



Doing Well by Doing Good

*International agricultural research –
how it benefits Australia as well as developing countries*

Report of the Crawford Fund
Doing Well by Doing Good Task Force

DECEMBER 2013

ABOUT THE CRAWFORD FUND

The Crawford Fund was established in 1987 as an initiative of the Australian Academy of Technological Sciences and Engineering (ATSE) to honour and carry forward the work of Sir John Crawford, an Australian internationalist who made major contributions to enhancing world food production in the 1960s and 1970s in his role as adviser to governments and the World Bank.

The Crawford Fund's purpose is to make more widely known the benefits that accrue both to Australia and internationally from international agricultural research and development.

The Fund conducts a range of public awareness activities, arranges specialist training in Australia and abroad for developing country scientists, and conducts master classes for developing country personnel on key topics in agricultural research and development.

The Crawford Fund operates through State and Territory Committees throughout Australia. It has a small central office in Canberra.

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WHAT IS 'INTERNATIONAL AGRICULTURAL RESEARCH'?

International agricultural research is research undertaken to enhance agriculture in developing countries. It has traditionally been conducted by institutions within the public and not-for-profit sectors and mostly funded by international development assistance, philanthropic agencies and governments of developing countries, although new partnerships with the private sector are becoming increasingly important. The Consultative Group on International Agricultural Research has been pre-eminent, along with several other international agricultural research centres, usually in partnership with national research agencies in developing countries and farmers' groups as well as with advanced research centres.

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PREFACE

The Australian people and Australian governments since European settlement have made the most of the continent's natural endowments. They rapidly showed that we could be competitive in the production of agricultural goods and minerals.

To enhance our agricultural capacity we have always invested in research; first to deal with the environment we were in and then to enhance the quantity and the quality of goods in which we had a comparative advantage. Australian State and Federal governments have always supported expenditure on research and, over the years, a substantial infrastructure and network of research organisations has been built up that has earned us a world-wide reputation in many fields. As a nation, we still fight for freer and fairer agricultural trade – in our interest and that of the developing world.

We are no longer a colony in an economic sense and we are no longer an island in a research sense. Our agricultural researchers, and the specialised fields they are in, have long been part of domestic and international networks. Australia was a founding member of the United Nations Food and Agriculture Organization (FAO). We cannot stop the world and get off, nor can we be research isolationists carrying out all essential research on our own. The world storehouse of human research capital is just too big to ignore.

In an increasingly complex and globalised world, many publicly funded Australian programs and organisations have multiple purposes. As a wealthy middle power and an agricultural exporting nation, Australia's agricultural research and development assistance programs merge to serve more than one purpose. The reasons for Australia being involved in international research and development assistance are at once altruistic and self-interested, with tangible and non-tangible benefits, and our involvement is of immense benefit to our international and trade relations.

We live in a networked world where issues such as biosecurity and food security are becoming more important. We cannot shut our minds to the billion or so people who live in abject poverty. We also need to compete on export markets. Research is essential to help the poor, to sharpen our competitive edge and to help create new markets.

Research requires infrastructure such as laboratories, researchers and research organisations, and funding, public and private. Above all, it requires cumulative knowledge and experience. Much, if not all, of Australia's farmed plant and animal genetic material is not indigenous. We need to be involved in international research for this very reason. Our domestic market is not large enough to enable the

private sector to invest heavily in research unique to our environment or in many of the countries in our region; we may have to find new ways of encouraging them to do so.

Many countries in our region do not possess the expertise we have. Yet exotic diseases may come to our shores from such countries – some with consequences for human health. Our scientists and researchers need to be familiar with the conditions in such countries.

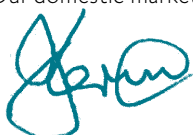
The central fact is that Australia cannot be out of the international research game. We must have a seat at the table so that we can both adapt the research of other countries and build on our expertise to win the respect that will bring opportunities.

This report addresses many of the arguments for and against our participation in international agricultural research. It is a debate that will always be alive, as is the debate on the best forms of international development to achieve a more peaceful, humane and prosperous world. It gives a largely positive report card for the contribution of international agricultural research to productivity in the developing world and in Australia. We believe that there is little to argue against in this contention.

We would add a sense of urgency and priority to the task ahead: urgency because the pressures of population and food security are mounting, and priority because not all development assistance projects are having positive impacts in our neighbourhood. The stability of this region is critical to Australia; boosting agricultural sustainability and rural incomes enhances that stability more than many other interventions. It is not helped at all by failed development projects; poor aid equals poor diplomacy.

ACIAR output, through its bilateral and multilateral projects, also depends on the efficiencies and effectiveness of the CGIAR, the FAO and many other international organisations. Clearly, some of these organisations are benefiting from governance reform processes. The CGIAR, in particular, has invested substantially in a change process and others are endeavouring to rectify problems under new leadership. But there is some distance to travel.

It may well be time for Australia, given our strong national interest in the success of these endeavours, to once again take a more prominent leadership role, as Sir John Crawford and many other prominent Australians did, at this crucial time in the history of food security. The G20 might provide a suitable forum for an Australian initiative in agricultural research for global development. We hope this report might, with other inputs, help to provide a trigger for such an effort.



The Hon John Kerin AM FTSE
Chairman
The Crawford Fund



The Hon Tim Fischer AC FTSE
Former Chairman
The Crawford Fund

ACRONYMS

AAHL	Australian Animal Health Laboratory	ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ACIAR	Australian Centre for International Agricultural Research	IFPRI	International Food Policy Research Institute
AIDAB	Australian International Development Assistance Bureau	ILRI	International Livestock Research Institute
ATSE	Australian Academy of Technological Sciences and Engineering	IPM	Integrated Pest Management
AusAID	Australian Agency for International Development	IRRI	International Rice Research Institute
AVRDC	World Vegetable Center	LDCs	Least Developed Countries
CABI	Centre for Agricultural Bioscience International	NFF	National Farmers' Federation
CGIAR	Consultative Group on International Agricultural Research	ODA	Overseas Development Assistance
CIE	Centre for International Economics	OECD	Organisation for Economic Co-operation and Development
CIMMYT	International Maize and Wheat Improvement Center	PNG	Papua New Guinea
CRC	Cooperative Research Centre	R&D	Research and development
CSIRO	Commonwealth Scientific and Industrial Research Organisation	RD&E	Research, development and extension
DAC	Development Assistance Committee	SPC	Secretariat of the Pacific Community
DAFF	Department of Agriculture, Fisheries and Forestry		
DPM&C	Department of the Prime Minister and Cabinet		
ERA	Excellence in Research for Australia Initiative		
FAO	Food and Agriculture Organization of the United Nations		
FMD	Food and mouth disease		
GM	Genetically modified		
GRDC	Grains Research and Development Corporation		
IARC	International Agricultural Research Centre		
IAS	Impact Assessment Series		
ICARDA	International Center for Agricultural Research in the Dry Areas		

ABOUT THIS REPORT

The Crawford Fund believes that Australian development assistance programs in agriculture and related sectors should retain their primary purpose of assisting economic and social development in developing countries, in accordance with Australia's national interests. In addition, and without detriment to this purpose, they can deliver direct and indirect benefits to Australia.

