration of regrowth on photosynthesis, leaf death and the average rate of growth in a rotationally grazed sward. Grass and Forage Science **43:** 15-27.

Poppi, D.P., McLennan S.R., Bediye S., de Vega A. and Zorilla-Rios J. (1997). Forage quality: strategies for increasing nutritive value of forages. In Proceedings XVIII International Grassland Congress.

Robards, G.E., Michalk D.L. and Pither R.J. (1978). Evaluation of natural annual pasture at Trangie in central western New South Wales. 3. Effect of stocking rate on annual-dominated and perennial-dominated pastures. Australian Journal of Experimental Agriculture and Animal Husbandry **18:** 361-369.

Santayana, G. (1905). Life of reason. 1(12).

Shelton, H.M. (2001). Shrub legumes. In Proceedings XIX International Grassland Congress.

Stapledon, R.G. (1937). Presidential address. In Report IV International Grassland Congress, pp. 1-6.

Weinmann, H. (1961). Total available carbohydrates in grasses and legumes. Herbage Abstracts **31:** 255-261.

Westoby, M., Walker B.H. and Noy-Meir I. (1989). Opportunistic management for rangelands not at equilibrium. Journal of Range Management **42:** 266-274.

Wilkins, R.J. (1982). Improving forage quality by processing. Pages 389-408 in J.B. Hacker, ed. Nutritional limits to animal production from pastures. CAB, Farnham Royal, UK.

Wilkins, R.J. (1997). Congress highlights from perspective of temperate regions. In Proceedings XVIII International Grassland Congress.

Wilson, A.D. and Leigh J.H. (1967). Comparison of the productivity of sheep grazing natural pastures of the Riverine Plain. Australian Journal of Experimental Agriculture and Animal Husbandry **10:** 549-554.

Wong, C.C. (1993). Growth and persistence of two *Paspalum* species to defoliation in shade. PhD Thesis, University of Queensland.