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A Profit in Our Own Country

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Developing Sustainable Farming Systems

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There are many concepts of what constitute 'sustainable farming systems'. The definition used for the purpose of this presentation is the one accepted by the Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research (CGIAR), which is:

'Successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of the environment and conserving natural resources' (TAC 1989).

One measure of the adequacy of world food availability is to divide current total world food production by current total world human population. By this measure, the basic nutritional needs of humanity are being met.

However, we know that problems of poverty, distribution and local availability disrupt this calculation. We are also coming to realise that current agricultural production is having ever-increasing detrimental effects on the resource base of farming lands and the environment as a whole. As human population continues to grow, and with it food demands, pressures on this resource base can only increase.

Quite simply, food security remains a vital issue, particularly for hundreds of millions of poor in the developing countries of Asia and Africa. In addition, it is looming as a longer-term threat to all as a result of the effects of degradation of the natural resource base.

This presentation describes how the international agricultural research and development community is facing up to this challenge. It particularly focuses on Australia's current involvement in these concerns, as well as its potential

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involvement in the future, highlighting some examples of particular relevance to Australian agriculture.

International Interventions in Agriculture

In the 1950s and 1960s the quantum shortfall in food production to meet the needs of the post-war population explosion was the main concern of those viewing agriculture from a global perspective. This prompted major international efforts, notably the development of international agricultural research centres (IARCs). These efforts led to the Green Revolution and the prevention of predicted famines during the 1970s and 1980s. Of course, instances of famine and malnutrition persisted, but reasons could largely be attributed to social upheavals and pervasive poverty, resulting in inadequate local production and/or distribution of foodstuffs.

In the 1990s, concerns of how to meet world food demands are again arising, but this time from the following new perspectives:

- Despite declines in population growth rate in Asia, total population increases (even based on low growth rates) predicted for the turn of the century and beyond are truly alarming. In Africa, where growth rates remain high, the situation is even more perilous. Although the absolute numbers are small by Asian standards, by 2030 they may be more comparable.
- In well endowed lands as well as marginal lands, the rate of deterioration of the agricultural resource base has increased rapidly.

Evidence of resource-base deterioration is well documented. An example is the GLASOD (Global Assessment of Human-Induced Soil Degradation) map set produced by UNEP with Sutch collaboration. Particular problems are arising due to:

- increasing salinity and waterlogging problems in the major irrigation areas of Asia, which produce most of Asia's food;
- soil erosion and nutrient depletion in marginal rainfed lands;
- rapid environmental degradation in hilly areas, such as the Himalayan region and the African highlands;
- ever shorter clearing-regeneration cycles in traditional slash-and-burn agricultural systems; and
- desertification in Africa and elsewhere.

Such deterioration of agricultural lands is also readily visible in Australia as desertification of marginal areas, soil erosion, salinisation and (more recently) acidification.

Australia and the Newly Emerging Scenario

An inadequate international response to the looming threats to food security and poverty alleviation arising from problems in the food production/environment protection nexus must inevitably lead to social upheaval. In an ever-shrinking world due to the communication revolution, Australia cannot hope to remain immune from these upheavals, especially as the areas most likely to be affected (in Asia and Africa) are in relatively close proximity to Australia.

Thus a concerted international effort to develop and implement sustainable farming systems in Asia and Africa is in Australia's interest from this perspective at least. Broader issues of social justice, humanitarianism, and equity would also encourage an Australian involvement in action to provide improved food security internationally.

Furthermore, if an international response does successfully address these problems, then those nations taking a high profile in this response are those most likely to reap the commercial advantages of sustained agricultural development, and of the consequent flow-on to other development activities, in Asia and Africa in particular.

It is important for Australia to recognise that involvement in such international efforts permits first-hand access to relevant technologies and expertise that may prove useful when tackling the challenges of developing sustainable farming systems at home. Such technologies may supplement or even supersede those currently in practice in Australia.

This involvement also permits first-hand access to the markets where new development is occurring, a concept well understood by countries such as Japan, and one that needs to be appreciated more clearly in Australia. Simply put, you have to 'be in it to win it'.

Particular advantages of a strong involvement in international efforts to develop sustainable farming systems include:

- a broadened perspective for Australian scientists and other professionals in agriculture, which feeds back into innovation in Australian agriculture;
- exploitation of educational and consultancy services offered from Australia;
- development of professional and personal linkages, which impact creatively on Australia's international relations in the longer term;
- a broadened industry perspective.