The National Farmers' Federation has argued that, in the face of a run down in our agricultural research capacities, international agricultural research funded by Australian aid should place more emphasis on benefits to Australian farmers and to our own research capabilities.

The Crawford Fund established a task force in March 2013 to consider benefits accruing to Australia from development-assistance-related investment in international agricultural research.

A first step by the 'Doing Well by Doing Good' Task Force was to commission a meta-review of published analyses of costs and benefits to Australia from the work of the international agricultural research centres and of a range of projects by the Australian Centre for International Agricultural Research (ACIAR).

The Crawford Fund also began a process of national consultation with stakeholders, peak bodies and others through a series of meetings around Australia.

An early draft of the task force report was distributed at the end of May and a discussion paper was published and distributed widely, including at the Crawford Fund Conference in August and directly to key stakeholders.

On the basis of this process, this report has the benefit of a wide range of inputs and experiences, including from key stakeholders and individual farmers, scientists, researchers, extension workers and others involved in domestic and international agricultural research.

HIGH LEVEL ADVISERS

In order to ensure the report reflects the long-held, high-level bipartisan wisdom that has guided Australia's participation in international agricultural research over the years, we asked two elder statesmen to read and comment upon an advanced draft of the report. I was particularly pleased that the Hon John Kerin and the Hon Tim Fischer, current and former chairs of the Crawford Fund, agreed to be these senior referees of the report and their views are captured in the report Preface.

TASK FORCE TERMS OF REFERENCE

1. Make an assessment, from published reports, of benefits to Australia in general from international agricultural research.
2. Synthesise the series of cost-benefit studies of ACIAR-funded activities that have attempted to measure direct benefits to Australian agricultural production.
3. Give special attention to the biosecurity and biodiversity contributions that international agricultural research has made, or could make, to preventing the incursion of exotic pests and diseases and the opportunity it affords for Australian scientists and quarantine staff to observe, first hand, exotic diseases. Possible human health benefits, especially in relation to a better understanding of zoonotic animal diseases and human nutrition, should be reviewed.
4. The assessment of benefits should include the benefits of partnerships and understandings that have arisen as a result of ACIAR and other aid programs that have led to collaborations well beyond the scope and lifetime of the aid investments.

TASK FORCE MEMBERS

I was honoured to lead the task force that included Dr Terry Enright, farmer and former chair of the Grains Research and Development Corporation; Dr Tony Gregson, who has an extensive science and corporate research management background, including board positions on a range of international agricultural research centres; Ms Cathy McGowan, rural consultant, academic and now Member of Parliament; Professor John Mullen from Charles Sturt University, a distinguished Fellow of the Australian Agricultural and Resource Economics Society. The task force has been supported by Crawford Fund staff. Task force members' biographical details are provided at the end of the report.

ACKNOWLEDGEMENTS

I am grateful to the many Australians and colleagues in the international sector who have provided input and comments at our consultation meetings, or provided their opinions directly, in general or on the draft report and discussion paper.



The Hon Neil Andrew AO FTSE
Former Chairman
The Crawford Fund

EXECUTIVE SUMMARY

THE ISSUE – PLACING MORE EMPHASIS ON SHARED BENEFITS

The National Farmers' Federation has argued that, in the face of a run down in our agricultural research capacities, international agricultural research funded by Australian aid should place more emphasis on benefits to Australian farmers and to our own research capabilities. A Crawford Fund task force, led by the Hon Neil Andrew, considered this proposition and found the following:

INTERNATIONAL AGRICULTURAL RESEARCH IS AID THAT WORKS

1. Australian aid well serves our national interests of regional peace and security by alleviating poverty and by enhancing food security and economic growth in developing countries.
2. Agricultural R&D is an effective way to meet these national interests. It is delivered by the Australian Centre for International Agricultural Research (ACIAR), which, in turn, relies on cooperation with other Australian agricultural research institutions, including State and Federal agencies. Their willingness to cooperate reflects a view that international agricultural research also serves their institutional objectives.
3. A review of ACIAR's bilateral research program (about 70% of its budget) found that the rate of return on investment by ACIAR and its Australian and developing country partners – from a limited sample of projects (about 10% of the total bilateral program) – was between 50:1 and 70:1, depending on whether benefits judged to be convincing or plausible are included. This return greatly exceeds total investment in bilateral research since ACIAR's inception 31 years ago. The return is mostly in the form of increased farm incomes in developing countries.

INTERNATIONAL AGRICULTURAL RESEARCH ALSO DELIVERS BENEFITS TO AUSTRALIAN FARMERS

4. Bilateral research programs providing the most benefit to Australian agriculture included:
 - a) Biosecurity gains from understanding mite pests of honey bees (Australian partner was CSIRO)
 - b) Access to the Japanese mango market through post-harvest treatment of fruit fly (Queensland Government)
 - c) Development of the sandalwood industry in Indonesia and the Ord River (Western Australian Government)
 - d) Incorporation of ICRISAT germplasm in the Australian sorghum breeding system.

5. Germplasm from international centres (particularly CIMMYT, ICRISAT and ICARDA), supported by ACIAR and institutions like the GRDC, has helped to keep Australian farmers competitive in world markets by increasing yields or reducing costs. The flow of benefits to Australia from these three centres has been of the order of \$100 million a year from an annual contribution to the global network of just \$10 million. Benefits also flow from the Global Crop Diversity Trust and other international centres.

AID CONTRIBUTES TO KNOWLEDGE AND RESEARCH CAPACITY

6. The cooperative work of scientists in Australia and developing countries, supported by ACIAR and its partners, has made a major contribution to scientific knowledge and capacity in Australia and globally. Fellowships for hundreds of developing country scientists, many of whom undertake research in Australia, have added to the stock of our knowledge. The value of these gains, which has not been quantified, includes:
 - a) Advanced research on Australian agriculture
 - b) The development and acquisition of scientific tools and experience in developing countries that proves valuable in Australian agriculture
 - c) Forewarning and experience of biosecurity risks
 - d) ongoing cooperation between Australian and international research institutions
 - e) Recognition of Australia's scientific credibility in international scientific forums.

SKILLED LEADERSHIP AND SOUND DESIGN IS NEEDED TO PURSUE TWIN GOALS AND NEW BENEFITS

7. There are other potential benefits to Australia that are still to be fully explored or exploited. ACIAR has substantial investments in commodities such as cocoa, coffee and oil palm. Increasing production in Indonesia, PNG and the South Pacific will benefit many poor farmers and their national economies. Increased production may provide trade opportunities for Australian food manufacturers.
8. As the independent review of ACIAR found, ACIAR and the international agricultural research it supports are integral to Australia's aid program and are part of Australia's innovation system. Pursuit of these twin roles and new opportunities requires highly skilled leadership and design directed at understanding, explaining and exploiting the shared interests of Australian research institutions and their international and developing country counterparts. These skills are crucial in securing benefits for Australia as well as developing countries.

