Grassland Production and Management – Trends and Perspectives for the 21st Century

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Abstract

The XIX International Congress is set in a time of unprecedented change, with increasing uncertainty about the long-term sustainability of established systems of land use. The major threats are the continuing rapid increase in the human population of the world, the pressure on land resources to meet food requirements, the effects of global warming on climate stability, and the consequence of these factors on land resource stability and food production potential. Overlying these threats is the impact of the global economy on land use policies.

Projections made at the XVIII International Grassland Congress in 1997 suggested that food production could be expanded to meet the needs of the world's population at least to 2020, but only by means of accelerated investment in agricultural research and development, and by the willingness of governments to control open market systems. However, following a period in the 1960's and 1970's when funding increased in most regions of the world in real terms, there has been a steady erosion of support for research and development at both national and international levels, with particularly worrying consequences to the food production capability of poorer nations. This effect has been exacerbated by the increasing emphasis on "market forces" economic models for determining priorities in research and development programmes.

There can be no doubt of the continuing importance of grasslands to food production and environmental stability, and it seems probable that there will be continuing emphasis on relatively simple pastoral systems in most regions of the world and a move away from high-capital, high-energy systems in regions where they currently exist. There will, therefore, be a continuing need to maintain a broad spectrum of research expertise, and close coordination of production and conservation interests, in order to ensure effective and timely responses to specific (and largely unpredictable) threats and opportunities which develop in future.

These issues are discussed in relation to the future of the International Grassland Congress, and the scope for influencing national and international policy and practice in resourcing and managing grassland research and development programmes.

Introduction

The XIX International Grassland Congress is set in a time of unprecedented change, with increasing concerns about the long-term sustainability of established systems of land use for food production coupled with increasing reservations about the health and safety aspects of food production and processing chains. The major threats to sustainability come from the continuing rapid increase in the human population of the world with its impacts on both food demands and the food production potential of land (Mooney, 1993; Greenland et al., 1998), and from the consequences of global warming and the adverse effects of climate variability on soil stability and productivity (Watson et al.,1998). Overlying these threats is the impact of the global economy on exploitation of land resources for production of tradable commodities, and on the balance of land use in producer countries to meet the increasingly specialised demands of the main consumer nations.

The basic theme which underlies this paper is concern about the serious and growing imbalance in standards of nutrition between the rich and poor countries in the world, and

between the rich and poor people within nations. Our ability to meet the food needs of poor people is one issue, frequently related as much to limitations in social policy, food storage and transport as to frank limitations in production of food (Pinstrup–Andersen and Pandya–Lorch, 1999). Meeting consumer demands of rich people is quite another, involving considerations of product specificity and safety, environmental protection and animal welfare (Dahlberg, 1986; Pardey et al., 1997). Liberalisation of world trade has exacerbated this imbalance, dictating that more and more resources are devoted to supporting production systems designed primarily to meet sophisticated consumer demands. At the extreme, we have the situation in many rich countries where the emphasis is on reducing food production in order to control local surpluses and protect local environments (Lowe, 1995). This latter objective is important in its own right, but needs to be set in the context of global concerns for food needs and environmental stability.

It is particularly appropriate to deal with these broad issues at this venue because Latin America, more that most regions of the world, provides examples of both the problems of land exploitation and the opportunities which exist to deal with them.

Production Needs and Funding Policies

Concerns about the future adequacy of world food supplies are not new (Malthus, 1798, Meadows et al., 1972), but it is probably fair to say that they are now defined much more sharply than they have been in the past. So far, scientific and technological innovation has allowed food production to keep one jump ahead of food demand – as, for example, in the adoption of settled farming, the principles of rotational cropping, the introduction of fertiliser technology, and more recently the "green revolution". None of these innovations has been without its problems and unfortunate consequences (Dahlberg, 1979) but, by and large, they have made major contributions to productive use of resources on a world scale. We might

legitimately ask the questions: “Where is the next innovation coming from? Will genetic technology provide the basis for the next major step in efficiency of resource use or will it, as perhaps seems more likely, focus on the control of processes which influence food and fibre characteristics without making major impact on environmental constraints to production? And in this context, what will be the future demands on management to maintain or enhance resource use efficiency and sustainability in food production?”