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The huge potential in Asian markets for the products of Australia's temperate agriculture has hardly been tapped.

Australian agriculture is highly export-oriented, but on a relatively narrow commodity base. Greater knowledge of trends in international agriculture leads to better understanding of the markets and ability to adjust to new opportunities. For example, the huge potential in Asian markets for the products of Australia's temperate agriculture, including out-of-season and niche markets, has hardly been tapped.

Australia already benefits from these effects in its economy, as a direct flow-on from the internationalisation of its agricultural research efforts. The potential to capture additional benefits, directly to Australian agriculture and indirectly to Australian business and the general community, is huge.

Potential for Synergistic Australia-IARC Interaction

There are many examples of the mutual benefits derived from interaction between agricultural research conducted in Australia and that conducted through bilateral programs, UN agencies or IARCs. Time will not permit a fair sampling of past achievements in this presentation, but a flavour of these is given as follows.

- The facilitation of germplasm acquisition to Australia of IARC-mandated plant species of agricultural importance, including:
 - tropical forage and pasture legumes from South America through CIAT
 - semi-dwarf wheats from North America through CIMMYT
 - chickpea from South Asia through ICRISAT.
- The linkages formed between ACIAR and national and international programs to improve tropical grain legumes in Southeast Asia.
- Physiological and adaptation studies on wheat, collaboratively undertaken by Australian scientists and CIMMYT.
- The numerous interactions between Australian researchers and IRRI scientists aimed at rice improvement in Australia and elsewhere.
- Pasture and livestock projects in China and India, especially aimed at degraded lands.
- Introduction of mechanised agriculture developed in Australia for marginal Mediterranean iso-environments of North Africa.
- An ACIAR project on cropping system sustainability in Kenya.

Land Resource Deterioration

There are many examples of research relevant to the development of sustainable farming systems that have potential for significant collaboration between Australia and the international agricultural research organisations.

One of the most important problems is land degradation, in particular desertification. As defined in UNCED's Agenda 21, desertification is:

'Land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities'.

Of the various threats to the sustainability of the physical resource base, the loss of topsoil through erosion—by both wind and water—is probably the single most important. According to the United Nations Environment Programme (UNEP), 3.6 billion ha, or 70% of the world's potentially productive drylands, are currently threatened by desertification.

In Africa, a population of about 400 million, two-thirds of all Africans, inhabit agroclimatic zones consisting of 1.3 billion ha of arid, semi-arid, and dry sub-humid areas. Recurrent droughts are a permanent fact of life throughout these drylands. Other problems contributing to desertification include uncontrolled population growth, inadequate soil and crop management practices, multiplication of livestock beyond the carrying capacity of natural rangelands, and deforestation.

Like Africa, Australia has extensive areas of arid, semi-arid and dry-humid lands. Significant areas have experienced some form of degradation during the past 200 years, the result of imposing essentially European agricultural systems on a fragile resource base. The effects of this imposition have varied, reflecting various climatic and socioeconomic factors. The problem in Australia may not be so much one of loss of productive land, but rather one of reduced productivity of marginal lands that have been degraded.

ICRISAT is taking a leadership role, together with its sister centre ICRAF, the International Centre for Research on Agroforestry, in the development and implementation of a Desert Margins Initiative. Relating primarily to sub-Saharan Africa, but also including the desert margins of Asia, the Initiative also involves several other CGIAR Centres in a collaborative venture with international, regional, and national institutions.

Some of the major objectives addressed by the Initiative are to:

- combat desertification;

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Australian participation in the Desert Margins Initiative could provide new insights for Australia's Landcare program.

- mitigate global warming;
- conserve biodiversity; and
- provide increased food security.

These objectives will be achieved by promoting improved and innovative crop/tree/livestock production technologies that are ecologically sound, economically viable, sustainable, and culturally acceptable. Specific outputs will include:

- provision of food, fodder, and fuel for the indigenous population, thus enhancing the quality of life while arresting deforestation;
- development of strategies to cope with climatic changes;
- improvement of climate and crop monitoring methods and data collection;
- better awareness among policymakers, the scientific community and farmers of the likely effects of climatic change and the need to preserve biodiversity;
- establishment of a cadre of skilled scientists to ensure the sustainability of the initiative;
- guidelines for the design and implementation of policies that encourage farmers to adopt sound technologies;
- better appreciation of the need for meteorologists, agriculturalists and farmers to work together to address the problems of the desert margins.