Conclusions and suggestions

WITH SOME REFINEMENT EVEN MORE COULD BE ACHIEVED

The task force concludes that international agricultural research:

- 1 Is highly effective aid with real and significant benefits to Australian farmers
- 2 Enhances Australian research capacity, delivering greater Australian productivity
- 3 Leads to more Australian food exports, as well as to increased agricultural productivity in the developing world, contributing to global food security.

The task force suggests that:

- 4 ACIAR remains integral to Australia's aid program and part of its innovation system
- 5 In establishing its portfolio activities, ACIAR could consider more closely Australia's *National Primary Industries R,D&E Framework* and the need to expand the number of agricultural researchers, alongside the priorities of partner countries. This would align the portfolio with Australia's expertise and interests and with those of ACIAR's partner countries, resulting in enhanced benefits to both developing countries and Australia
- 6 ACIAR consider supplementing its impact assessments by including measurement of the strengthening effect that participation in international agricultural research has on Australian institutions
- 7 ACIAR continue to explore greater scope for private sector participation in international agricultural research, including exploration of benefits to Australia as well as developing countries.

The task force also suggests that:

- 8 Aid funding for Australia's international agricultural research should grow at least at the pace of inflation and faster once regular reviews show an increasing contribution to Australian and developing country agricultural productivity.

I. ACIAR is part of both Australia's aid program and its agricultural innovation system

THIS REPORT DERIVES from a proposition by the National Farmers' Federation (NFF) that in the face of a run down in our agricultural research capacities – potentially made worse, in the NFF's view, by diversion of those capacities to serve the Australian aid program – international agricultural research that is funded by Australian aid should place more emphasis on benefits to Australian farmers and to our own research capabilities. In effect, the NFF is suggesting that the split of benefit between developing country and Australian agriculture should be moved somewhat in Australia's favour.

In interpreting its terms of reference, the task force was guided by several major signals: the recently published independent review of ACIAR¹; an Inquiry by the House of Representatives Standing Committee on Agriculture, Resources, Fisheries and Forestry²; a submission by Mr James Ingram³, a former Executive Director of the World Food Program who was Director of AIDAB (AusAID's precursor) at the time of ACIAR's foundation; and what we understand to be the aspirations of the recently elected Australian Government.

The independent review of ACIAR said that:

ACIAR is an integral part of Australia's development assistance program and a part of Australia's agricultural innovation system.

It also concluded that:

The benefits to Australia of ACIAR's work – showcasing Australian capabilities; creating and enhancing links between Australian and overseas researchers and institutions and, in some cases, providing research of benefit to Australian as well as overseas farmers – do not detract from the benefits of ACIAR's work for developing countries.

The Inquiry by the Standing Committee on Agriculture, Resources, Fisheries and Forestry commented in similar terms as follows:

Whilst ACIAR's focus is primarily on its international work, it is clear that the results of its projects have domestic benefits for the Australian agricultural sector. The Committee is pleased to see that ACIAR

understands and contributes to how the results of its research can have applications in the Australian agriculture sector [and it] hopes that the Australian Government continually evaluates the results of ACIAR research to ensure that, where appropriate, any results or lessons learnt are applied domestically.

Mr Ingram's submission described the unique Australian national interest dimensions of international agricultural research as follows:

When we were establishing ACIAR I at least hoped that in determining its work program it would begin by making an inventory of research required to improve production in Australian regions with similar climatic, soil and other relevant characteristics to those in selected developing countries. Having done so, depending on their research capacities and priorities, cooperative programs would be established with developing countries considered most appropriate from a technical point of view, but also taking into account the political preferences of the Australian Government. The ultimate aim to benefit developing countries would remain but the process would begin with a clear-eyed, explicit assessment of our own research needs and where joint efforts would be to our mutual benefit. The long-term global food challenge and the need for developing our north, as well as meeting the challenges posed by a hotter, drier climate in what are currently our main production regions, means that such an approach is now more appropriate. Moreover, the capacities of developing countries have also improved, so making genuinely cooperative programs more rewarding. The suggested approach could also be a means for helping to reverse the decline in Australian agricultural research capability.

The recently released *National Food Plan* (DAFF 2013), the white paper *Australia in the Asian Century* (DPM&C 2012) and the Coalition's *2030 Vision for Developing Northern Australia*⁴ emphasise the growing opportunities for Australia through enhanced trade and increased production of agricultural commodities, as the demand by the burgeoning Asian middle class for food changes and grows.

The task force was aware of the view, strongly held in some quarters, that Australia's aid program should not

1 *Independent Review of the Australian Centre for International Agricultural Research (ACIAR)*, 2013, <http://aciar.gov.au/publication/cp025>

2 Inquiry into the Australian Centre for International Agricultural Research Annual Report 2011-12, House of Representatives, Standing Committee on Agriculture, Resources, Forestry and Fisheries, The Parliament of the Commonwealth of Australia, June 2013, Canberra.

3 Letter to task force by JC Ingram, September 2013.

4 *2030 Vision for Developing Northern Australia*, <http://lpaweb-static.s3.amazonaws.com/Policies/NorthernAustralia.pdf>

be distorted to enhance its direct benefits to Australia at the expense of the quality and beneficial impact it has on developing countries, its pre-eminent target.

We are also aware of serious reservations expressed, for example in past reviews of the aid program, about the use of aid funds to subsidise the cost of Australian goods to make them more competitive in the marketplace. The Development Assistance Committee of the OECD has quite strict guidelines about such practices⁵. Against this background, we saw our task as one of striking the right balance between ACIAR's twin roles as an integral arm of the Australian aid program – its primary role – and as part of Australia's agricultural innovation system. We concluded that the factor that brings the two roles together is the national interest.

We believe that the opportunities for win-win outcomes in the national interest are particularly high in agricultural research, just as they are, for example, in research on tropical health. In agriculture this is the case when countries on either side of an artificial divide share soil, water and climatic conditions, interests in the same plant or animal varieties, and are troubled by similar pests and diseases.

To contribute to world food security in a sustainable way, Australia has to increase its own food production and contribute to increased food production in the developing world. Increased agricultural productivity through agricultural research is key to both imperatives. By fostering international agricultural research that benefits both developing countries and Australia, Australia can adopt the central claim of 'doing well by doing good'.

As competition for financial resources becomes ever keener, it appears timely to revisit and document this claim and thus ensure a broader appreciation of the value of international agricultural research in the Australian community, by peak bodies and among policy makers.

To aid its work, the task force drew on independent impact assessments and undertook a survey of Australian participants in ACIAR projects, inviting them to identify benefits to Australia from the projects in which they were involved. We invited international agricultural research centres to identify areas of their work that were beneficial to Australia. We also participated in the series of ACIAR strategic planning meetings with stakeholders that were held around Australia in May 2013, where we specifically raised the issue of benefits to Australia.

Finally, the task force drew extensively on the stock of knowledge recorded in the proceedings of the Crawford Fund's Parliamentary Conferences over the past 25 years.