In a seminal paper to the XVIII Congress, Pinstrup–Andersen and Pandya–Lorch (1999) summarised the results of an extensive study of projections of food demand and supply on a world scale (IFPRI, 1995). They showed that the rate of growth in the production of staple goods did not keep pace with population increases in the 1980’s and early 1990’s. Of the land devoted to agriculture, permanent pasture, forestry and woodland, 23% had been degraded in the last 50 years to offset gains in output from productive land, with 74% of agricultural land in Central America and 45% in South America being affected by soil degradation (Pinstrup–Andersen and Pandya–Lorch, 1999). Latin America was identified as one of the four regions of the world where significant increase in the area of agricultural land is possible, but this is also a region in which policies of forest clearance for land development have been a source of much contention (Hadley, 1993; Mooney, 1993). In some areas, water may be a more serious limiting resource than land (Greenland et al., 1998). Despite these negative signals, Pinstrup–Andersen and Pandya–Lorch (1999) concluded that food production could be expected to meet the needs of the projected increase in world population to around 8 billion by 2020. However, they placed several important qualifiers on this conclusion, arguing the need for accelerated involvement in agricultural research, international control of open marketing systems, and continuation of funding aid to developing countries if food production targets are to be achieved.

In the context of these comments, recent trends in funding for agricultural research and development should be of major concern. Following a period in the 1960's and 1970's when funding in both categories increased in most regions of the world in real terms, there has been a steady erosion of funding support at both national and international levels, with particularly worrying consequences to the food production capability of poorer nations. Pardey et al., (1999) show that the annual rate of increase in public agricultural research expenditure in 22 OECD countries slowed substantially from 2.7% in the decade 1971 – 81 to 1.7% in 1981 – 1991. From 1981 to 1991, agricultural research expenditure in the same countries declined from 8.9% to 7.5% of total public research and development expenditure, and private funding increased from 50.6% to 58.1% of the total agricultural research expenditure. Rates of increase in research expenditure were greater for developing than for developed countries, though in relative terms the decline from 1971 – 81 to 1981 – 91 was similar (Table 1). However, category mean values hide substantial variation between countries. The annual rate of increase in agricultural research expenditure was only 0.1% for a group of Sub-Saharan African countries in 1981 – 91 (Pardey et al., 1997), and was negative (-0.5%) for a group of 38 Latin American and Caribbean countries over the same period (Table 1). Public expenditure on agricultural research and development declined by 2.2% and 0.2% annually in New Zealand and the U.K. respectively over the same period, and in Australia and the Netherlands funding was virtually unchanged (Alston et al., 1998). In Africa as a whole, the number of researchers increased by 30% between 1981 and 1991, but expenditure on agricultural research increased by only 1% (Pardey et al., 1997). In 1991, the level of agricultural research expenditure relative to agricultural GDP in developing countries (0.50%), was still only one fifth of that in developed countries (2.39%) (Alston et al., 1998). Support for research in developing countries through the CGIAR (Consultative Group on International Agricultural Research) increased rapidly from US$50 million at its

establishment in 1971 – 72 to US$250 million in 1985 – 86 (both corrected to 1985 values), but showed little material change in real terms over the decade 1986 – 96 (Alston et al., 1998; Pardey et al., 1999).

It is difficult to find more up-to-date collated information on funding trends, though several authors (Pardey et al.,1997; USDA/CSRS, 1993) comment that the patterns of erosion established in the late 1970's and 1980's have continued. This impression is largely substantiated by information from correspondents in a sample of the grassland nations of the world which show the following changes (all corrected for inflation):

A reduction of 59% in "grassland and upland" research funding by the Ministry of Agriculture, Fisheries and Food in England and Wales between 1990 – 91 and (estimated) 2000 – 01, and a decline of 17% in the scientific staff of the Grassland Research Institute (now the Institute of Grassland and Environmental Research) over the same period, following a fall of 34% between 1979 and 1989 (R J Wilkins, personal communication).

A reduction of 8.8% in support for pastoral-based research in Scotland by the Scottish Executive between 1993 – 94 and 1999 – 2000 (J A Milne, personal communication).

Reductions of 12.3% in support for pastoral research and of 12.9% in funding for the Crown Pastoral Research Institute from the Foundation for Research, Science and Technology in New Zealand between 1992 – 93 and 1998 – 99 (FRST Research Reports 1992 – 93 and 1998 – 99).

A fall of 48% in funding for the National Institute for Grassland Research from the Ministry of Agriculture, Fisheries and Food in Japan between1989 and 1998 (H Hirota, personal communication).

