A Profit in Our Own Country

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Tropical Pastures for Australia's North

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A major proportion of Australia's cattle is produced in the North in the tropics and subtropics, the slaughtered value being $1600 million annually. Although they are grazed largely on native pasture, approximately 40% of the area has a potential for cropping or sown pasture. Presently 17% of this potential area already contains introduced species.

These naturalised and sown forage or pasture species exist because they are more persistent or are sown because they are of higher quality than the native species. Of particular interest are the introduced legumes. They will be used more widely in the future because:

- they can increase the feed value of the pasture on low-fertility soils;
- they can halt the declining productivity of sown grass pastures;
- legume–grass pastures sown in rotation with crops can restore soil fertility and thus contribute to a sustainable farming system.

Most of the useful tropical grasses come from Africa and the legumes from South America, where CIAT is situated. Notable examples of legumes are those from the genera *Stylosanthes* and *Arachis.*

Legume sowings in Australia's North now total 1.5 million ha, of which half are estimated to be stylos. The area in stylos is being increased annually by 100 000 ha.

This widespread use of the stylos has not come about without a long history of research and some major setbacks. An annual stylo was becoming naturalised in the North by the 1960s but was devastated by a fungal disease, anthracnose.

Fortunately, other introductions from South America proved to be resistant.

What is the role of CIAT and other CGIAR centres in this quiet pasture revolution that is occurring in north Australia?

Collaborative Research

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Australia needs to protect this 20-year investment in research and development of the stylos and prevent another catastrophe like the demise of Townsville stylo in the 1960s. Some of the questions being asked are:

- Will the present varieties maintain resistance to anthracnose?
- Are they resistant to the wider range of races of the disease that occur in South America?
- Will new races of the disease evolve in Australia as they must obviously have done in South America?
- How can multiple resistance be introduced into the present successful varieties?

A collaborative project between ACIAR, CSIRO and CIAT is designed to provide a solution to these questions through comparative studies in Australia and South America. Four research sites have been set up in collaboration with CORPOICA in Colombia and EMBRAPA in Brazil. These are 'hot spots' for the disease, places where virulence of the disease is high. Stylo selections that have been selected or bred in Australia are being evaluated at these sites together with stylo selections being used in South America. We will obtain information not only on plant resistance but on the virulence and diversity of the fungus *Colletotrichum gloeosporioides*, the cause of anthracnose disease. This will enable multiple resistance to be incorporated into new stylo varieties being developed in Australia.

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CIAT has a strong forage research team, good facilities and good liaison with national agricultural research centres (NARS). CIAT also has crop improvement programs in beans, cassava and rice, and natural resource management programs for the tropical lowlands and hillsides. It can facilitate access to operation in other countries in South America which would not be eligible directly for Australian aid. On the other hand, CIAT cannot participate without itself receiving assistance. The international centres rely completely on donor support.

Exchange of Forage Germplasm

Australia first acquired its resources in tropical forage germplasm at a time when the international centres were young and developing their own collections. It was a time of free access to those countries willing to export or exchange their germplasm.

But now that basic collections have been made, Australia relies increasingly on exchange of material. The international centres play a major role in this exchange. Recently CIAT passed on, without cost, a collection of 800 accessions of the forage genus *Zornia* to the Australian Tropical Forages Genetic Resources Centre (ATFGRC) in CSIRO. Similarly, Australia benefits from the exchange of tropical forage germplasm from ILCA (International Livestock Centre for Africa) in Ethiopia and ICRAF (International Centre for Research in Agroforestry) in Kenya.

The international centres will continue to provide free access to the forage accessions held in their genetic resource centres and work with national organisations to maintain natural centres of diversity of important species.

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The plant genetic collections such as the 21 000 forage accessions held at CIAT and 15 000 at ILCA form part of the worldwide effort to conserve plant genetic resources. The centres are signatories to an FAO convention to conserve such material and provide unrestricted availability to the world community. The centres also aim to seek protection for naturally occurring genes.

While the major genera have been defined for Australia's North, new species within these genera are likely to be of importance in the future. One such genus emerging is that which contains the common peanut, *Arachis hypogaea*. The perennial, herbaceous legumes in this genus have similar characteristics to white clover and have proved to be the most productive and persistent forage legumes in legume–grass associations in the subhumid and humid tropics. There could be more widespread use in Australia if species adapted to semi-arid environments can be identified.