ENTRÉE TO INTERNATIONAL CAPACITY

If we are going to achieve targets for agriculture in terms of productivity and profitability, and increase exports into Asia, we're going to need to be developing a whole range of new technologies. To develop those new technologies we'll require research partnerships. We don't have the capacity to solve all of those issues here in Australia by ourselves, we've got to be working in international alliances, international consortia to get those answers, to leverage their brain power, leverage some of those international resources onto the things we want to achieve here in Australia. And by supporting the international centres that just gives us a ready entrée into all of that international capacity.

Professor Tim Reeves, former Australian Director-General of CIMMYT

AUSTRALIA'S FOOD CONTRIBUTION

Australia can contribute to a food secure world by growing and exporting as much food as is possible within constraints formed by our natural resource base and by market demand and prices. Within these limits, and with increased allocations to research, Australia can become one of a number of world food bowls. By itself, Australia cannot feed more than a fraction of the world. Its contribution through research, however, could be globally significant and contribute beneficially to the diets of 400 million or more.

*D.G. Blight, Chief Executive, Crawford Fund,
Proceedings 2012: the Scramble for Natural resources*

⁵ Implementation of the 2001 DAC recommendation on untying ODA to the LDCs: 2009 Review, OECD, Paris. <http://www.oecd.org/dac/43596009.pdf>

II. International agricultural research serves Australia's development assistance objectives

IN THIS CHAPTER we consider – briefly, because the question has been comprehensively examined by the recent independent review of ACIAR – the role and effectiveness of international agricultural research in the Australian aid program. We argue, as did the independent review of ACIAR, that Australian aid serves our national interests of regional peace and security by alleviating poverty, enhancing food security and assisting economic growth in developing countries.

Agricultural research for development is a particularly effective way to meet these national development assistance goals because Australia has relevant skills and experience. Our contribution to international agricultural research is delivered, mostly, through ACIAR.

An independent impact assessment of ACIAR's bilateral research program, which constitutes about 70% of its budget, found that the economic return on investment by ACIAR and its Australian and developing country partners for a sample of projects (that represented only about 10% of the total bilateral program) greatly exceeded total investment in bilateral research since ACIAR's inception 31 years ago. The majority of these returns are in the form of increased farm incomes in developing countries.

Similarly, high returns to developing countries are reported from Australian aid investments in multilateral agencies and, in particular, institutions under the umbrella of the Consultative Group on International Agricultural Research and related international centres, such as the World Vegetable Center and CABI. The key international agricultural research centres are listed at the end of this report.

The objective of the overseas aid program is to assist developing countries to reduce poverty and achieve sustainable development in line with Australia's national interest. Bill Gates was recently quoted as saying:

It's been proven that of all the interventions designed to reduce poverty, improving agricultural productivity is the best.

Most importantly, agricultural research is critical to agricultural productivity growth, which in turn underpins profitable agricultural production, a cornerstone for economic and social development in most developing countries. The independent review of ACIAR expressed this sentiment in the following way:

It is well established that R&D is an essential driver of productivity growth in agriculture, fisheries and forestry; and that the major increase achieved in

agricultural production in the second half of the 20th century to meet food and fibre demand growth from the near doubling of the world's population was significantly attributable to improvements in agricultural productivity attained through technological change enabled by investments in agricultural R&D. The slowdown in agricultural productivity growth in much of the world over the past decade is commonly attributed in large part to declining growth in agricultural R&D investment in most countries (for example, from more than 3% a year in the 1950s and 1960s down to around 1% in the past decade in most developed economies), and the falling share of that R&D investment allocated to basic research on agricultural productivity as opposed to other areas like nutrition and biosecurity.

The importance of agricultural research as a component of Australia's aid program was also a consistent theme of ACIAR's strategic planning meetings and of the Crawford Fund's survey of institutions, and it has been addressed in the Crawford Fund's Parliamentary Conferences for some 25 years.

Other major studies include *Agricultural Science Policy: Changing Global Agendas*, by J.M. Alston *et al.* (2001); *Agricultural R&D in the Developing World: Too Little, Too Late?* by P.G. Pardey *et al.* (2006); and *World Development Report 2008: Agriculture for Development* by the World Bank (2008).

Dr Philip Keane, from the Centre for AgriBioscience in the Department of Botany at La Trobe University, who was consulted in the course of the task force's work, expressed the contribution to stable development as follows:

The main point about agricultural research and development projects in our near neighbours is that they help the countries develop their own research capacity in an area (agriculture), which is critical for them and where Australia has special expertise to give. Improved capacity for agricultural research can be applied to many crops, including food crops, hopefully contributing to stable development. Australia's particular interest in eastern Indonesia, relevant to our ACIAR cocoa project in Sulawesi and Papua, is to contribute to stable development in the poorer outer provinces, heading off political and economic instability. If the cocoa industry continues to decline because of the build-up of pests and diseases and declining soil fertility, this will have serious economic implications. Our ACIAR project is helping Indonesian researchers and agricultural development organisations to address these problems.

A virtuous circle (see Figure 1) comprises the following segments:

- International agricultural research has demonstrated potential to enhance agricultural productivity in Australia
- International agricultural research can strengthen Australia's research capacity
- Australia's ability to receive maximum benefit from international agricultural research depends on it having strong domestic research institutions
- Enhanced research capacity in Australia contributes to the depth, breadth and relevance of expertise in Australia that is available to ACIAR and the international agricultural research system.

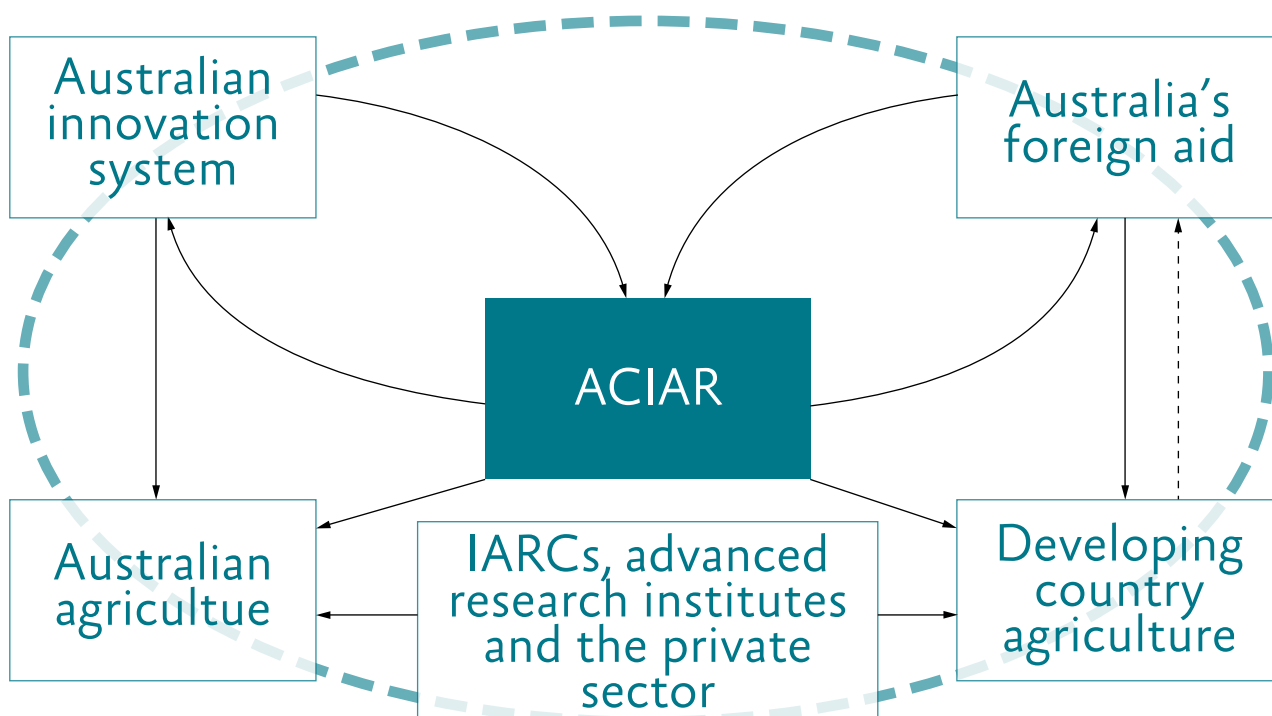
All of this helps to build enduring linkages between Australian research institutions and their international counterparts, keeping Australia within the circle and enabling access to global knowledge and product innovation networks while enhancing trade opportunities.