A fall of 32% in funding for grassland research from the Chinese Ministry of Science and Technology between 1991 – 95 and 1996 – 2000 following a rise of 66% between 1986 – 91 and 1991 – 95 (Nan Zhi Biao, personal communication).

It is clear that there has been a general erosion of funding for agricultural research at both national and international level over the last 20 – 25 years of the 20th Century, and every indication that this trend is continuing, despite consistent evidence of substantial return to investment in agricultural research (Alston et al., 1998). There can be no automatic entitlement to support for agricultural research more than for any other research sector, and shifts in the balance of funding between the biological, physical and social sciences are apparent in many developed countries (USDA/CSRS, 1993; Alston and Pardey, 1998). However, the continuing slackening in support for agricultural research outlined above, set against the specified need for increased research expenditure to meet future food demands, (Pinstrup–Andersen and Pandya–Lorch, 1999) paints a bleak picture for the people in the poorer countries of the world. The effects of this trend are exacerbated by the increasing emphasis in many national research budgets on privatisation of research and development, and on industry rather than government funding for research, with increasing polarisation between basic ("public good") and applied ("appropriable') research. The consequence has been an increase in funding for "value added" and product – oriented research, at the cost of a decline in support for production – oriented research (Alston et al., 1998; Pardey et al., 1999) and a shift away from integrated systems studies to discipline –oriented research (Pardey et al., 1997), with current emphasis on genetic technology as a prime example. In New Zealand, the proportions of total grassland funding allocated to "processing" research by the Foundation for Research, Science and Technology increased from 9.9% in 1993 – 94 to 12.3% 2000 – 2001 and the trend from production – oriented to processing – oriented research appears to be increasing. (E Prendergast, personal communication), Frequently, too, these changes lead to a failure to achieve linkage between production – oriented and conservation – oriented research (G.Lemaire, personal communication) where there are clear advantages to be gained from effective integration of the two.

All of these examples reflect the predominant influence of "market forces" economic models in determining priorities for national and international research and development programmes in the 1980's and 1990's (Alston et al., 1999), and the effectiveness of these models in planning research to meet food production needs rather than business opportunities must now be seriously questioned. Whilst commenting that privatisation of agricultural research and development in developing countries should be encouraged, Pinstrup–Andersen and Pandya–Lorch (1999) make the point that much of the research needed in these countries is in fact public good in nature and is unlikely to be funded by commercial agencies.

Research and Development Priorities

Given the scenario outlined above, what are the implications for grassland research and development in the 21st Century?

In general terms, there can be no doubt of the continuing importance of grasslands to global food production and environmental stability. Reservations about the use of high potential soils for systems of pastoral production to meet demands for high value animal products are understandable though, on the substantial area of land unsuitable for cropping, grazing animals provide the only effective means of using the land resource for food production. (Pimentel and Pimentel, 1986). It seems likely that the current trends away from high capital, high energy systems of grassland utilisation in regions where they currently exist ('T Mannetje, 2000) will continue. Conversely it can be suggested with some confidence that there will be continuing emphasis in most regions of the world on relatively simple pastoral systems with the characteristics of robustness and flexibility in the face of climate variability and unpredictability (Stafford-Smith, 1996, Tainton et al., 1996). These systems will have to be adaptable to meet the demands of new and more specifically engineered plant and animal resources resulting from breeding programmes enhanced by the

application of genetic manipulation technology, and to withstand the impacts of changing environmental constraints. They will need to strike an acceptable balance between the demands for efficient resource use for food production and for the protection of these same resources. And there will be particular need to keep in focus the major contribution of grasslands to soil conservation and stabilisation, and to beneficial (e.g. carbon sequestration), and adverse (e.g. methane production, ground water pollution, salinity) effects on climate warming and environmental protection. (Watson et al., 1998; Goudie, 2000).

Against this background it would be dangerous to attempt any prediction of research priorities for the 21st Century. At the XVII Congress, Nores and Vera (1993) commented that it is virtually impossible to generalise about research needs at the regional or even the national level because of the heterogeneous nature of groups of grassland producers, their technology needs and their socio-economic circumstances. A prevailing theme at recent Congresses has been the need to balance biophysical science with social science in planning and evaluating research programmes (Hadley,1993; Nores and Vera, 1993; Riveros, 1993), and this emphasis seems likely to continue (Jiggins, 1995).