CIAT is working with the Brazilian national genetic resource center, CENARGEN, and ICRISAT (International Crops Research Institute for the Semi-Arid Tropics), which has the CGIAR mandate for *Arachis,* to explore the full potential of this species not only in terms of improving the common peanut but in opening up new uses as a forage and cover crop. Such germplasm will be freely available to Australia.

Maintenance of Biodiversity

For forage species, it is not possible to collect and maintain sufficient diversity in genetic resource centre collections (what we call ex-situ collections) for all potentially useful species, simply because of the large numbers involved.

Thus the CIAT collection of the common bean, *Phaseolus vulgaris*, contains 25 000 accessions of the one species while, by way of contrast, the CIAT forage collection of 21 000 accessions includes accessions from 150 genera and 700 species; the largest collection of a single species being for *Stylosanthes guianensis* (1400 accessions). So obviously the forage collection does not contain so complete a sample of the available genetic diversity as does the bean collection.

However, by using new techniques of molecular fingerprinting it will be possible to examine the degree of diversity in natural populations and identify the material that should be collected and conserved in ex-situ collections to ensure a reasonable cover of the diversity that exists in the wild (or in situ). Further, those field sites that represent the greatest diversity will be identified. CIAT has the capacity to undertake this research and to work with national governments in identifying important sites for in-situ protection.

There is a need for a change in attitude and a review of plant variety rights legislation as it affects developing countries.

These efforts in identifying and conserving plant germplasm need to be recognised by developed countries like Australia. There is also a need for a change in attitude and a review of plant variety rights (PVR) legislation as it affects developing countries that have been the source of the original germplasm.

In contrast with the free distribution of the *Zornia* collection to Australia, recently, in order to receive and evaluate an improved forage legume from Australia that originated in South America, we were requested to sign a declaration that stated:

1. 'The seed is supplied to you on the understanding that it is for testing purposes only. If it is entered in trials it should be identified as 'xxxx' and not only by a CIAT number.
2. 'xxxx' is protected by PVR in Australia and in all countries that are signatories to UPOV. Thus it cannot be multiplied for sale except under license. It is doubted if country xxx is in UPOV but CIAT is expected to adhere to this restriction.'

In a similar vein, under plant variety rights (PVR), forage varieties that have simply been selected from a collection of wild species without any improvement by breeding are being released in Australia. Presumably a similar request will be made to the country that supplied the original germplasm. What went out free comes back with a price tag.

How do you expect national governments to react to more requests to collect their native germplasm when they have to sign such declarations to receive back germplasm that has only been modified by a re-arrangement of genes or simply identified as having utility? More damage is being done by this sort of practice than the paltry royalties that come from registering forage germplasm under PVR.

Scientific Exchange

The advance of science has depended on the exchange of information which has occurred freely in the past. Access to new materials and processes is now under threat due to the movement in developed countries to patent anything that may bring in research funds from private industry. This leads to secretiveness similar to that in the defence industries. The international centres still advocate free exchange of information and will only seek to patent materials to prevent them being patented by others.

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Strategic research

CIAT has marked or identified the gene that controls apomixis in the grass *Brachiaria.* Marking the gene allows a plant breeder to identify this characteristic in young seedlings.

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Why was the work undertaken? Many tropical grasses are apomictic. Seed from such species produces plants that are identical to their mother parent, because there is no sexual crossing involved in seed formation. Traits are therefore fixed and there is no biological variation as in the case of sexual crossing. By being able to manipulate apomixis, one can introduce new traits into a species and then fix these traits easily and permanently. In this case CIAT wished to introduce spittlebug resistance into *Brachiaria decumbens*, a grass from Africa that is planted on 40 million ha in South America and whose productivity is greatly reduced by spittlebug. It may also prove to be advantageous to change apomictic populations to sexual populations to permit more variation and natural adaptation to changing environmental conditions.

Further, there is a good prospect that mapping of the apomixis gene in *Brachiaria* will lead to its cloning, whereby it can be transferred to other plants. This will dramatically reduce the time taken by plant breeders of other crops to fix desirable traits. By being carried out in an international centre the knowledge can be protected for use by all countries.

Technology development and transfer

In South America, integrated crop–pasture systems are now recognised as essential in creating sustainable and profitable farming systems. CIAT has been at the forefront in integrating

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crop improvement with natural resource management. By breeding rice varieties adapted to the acid infertile soils usually reserved only for pastures, and developing an integrated rice –pasture system, an economic means of establishing improved pastures and renovating degraded pastures has been demonstrated and is being used by farmers in Colombia and Brazil.