SORGHUM BENEFITS FROM ICRISAT

We have used as breeding lines ICSV 745, ICSV 197 and PM 13654 in our program. ICSV 745 and PM 13654 have contributed to material that is elite or semi elite. PM 13654 has made it into commercial cultivars at a small level but more for genetic diversity contributing to yield rather than midge resistance. In terms of midge resistance we had very good levels of resistance before these lines came along. ICSV 745 has a different mechanism of midge resistance (antibiosis compared with antixenosis) and different mode of inheritance (single gene major effect compared with multi-genetic quantitative). We have used it to broaden the base of resistance and also give us a quicker way to produce resistant hybrids (i.e. we can combine this gene with low levels of antibiosis to get good resistance). The benefits of the latter approach are yet to be seen in farmers' fields. In addition to the mentioned lines, material like ICSV400 and Macia also from ICRISAT have been used widely by us in breeding.

*Dr David Jordan, Principal Research Fellow/
Associate Professor, Sorghum Plant Breeder and Team Leader,
Queensland Alliance for Agriculture and Food Innovation*

Figure 1 The virtuous circle linking Australian agriculture with the aid program – based on Pearce *et al.* (2006). R&D is an essential driver of productivity growth in agriculture, fisheries and forestry. The research collaboration also bolsters Australian trade in agricultural products as demand grows from developing countries for income and services.



III. Australian agriculture benefits from ACIAR projects

IN THIS CHAPTER we consider the benefits derived by Australian agriculture from investments in ACIAR's bilateral program, through which it commissions research by Australian organisations and developing country and international partners. Our work was aided by ACIAR's enviable record in evaluating the impact of the investments it makes in agricultural research.

Evaluations of its bilateral research program are reported in its impact assessment series or IAS (available from the ACIAR website). ACIAR has invested about \$2.5 billion (2012 dollars) in bilateral research since its inception in 1982. Projects accounting for almost 10% of this investment have been subject to rigorous assessment of their economic impact in developing countries and in Australia.

ACIAR has commissioned two series of reviews of the impact assessment reports: a series of reports prepared by the Centre for International Economics (CIE) (Pearce *et al.*, 2006; Harding *et al.*, 2009) focused on estimating benefits to Australia from ACIAR bilateral research, and reviews by Raitzer and Lindner (2005) and Lindner, McLeod and Mullen (2013).

The key point of difference between these sets of studies was that in the Lindner studies, the impact assessment reports were rated for their rigour and transparency, to identify a subset of analyses whose findings were "convincing", hence constituting a lower bound estimate of returns to ACIAR's activities.

The task force asked Professor John Mullen to review these past studies. A summary of the key points from this review is presented here. The full report is to be published on the Crawford Fund website.

THE CIE STUDIES

The CIE provided ACIAR with an unpublished update of the Harding *et al.* (2009) analysis and the earlier Pearce *et al.* (2006) analysis in December 2011. At the time of this update, the IAS series encompassed 75 reports, with 48 reporting quantitative estimates of benefits.

Total investment by ACIAR and partners over the 48 impact assessment studies was \$439 million and by ACIAR alone, \$219 million. Total benefits (attributable to ACIAR and partners) were \$37,002 million and benefits attributable to ACIAR investment (based on a 50% cost share) were \$18,459 million, giving a benefit cost ratio of 84.2:1.

Total benefits to Australia quantified in the CIE studies amounted to \$2549 million or about 7% of total benefits.

THE LINDNER STUDIES

The IAS studies have been conducted by many people under varying conditions of data availability, methodology and complexity of technology impacts. Not surprisingly, there is some variation in the quality of the studies across the series. Aware that impact assessment reports varied in their plausibility, ACIAR commissioned first Raitzer and Lindner (2005) and then Lindner, McLeod and Mullen (2013) to review the reports and rate them from conceivable to plausible to convincing.

For the purposes of its analysis, the task force restricted its focus primarily to the third subgroup – the convincing assessments.

THE 2005 STUDY

At the time of the Raitzer and Lindner (2005) study, 34 reports had been published in the IAS series but only 29 made quantitative estimates of economic impact. Only seven studies qualified as demonstrating convincing impacts. Twelve were 'plausible' and 10 remained in the 'potential' or 'conceivable' group.

The 'convincing' group of seven delivered benefits attributable to ACIAR of \$2709 million and a benefit-cost ratio of 1.31 against ACIAR total investment since inception.

Australia's share of benefits from this one group of seven was 17.2% (\$466 million).

Nearly 90% of the benefits in this convincing group came from three of the seven projects:

- Eucalyptus improvement in China
- Banana skip biocontrol in PNG
- Pig genetic improvement in Vietnam and Australia.

Other research areas in the convincing group were:

- Acacia hybrids in Vietnam
- Increased efficiency of straw utilisation by buffalo and cattle
- Pigeon pea improvement
- Control of foot rot in small ruminants in Nepal.

This extract from the 2005 study describes the benefit-cost ratios as "justifying the investment in bilateral research activities" and is followed by a description of each IAS report.

This [benefit-cost ratio] is an impressive achievement, a very few aggregate government programs have comprehensively illustrated the economic worth of funds received. This is particularly the case for

the development assistance sector, where no large bilateral agency has yet shown that overall investment has been justified. Furthermore, these aggregate benefit levels are only partial, as the sources of these benefits comprise less than 7.8% of the total cost of ACIAR bilateral programs, yet they provide benefits well in excess of total investment.

ECONOMIC BENEFITS TO PNG AND AUSTRALIA FROM THE BIOLOGICAL CONTROL OF BANANA SKIPPER (*Erionota thrax*) – IAS 012

Using the estimated production value of bananas in PNG to the year 2020, the losses due to banana skipper each year were calculated. Using a discount rate of 5%, the net present value of lost production amounts to about \$301.8 million. The value of damage prevented by biological control is estimated at \$201.6 million. The reduction of banana skipper abundance by 90% in southern PNG has also reduced the chance of adults invading Australia. Bananas are a significant commercial crop in Australia and biological control in PNG has reduced the probability of the skipper's entry to Australia, and hence the prospect of substantial damage to Australian crops from 100% to close to zero.