Land management in Australia is focused on a mix of policy mechanisms to achieve ecologically sustainable management of natural resources, including land, water, vegetation and nature conservation. This is set against a background of applicable institutional arrangements, land tenure, and social and economic conditions.

Resource management problems, meanwhile, are addressed through the cooperative action of Government, private landholders, and the community. Approaches seek to integrate economic and environmental objectives with the aim of achieving ecologically sustainable development across the continent as a whole.

The 'Landcare' movement is the centrepiece of this process. I believe that Australia's success in achieving the sustainable management of its resources can provide valuable insights for other parts of the world. Similarly, Australian participation in the Desert Margins Initiative could provide new insights for Australia's Landcare program.

Modeling of Agricultural Systems

Mathematical models play an increasingly important role in agricultural research. The relationships between the different

components of agricultural systems are far too complex for simple 'intuitive' or conceptual models. Through mathematical or simulation modeling, it is possible to quantify the major variables and processes that determine the dynamics of an agricultural system in a physically and biologically meaningful way, and to describe the interactions between these factors and processes.

Modeling is an important tool in developing sustainable agricultural systems, some of which may be less dependent than traditional systems on external inputs such as chemical fertilisers, fossil fuels, and pesticides.

Australia, which long ago recognised the importance of simulation modeling in agricultural research, has developed considerable expertise in the field. The Agricultural Production Systems Research Unit (APSRU) in Toowoomba, which is a cooperative venture between the Queensland Department of Primary Industries (QDPI) and the Division of Tropical Crops and Pastures of CSIRO, is among the world's leading groups in the field of modeling of agricultural systems.

For the past six years, ICRISAT has cooperated closely with QDPI in a project aimed at arresting soil erosion in the light-textured soils of the Indian semi-arid tropics. This cooperative project has resulted in important information on the factors that cause soil erosion and on ways of preventing erosion through vegetative covers, porous barriers such as vetiver grass hedges, soil cultivation, and soil amendments such as crop residues.

The results of field experiments in India have been used to calibrate and validate a simulation model for soil erosion. The model, which is known by its acronym PERFECT, was developed by scientists at QDPI. This model was designed primarily for the semi-arid environment of Queensland, but turned out to work very well under the semi-arid conditions of India as well.

The results of this cooperative project not only benefited ICRISAT and the Indian national programs, but also the Australian scientists involved. The testing of simulation models under a wide range of environmental and geographical conditions increased the precision and value of these models for application under Australian conditions.

In addition, although the Australian scientists were exposed to environmental conditions with which they were quite familiar, the socioeconomic conditions they encountered were utterly new to them. Dealing with completely different farming systems in a climatically familiar environment broadened the scientific horizons of all the scientists involved in the project.

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Legumes in Farming Systems

The role of legumes in contributing to the sustainability of cropping systems is well documented. The ability of legumes to fix atmospheric nitrogen is perhaps the most important quality, but many other positive effects are also significant.

Australia has long used legumes in its relatively low-input, extensive agriculture, from the 'sub and super' technology right through to the current expansion in cultivation of grain legumes (e.g., lupin, chickpea). Most cultivated legumes grown in Australia are exotic, and additional germplasm acquisitions must be imported.

Access to a wide range of germplasm is fundamental to any crop improvement effort. Now that many countries around the world are beginning to assert sovereignty over their native germplasm resources, the presence of international institutes maintaining world collections of the seeds of cultivated species held in trust becomes crucial to the free flow of germplasm across national borders.

Australia has been a leader in biological nitrogen fixation (BNF) research and rhizobium inoculation technology. This knowledge has been widely disseminated, with the assistance of the IARCs. However, valid technology for Australia does not always work adequately in other environments. There is now a two-way exchange in progress between Australia and international BNF researchers, giving benefits to both parties.

Drought is a major factor determining sustainability of rainfed cropping systems, and is a particularly important determinant of crop yields in Australia. There is well-established, ongoing and promising collaboration in drought research between Australian and IARC scientists, with studies ranging from agroclimatic analysis of drought-prone environments to identification of drought-resistant crop genotypes.

A good example is an ACIAR project, conducted jointly with the Government of India and ICRISAT, aimed at improving the water-use efficiency of peanut. Also, Australian scientists are keen participants in a global grain legumes drought research network, coordinated by ICRISAT and ICARDA.