Advances in genetic technology offer new opportunities for precise manipulation of the characteristics and behaviour of plants and animals in grassland systems, and of the microbial populations of soil and rumen systems Lindsay and Jones 1989; Peacock, 1993; Murray et al., 1999), providing new dimensions to research on the control of pests and diseases, and on the nature and value of the end products of plant and animal production. Advances in remote sensing and information processing technology provide new opportunities for planning, monitoring and managing systems of food production (Burrough and McDonnell, 1998; Mansell and Wehn, 1998). These are two areas of technological development which will clearly impact on pastoral production systems in the 21st Century. Ultimately, however, sustainable limits to production are set by the available environmental

resources and the effectiveness with which the plant and animal components of pastoral systems can be integrated in the use of these resources.

This analysis indicates the need to maintain a broad spectrum of research capability, and to emphasise the co-ordination of production and conservation research interests, in order to ensure effective responses to current threats and opportunities and timely responses to specific (and largely unpredictable) threats and opportunities which develop in future. This emphasis on a broad balance of capability, whilst embracing interests in new technology, is apparent in the proceedings of previous Congresses (Humphries, 1997). It seems unlikely that this need for balance will change in future, though it is important that balance should be seen as the outcome of deliberate policy decisions rather than the consequence of an essentially passive planning approach. It will be important to maintain effective balance between the biophysical sciences and socio-economics in planning the development and adoption of new technology by pastoral communities. In this context, there is continuing need to develop or adapt technology which is particularly appropriate for the low input and small scale systems which characterise many parts of the world, and where the use of grassland as a source of animal manures for the crop component may be as important as its animal production function in mixed farming systems. These are sectors in which there is still substantial scope for improvement in both research support and technology adaptation.

The International Grassland Congress

What is the future for the International Grassland Congress in this scenario? In the past it has acted primarily as a medium for exchange of information and ideas about research and practice amongst grassland professionals. This was the basis for the critical judgement by Nores and Vera (1993) that the grassland profession may be seen as "somewhat isolated" and "talking to itself". The question is, can we afford not to get involved in what might be termed

grassland sociology and politics? If the IGC does not campaign for better balance in determining the allocation of resources to grassland research and development, and in the planning and administration of research programmes, who will? And which agencies are better fitted than the IGC to promote the importance of grasslands as a moderating force in facing, for example, the issues involved in enhancing world food supply, conservation of soil and vegetation resources, and amelioration of global warming?

We would do well to recall the concerns articulated by Brougham (1993) who, in his Presidential address to the XVII Congress, warned of the risks of declining support for pastoral science on a world scale, and pleaded with delegates to take every opportunity to emphasise the importance of the pastoral industries in food production and environmental stability. This followed an appeal at the XV Congress in Japan (IGC, 1985), for .."long term institutional support for grassland research and education…" It must be questioned whether the IGC has had a measurable impact on national and international policies in the interim. However, it must also be accepted that the current constitution, with its emphasis on arrangements for a linked series of conferences rather than the provision of continuity and support for a body of international importance, does little to aid the development of a credible force for the promotion of grassland interests.

Perhaps the concept of the Congress as a body with credibility in international fora on major issues of grassland research and practice is too optimistic, but we should seriously consider the feasibility of such a function and the constitutional modifications required to make it possible. At the very least we should give high priority to the procedures necessary to achieve effective reunion with the International Rangeland Congress so that we can again speak with one voice about issues of vegetation use and pastoral livestock production. This will be a small initial step, but it could provide the catalyst for a major development in the influence of grassland professionals on the processes of planning and funding grassland

research and development programmes on national and international scales. Hadley (1993) challenged the XVIII IGC to "examine what needs to be done and what must not be done in order to promote grasslands as sustainable systems". Can we meet that challenge?

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Table 1 - Trends in public agricultural research expenditure (% annual increase) 1971 – 1991 (from Pardey et.al.,1999)

	% annual increase	
	1971 – 81	1981 – 91
Developed countries (22)[+]	2.7	1.7
Developing countries (131)	6.4	3.9
Sub-Saharan Africa (44)	2.5	0.8
China	7.7	4.7
Asia and Pacific (28)	8.7	6.2
Latin American and Caribbean (38)	7.0	-0.5
West Asia and North Africa (20)	4.3	4.1

[+] Numbers of countries in parentheses