BREEDING AND FEEDING PIGS IN AUSTRALIA AND VIETNAM – IAS 017 AND IAS 052

The study identified and examined the impacts of an ACIAR project to develop and implement genetic and nutrition research to improve pig productivity in Vietnam and Australia, and in particular to produce leaner pork with great production cost-effectiveness. IAS 052 updated the estimates of the earlier impact assessment.

It highlights two important issues. First, the total benefits from this research activity and subsequent follow-up activities have increased substantially, from a net present value of benefits of nearly \$500 million to nearly \$2.0 billion. This provides a benefit-to-cost return of more than 250:1 and an internal rate of return of 74%. Second, the capacity building included as an important component of the original project has been crucial in sustaining and extending the impact of the research.

INCREASED EFFICIENCY OF STRAW UTILISATION BY CATTLE AND BUFFALO – IAS 002

This report contains an economic assessment of three projects. As well as validating the feasibility of improving the efficiency of straw-based diets through strategic supplements, the projects under review played a significant role in the commercial introduction of urea molasses blocks and bypass protein feed. The results of the analysis

indicate that these projects are economically viable. The most important benefit from the project is the increased farm income accrued to the Indian dairy farmers from increased milk production.

PIGEON PEA IMPROVEMENT – IAS 006

This study was commissioned by ACIAR to evaluate the economic impact of two projects (8201 and 8567) for which ACIAR provided support from 1982 to 1989. These projects aimed to improve the grain yield potential of pigeon pea (*Cajanus cajan*) using modern plant breeding, along with associated physiological, agronomic, processing and socioeconomic research.

DEVELOPMENT OF SUSTAINABLE FORESTRY PLANTATIONS IN CHINA: A REVIEW – IAS 045

The forestry sector in China is a major contributor to economic growth. The development of fast-growing, high-yielding plantations for wood production has made a significant contribution to this sector. This report documents the story of Chinese forestry development. Eucalypts are providing new sources of income for individual farmers and collectives with the necessary management skills, access to capital and land to grow plantations. Employment opportunities created in some areas will assist some of the poorest households, or poor migrants from other provinces, to secure off-farm income.

CONTROL OF FOOTROT IN SMALL RUMINANTS OF NEPAL – IAS 016

Footrot, a bacterial disease that causes lameness and high levels of sheep and goat mortality, was endemic in the western districts of Nepal. As a result of the collaborative efforts between Nepalese, Australian and UK scientists within several ACIAR projects, AS2/1991/017, the virulent form of this disease has been eradicated from the livestock industries of Nepal. In 2001, the authors concluded that the projects were “likely to have flow-back benefits to Australia as it has been demonstrated that specific footrot vaccination works, along with blood tests being shown to be useful in assessing disease prevalence and providing evidence of disease freedom. These tests are now actively investigated in Australia.”

IMPROVED AUSTRALIAN TREE SPECIES FOR VIETNAM – IAS 047

The study looked at the impact on Vietnam of projects researching growth of tree species in various countries and environments. It showed that, through adaptation, significant improvements in productivity can be achieved by selecting tree provenances that are best suited to specific environments. The returns on investment were shown to be very high.

THE 2013 STUDY

The analysis by Lindner, McLeod and Mullen (2013), commissioned in 2012 by ACIAR, was to update the Raitzer and Linder (2005) study and so focused on the impact assessment studies IAS 36 to IAS 80. In the ultimate study pool of 27 impact assessment reports covering 103 bilateral R&D projects, 38 independent quantitative estimates of streams of benefits were identified. Again, each was rated 'conceivable', 'plausible' or 'convincing', and again we have restricted our focus to those rated 'convincing'.

The 2012 present value of cumulative expenditure by ACIAR alone on all study pool projects was \$151 million, and the corresponding combined investment by ACIAR and partner organisations on the study pool was estimated at \$449 million.

By 2012, the present value of cumulative investment by ACIAR on all bilateral R&D since inception was \$2517 million. Of the 38 conceivable benefit streams rated as 'plausible', 15 were then rated as being 'convincing' (Table 1)⁶. In aggregate, the 2012 present value of all 'convincing' benefits was estimated to be \$22,995 million.

Overall, the ratio of total convincing benefits to combined investment in study pool projects was more than 50:1. Of these total 'convincing' benefit flows, \$10,098 million could be attributed to funding from ACIAR. The ratios of ACIAR convincing benefits to ACIAR study pool costs on the one hand, and total investment by ACIAR since 1982 on the other, were 103:1 and 4.3:1 respectively.

There were four streams delivering benefits to Australia:

- Biosecurity gains from understanding mite pests of honey bees (IAS 46) (\$161 million)
- Incorporation of ICRISAT germplasm in the Australian sorghum breeding program (IAS 48) (\$131 million)
- Access to the Japanese mango market through post-harvest treatment of fruit fly (IAS 56) (\$4.4 million)
- Development of the sandalwood industry in the Ord River (IAS 71) (\$936 million).

BETTER MANGO PRODUCTIVITY

ACIAR is working on two exotic diseases of mango, mango malformation and mango sudden death. A better understanding of the ecology and management of these diseases through research activities in Pakistan is reducing the risks in Australia of an incursion or the spread of an incursion. An ACIAR Pakistan project has also funded a John Allwright student to work in Australia on the Australian post-harvest disease mango dendritic spot.

Only one of these benefit streams (sorghum germplasm) was classed as plausible rather than convincing. The total flow of benefits to Australia classed as convincing amounted to \$1101million. While only about half ACIAR's investment in bilateral research since 1982, it easily exceeded ACIAR's investment of \$448 million.

Lindner, McLeod and Mullen (2013) aggregated Raitzer and Linder's stream of 'substantially demonstrated' benefits and their stream of 'convincing' benefits to give an aggregate value of highly credible benefits as \$12,332 million, which exceeds ACIAR's total investment in bilateral R&D of \$2517 million by a factor of 4.9:1. They argued that this represented a lower bound estimate of the returns to ACIAR's investment in bilateral R&D since 1982. Brief descriptions of the project streams are given below.

IAS 46 – MITE PESTS IN HONEY BEES (FOUR PROJECTS ASSESSED)

Mite pests of honey bees have a significant impact on productivity and production costs. In Australia, the only country in the world without these mites, the maintenance of effective quarantine strategies against them is a major aim. The assessment studied four projects in the area. There are two major benefits from the research: first to bee-keeping, through better understanding of mite-control methods; and second to quarantine procedures, through better understanding of the true nature of the risks posed by the mites.