Further, the inclusion of legumes in the pasture has been shown to increase available soil nitrogen, increase earthworm activity, improve soil physical structure and double subsequent rice yields. This type of result is not unique to research conducted at CIAT, similar effects having been demonstrated in tropical areas in north Australia. What is unique about the CIAT research is the integration of germplasm improvement for acid soils with soil management directed to sustainability.

CIAT places major emphasis on involving farmers and the community in the research and development process. This participatory approach initially arose from research by scientists from developed countries working in developing countries. CIAT has been a leader in extending the methodology and in the preparation of training materials for implementation. For example, it led to rapid adoption of climbing beans in Central Africa. It is now being used in the introduction of forage legumes for fallow improvement in the Andean hillsides. The approach is slowly being introduced into Australia using focus and contact groups. But the involvement of farmers themselves in the research process could be developed further than it has been to date. In the Andean hillsides, smallholder farmers are involved in the initial selection of forage germplasm before it is moved on to their farms.

Conduit to National Agricultural Research Centres

As a centre operating in Central and South America, CIAT can facilitate the interaction of scientists from developed countries with those of countries in the region. This can be done simply by way of introduction or by using CIAT as a link in the research process. In some cases it may be most effective to channel funds to a region through a centre with a strong administrative and technical base, which CIAT has. At present, this is achieved through consortium arrangements between donors, the international centres and the national centres. In both the ACIAR-funded Stylosanthes Project and the AIDAB-funded Forages for Smallholders Project in Southeast Asia, CIAT is channelling funds to and developing the capacity of national centres.

European countries make use of international centres to train their students in tropical agricultural research. The trainees become familiar with the region and language and subsequently often become involved in commercial partnerships between Europe and the developing countries.

Mutual Benefits in Funding Overseas Developments

Will financing of the international centres by Australia also help production in other countries? Yes, this is inevitable, but Australia will also benefit. As the Latin American economies develop they will become vehicles for investment and consumer demand. In Asia this has already happened in South Korea and is happening in Thailand, while it is under way in Chile in South America.

The outputs of the international centres—the new germplasm, scientific discoveries and technologies—will continue to have a major effect on domestic productivity of the developed countries. Domestic productivity forms the major part of any country's economy. It is the economic engine. Within the beef industry, exports form a higher percentage of the gross productivity of that industry, but this industry can benefit from the opening up of markets in developing countries where higher living standards have resulted from the outputs of the centres.

Cooperative Endeavours

The work of CIAT on tropical forages complements that in tropical Australia.

Australia has a comparative advantage in the livestock industries and in the excellence of research and development in pasture improvement and management. But the work of CIAT on tropical forages complements that in tropical Australia. Whereas in north Australia the emphasis has been on pasture development for the semi-arid areas, in CIAT it has focused on infertile acid soils of the humid tropics. CIAT has a unique collection of forages adapted to acid infertile soils.

These complementary forage resources held by CIAT and the ASTFGRC have been combined in an AIDAB-funded project to select and deliver forages for smallholder farmers in Southeast Asia. Forages are being used not only for livestock feeding but also for soil improvement and creating more sustainable farming systems. The project is collaborating with the Upland Farming Systems Program of IRRI (International Rice Research Institute). The outcome will be greater livestock productivity and more productive farming systems, particularly in the uplands.

However, it is also likely to open up markets for the export of live cattle from Australia to Southeast Asia which has been increasing and is presently 160 000 cattle per annum. This export trade has been restricted by the shortage of feed in the regions to which cattle have been exported, to the extent that the Australian Meat and Livestock Corporation has officers in the region monitoring the situation.

Final Thoughts

Australia cannot expect to prosper by turning inward in terms of research funding.

Australia cannot expect to prosper by turning inward in terms of research funding. During the 1950s Australia benefited greatly by the recruitment of scientists from overseas and training of Australians overseas.

It also needs to be said that the international centres were not set up to benefit developed countries like Australia. They are primarily concerned with increasing food supplies to improve the welfare of the poor in society both in rural and urban areas, in contributing to greater equity among persons in a community and in developing technologies that are sustainable—both in an environmental sense and in the ability of local communities to continue to maintain new technology without subsidy.

Nevertheless, substantial benefits will come to Australia in the future from the availability of genetic resources of forage germplasm, in scientific collaboration and increasing the welfare of those in developing countries, which in turn opens up markets for Australia. Providing funds for international centres will increase Australia's own domestic productivity.