Australian, Indian, and ICRISAT researchers are collaborating on specific challenges of common interest with regard to improving sorghum in the semi-arid tropics. The parties to such partnerships can only gain from these endeavours to ensure rapid, frequent and free exchange of information in this research area.

Another example of direct benefits to Australia derived through close contacts with IARCs is the acquisition of very

Australian scientists are keen participants in a global grain legumes drought research network.

promising chickpea lines introduced for cultivation in Western Australia. These lines were selected for cold tolerance by ICRISAT scientists in northern India and ICARDA scientists in Syria.

Chickpea is a crop of great potential for the wheat belt of Australia. While offering a promising and profitable alternative to cereals, it can also help restore the nitrogen economy of degraded wheatlands. The crop's ability to utilise otherwise unavailable phosphorus at depth offers substantial savings for farmers, and attendant benefits to soil structure.

Food legumes, or pulses as they are called in Asia, seem to be favoured as much by insects as they are by the vegetarians of South Asia. Integrated pest management, or IPM, offers considerable promise as a cost-effective and environmentally friendly way of alleviating constraints to enhanced productivity of pulses. Australia's long history of successes with biological control methods, such as its prickly pear research, puts it in a good position to significantly contribute to the world body of knowledge in the fight against insect pests. ACIAR has a major biological control program, a key weapon in IPM.

Another IPM initiative involves three collaborating partners—ICRISAT, the Natural Resources Institute in the UK, and the cotton industry in Australia. The three partners are working together to determine the extent of resistance to insecticides of the number one insect pest of both cotton and pulses, the pod fly. IPM strategies are being designed that involve a more judicious and strategic use of new insecticides to prevent further development of resistance by the insect. Success in this project would clearly be of huge benefit to many countries.

Phosphorus

A workshop held at the ICRISAT Asia Centre in Hyderabad in March of this year indicated possible ways to internationalise future research on problems of global importance. This workshop aimed at developing a global project to exploit recent advances in knowledge of plant nutrition and molecular biology to most efficiently use phosphorus in cropping systems.

It was sponsored by ICRISAT, FAO and IAEA, and Australian scientists strongly participated. A pathway was charted towards developing a global consortium of scientists to tackle a global problem at the heart of sustainable agriculture; namely phosphorus management.

Australia is in a good position to significantly contribute to the world body of knowledge in the fight against insect pests.

Without continual international transfusions of genetic resources and scientific technology, Australian agriculture may simply not be sustainable.

Australian scientists, as important contributors to this effort, can expect to gain from external funding for their research and ready access to latest research on phosphorus cycling in cropping systems. And Australian industry will reap the benefits of the improved technologies arising from this research internationally. Everyone will win!

Time constraints prevent me from citing numerous other opportunities for Australian participation in the global challenge to develop sustainable farming systems. There are many such examples of Australia's comparative advantage as an effective participant. Australia would, therefore, be at or near the head of the queue to capture the resultant benefits.

Conclusion

In simple terms, Australia can ill afford not to be an active player in international agricultural research.

In the GATT era, agriculture will be increasingly internationalised. And in a world ever more concerned with environmental pollution and degradation, we can expect significant market volatility driven by consumer demands for safe and reliable foods. At the same time, consumers and policymakers will seek a global agriculture that both sustains the environment and conserves biodiversity.

The implications of these developments for the Australian economy are quite basic and far-reaching. They involve policy adjustments, and real commercial opportunities will arise from special advantages (such as marketing 'Australia Clean' food). In addition, substantial technical and industrial challenges will need to be resolved in order to sustain the natural resource base and provide increased productivity.

International agriculture is intensely competitive. So far, Australia has had success with its exports largely because they are high-technology products designed to reliably supply an acceptable quality at a competitive price. This is possible only because of the technology built into those products. To maintain that competitive edge and comparative advantage, while at the same time sustaining the natural resource base, Australia must strive to continue to improve its technology and its management systems.

Sustained and well-targeted research is a basic requirement for this objective. Australia is recognised internationally for its contributions to agricultural research. Our country's agriculture, however, is based very largely on exotic species, fragile land systems, and low-fertility soils. The truth is that without continual international transfusions of genetic resources and

scientific technology, Australian agriculture may simply not be sustainable.

The exchange of international research, from which Australia has already received significant benefits, is crucial in view of the looming threats to global food security. It is therefore very much in Australia's interest to continue to support a strong international agricultural research capability.