IAS 48 – OVERCOMING PRODUCTION CONSTRAINTS TO SORGHUM PRODUCTION IN RAIN-FED ENVIRONMENTS IN INDIA AND AUSTRALIA (A JOINT PROJECT BETWEEN INDIA, AUSTRALIA AND ICRISAT)

Sorghum is an important crop for food and fodder in India and parts of Australia. It is one of the few crops that can withstand hot and arid conditions. However, yields in both countries are poor, with little or no change in productivity in two decades. The report aimed to estimate the contribution the project has made to wellbeing in India and Australia. A secondary and unintended outcome of the project was the discovery that one sorghum variety has high radiation-use efficiency. This finding was used to test the variety in Australia leading to its potential widespread adoption in Australia

IAS 56 – FRUIT FLY (17 PROJECTS ASSESSED)

ACIAR's involvement in fruit fly research goes back some 25 years to an initial project in Malaysia. Since then, there has been an almost continuous involvement in most areas of fruit fly control. The 11 core projects focused on in this assessment included identification and control of fruit flies in the Pacific Islands, Bhutan, PNG, Malaysia, Thailand, Vietnam and Indonesia. The objective of developing

⁶ These are total benefits and benefits attributable to ACIAR. In both scenarios some of these benefits (sometimes all of these benefits) flow to Australian agriculture.

and efficacy testing a protein bait spray was one of the common threads running through several of the larger projects. ACIAR projects were also funded to look at post-harvest heat treatment, use of improved temperate fruits and orchard management, supply chain improvement and integrated pest management. Quantifiable potential benefits that might be generated were categorised as coming from:

- Improved biosecurity to the risk of incursion by exotic pest fruit flies
- Market access for fruit exports based on non-host status
- Field control of fruit flies with protein bait
- Introduction of low-chill temperate fruit and improved orchard management.

Another significant benefit to Australia and its partner countries from the fruit fly projects has been capacity building. There has been a notable informal element to capacity building resulting from collaboration between Australian researchers and their partner-country counterparts. It can enhance the more general personal and leadership capabilities of all parties and, in the long run, generate even more benefits than those from project-specific training. This point is relevant to our discussion in Chapter V on the strengthening of Australian research capacity.

IAS 71 PLANTATION FORESTRY (12 PROJECTS ASSESSED).

This broad plantation forestry assessment was applied to 12 projects among a set of activities funded by ACIAR for more than 20 years. Collaborative projects between Australian and Indonesian scientists aimed to improve plantation forestry in both countries. The span of these stud-

ies has included silvicultural practices, the domestication of Australian trees for reforestation and agroforestry, control of insect pests and fungal pathogens, development of sustainable management systems and the application of molecular marker technologies for genetic improvement of forest plantations.

These projects have the potential to generate significant benefits in Indonesia and Australia if planned outputs are achieved and adopted. Two of the projects had essentially the same set of aims and were, in effect, a single, long project. The ultimate aim of the Australian component of both projects was to facilitate the development of a sandalwood plantation industry in the Kimberley region of Western Australia. While the potential is clear, it remains to be proven.

SUMMARISING THE CIE AND LINDNER STUDIES

Focusing on the CIE and Lindner studies, Mullen summarised their findings as:

- According to the CIE/Harding study, total quantified benefits to Australia from 48 assessments amounted to \$2.55 billion or about 7% of total benefits. At the time of this unpublished update, ACIAR had invested \$3.1 billion since its inception.
- Potential benefits to Australia identified in the Lindner studies might amount to about \$2 billion (duplication between the two studies makes difficult a more definitive estimate). This is less than the CIE estimate but Linder *et al.* (2013) also made a lower estimate of total investment by ACIAR in its bilateral program of \$2.5 billion.

Table 1 Total benefits and costs and total benefits and costs attributable to ACIAR from Lindner, McLeod & Mullen (2013) 'convincing' set of IAS reports.

Report ⁷	Benefit stream	Benefits (\$ million)		Costs (\$ million)		Benefit-cost ratio
		Total	ACIAR	Total	ACIAR	
36	Mudcrab hatchery technology in Vietnam	24	8	7.0	2.3	3.4
43	Irrigation water management in Vietnam	74	50	4.3	2.9	17.4
46	Bee mite pest control in Australia	161	108	8.2	5.5	19.7
47	Improved tree species in Vietnam	203	111	2.6	1.4	19.7
52	Pig breeding in Vietnam	4206	1648	45.2	17.7	118.1
52	Pig feeding in Vietnam	1135	445			
56	Fruit fly biosecurity benefits to Australia	67	30	70.8	32	1.6
56	Fruit fly post-harvest benefits in the Pacific and Australia	47	21			
57	Endoparasite control in goats in the Philippines	48	4	8.5	0.7	5.6
59	Grain drying in the Philippines	0	0	6.0	3.9	0
62	IPM in stored grain in the Philippines	2508	1812	14.1	10.2	177.4
71	Indonesian Forestry – sandalwood in Australia	936	373			
71	Indonesian forestry – Australian trees in Indonesia	13,354	5320	44.1	17.6	323.9
75	Rice yields in Laos	128	105	0.9	0.7	144.6
80	Oil palm in PNG	105	64	4.7	2.9	22.4
Total		22,995	10,098	216.3	97.7	103.3

7 ACIAR Impact assessment series report number.

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- **Both studies estimated a strong flow of benefits to Australia. This flow of benefits was almost equal to ACIAR's total investment in its bilateral program since 1982. Not only has the ACIAR investment delivered very high returns in terms of benefits to developing countries, it has also delivered benefits to Australia almost as large as the value of the total ACIAR investment.**

AUSTRALIAN INVOLVEMENT

Nearly from the dawn of the international agricultural research enterprise Australia joined in, led by the vision of such path-breakers as Sir John Crawford and Professor Derek Tribe and the institutions they helped create, ACIAR and the Crawford Fund. The incredible numbers of Australian scientists and science leaders⁸ since then, to use a sporting analogy, reads like our Olympic medal tally – we have had a disproportionate number relative to our population size. At one point when I was a CGIAR Center Director–General four of the 15 Directors General were Australians and one was an ‘honorary Australian’, a New Zealander who did his PhD in Australia. We have also enjoyed more than our pro rata share of Board chairs and members, TAC and Science Council members, etc. And the enriching international experience of such agricultural researchers and leaders has brought back to Australia the ‘inside tips’, the insights and knowledge our agriculture needs. For example, much of Australia’s crop germplasm, especially for dryland crops, comes from the international genebanks, to which we also contribute in funds and accessions. Australian universities have been enriched greatly in their undergraduate, postgraduate and teaching capacity by many agricultural students, who have become life-long contacts and Australian supporters.

Dr Meryl Williams, former Australian Director of the WorldFish Center and ACIAR Commission Chair

- Both studies agreed that the total flow of benefits to Australia *and its partners* from the sample of projects subject to impact assessment (less than 10% of total investment) easily exceeded not only the investment in these projects (almost 70:1 according to Lindner *et al.*, 2013) but also ACIAR’s total investment in bilateral research since 1982 (almost 5:1 for the small set of ‘convincing’ analyses identified in the Lindner reviews as the basis for a lower bound estimate of the returns to ACIAR’s activities).

There are many other foodstuffs produced in Australia that benefit from international agricultural research. The target of focused research within CRCs, for example the poultry CRC, draws on international research. Poultry production and processing, largely for domestic consumption, is a major industry in Australia. The broad range of possible interventions for international agricultural research investment points to the need for some form of research priorities framework for agencies such as ACIAR, an issue we discuss in Chapter VIII.



⁸ Two of the authors of this report served with international agricultural research centres: Dr Eric Craswell was a senior scientist at the International Fertilizer Development Center, a foundation staff member of ACIAR and Director–General of the International Board for Soil Research and Management; Dr Denis Blight was the first Centre Secretary of ACIAR and the Director–General of CAB International. Australia is currently represented at Director–General and other senior staff levels at international centres and on boards of a number of centres.

IV. Benefits to Australia from its support for international agricultural research centres

AUSTRALIA HAS LONG supported and benefited from the international agricultural research centres that are part of the Consultative Group on International Agricultural Research and from related centres such as CABI and the World Vegetable Center. Although this view is broadly supported in the Australian agricultural community, it is timely to retest its basis, the focus of this chapter.

PLANT GERMPLASM FROM CGIAR CENTRES

The CGIAR includes some 15 centres with mandates ranging from wheat and maize (CIMMYT), rice (IRRI), crops of the semi-arid tropics such as sorghum, chickpeas and pigeon peas (ICRISAT), and agricultural research in dry areas and crops such as barley, durum, chickpeas, faba beans and lentils (ICARDA). Australia, through such figures as Sir John Crawford and Professor Derek Tribe, were leaders in the development of the CGIAR, along with people such as James McWilliam, Meryl Williams, Lloyd Evans and Tony Fischer, a group of donors, and developing country governments. The CGIAR provides a broad level of coordination, priority setting guidance and funding for the centres. Sir John Crawford was the first chairman of the Technical Advisory Committee for the Group and provided leadership in the establishment of new centres and periodic reviews of the centres' operations and effectiveness. Australia has supported the centres almost from their first establishment.

While the centres were established to support agricultural research and development of crops, livestock and farming systems that are important for developing countries, Australia has always been seen as a beneficiary of the work because of the importance to it of some of the crops and agro-climatic conditions embraced in the centres' mandates.

Professor John Mullen's review, undertaken at the request of the task force, looked in particular at evaluations of Australian benefits from three of the centres (ICRISAT, ICARDA and CIMMYT) by Dr John Brennan and colleagues. The full detail of his review is included in his report, to be made available on the Crawford Fund website. Australia benefits from other centres in the group but the three identified are ones for which existing studies are available. Descriptive and anecdotal material on these other centres is included later in the chapter.

In recent years, Australia has contributed about \$10 million a year to CGIAR centres in the form of core grants or support for specific projects.

The findings by Brennan and Quade (2004), Brennan *et al.* (2002) and Brennan and Bantilan (1999) are summarised in Table 2 where the annual benefit flows, largely derived from the use in Australia of germplasm from the three centres, has been expressed in present value 2012 dollars.

The annual flow of benefits from these three centres is estimated at \$97 million.

Mullen acknowledged some qualifications, both positive and negative, to this estimate. These are spelt out in more detail in his report but include:

- Brennan's study focused on a subset of benefits amenable to economic analysis – in particular, the flow of genetic material from the centres. Other benefits such as improved crop management practices, may have delivered productivity gains, better environmental outcomes and gains in scientific capacity, which in turn might be expected to lead subsequently to economic impacts in later times. But these have not been quantified.
- The studies were undertaken some time ago (1999, 2002 and 2004) when the benefit gains were prospective (rather than realised) as few varieties in Australian fields contained germplasm from the centres, with the notable exception of CIMMYT.

The task force has not been able to update Brennan's empirical work. Even so, we are confident that the prospective benefits have materialised and new material from the three centres has been acquired and is likely to have been used with germplasm derived from Australian R&D and breeding programs in other countries.

None of the studies claim to be cost-benefit analyses of ACIAR's investment because there was no process of directly linking ACIAR's investment to a set of outcomes directly attributable to these investments. Rather, Brennan and colleagues have sought to identify a gross flow of benefits to Australia from IARC activities.

For some of the crops, Australia farmers may have lost because the yield gains (or cost savings) that they were able to achieve were less than the fall in world prices. So, referring to Table 2, Australian growers were made 'worse off' by the efforts of ICARDA and ICRISAT in developing varieties for durum, sorghum and chickpeas that delivered larger yield gains in developing countries than in Australia.

However, the gains to Australian consumers (often feedlot operators) in the form of lower prices were generally large enough to offset losses to the producers, delivering substantial net gains to Australia. Moreover, the losses to producers would have been much larger if the technology had not been made available to Australian farmers.

In Brennan *et al.*'s CIMMYT analysis, benefits to Australia were estimated under two scenarios: the scenario where CIMMYT varieties are used in Australia and also the scenario of the impact on Australia of CIMMYT activities were there no flow of germplasm to Australia. In this second scenario, Australia does not take advantage of yield gains but does suffer the lower world wheat price.

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SAVING PACIFIC COCONUTS THROUGH COLLABORATION

More than 50 billion coconuts are harvested every year; these days coconuts are facing major challenges. Old diseases come back and there also new diseases coming, probably as a consequence of climatic change. We know there is only one solution to all these difficulties: that is crop diversity. In Samoa, in the 1990s, taro was almost wiped out by what was called 'Taro Leaf Blight'. Then a program was developed: it was funded by AusAID and it was handled by actually an organisation which my organisation supports, namely the Secretariat of the Pacific Community; and through this cooperation was able to find the solution to the blight and now we're fine! It shows: co-operation works.

Dr Marie Haga, Director, the Global Crop Diversity Trust

Under the first scenario Australian growers lose almost \$52 million because yield gains are smaller in Australia than in other countries using CIMMYT varieties and are offset by a decline in the world price for wheat occasioned by these yield gains. However, had CIMMYT varieties not been introduced to Australia the losses to producers would have been about \$112 million. Hence, the net gain to Australian producers from using CIMMYT varieties is \$59.8 million (Table 2). Consumers gain about \$24 million under both scenarios.

If a similar alternative scenario has been incorporated into the analyses for ICARDA and ICRISAT, the benefits

in Table 2 might, as Brennan *et al.* warned, significantly understate the net benefits to Australia from the investment in the two centres.

Scenarios under which Australia receives no flow of germplasm from the three centres suggest that our producers and consumers would be seriously disadvantaged. While a zero flow of germplasm is unlikely, the gain in benefits from a reliable flow of germplasm rather than an uncertain flow, underlines the importance of an ongoing formalised pathway between the centres and Australia, which ACIAR support has required and encouraged and without which the flow of germplasm to Australia would have been irregular and haphazard. A large share of the net gains identified in Table 2 can, therefore, be attributed to ACIAR and the networks it encourages¹⁰.

Mullen concludes that the opportunity for Australian scientists to work collaboratively with scientists from the international agricultural research centres is particularly important for the small crops where issues of critical mass in research resources are pivotal to success.

THE BENEFITS TO AUSTRALIA FROM ICRISAT

ICRISAT, founded in 1972, conducts research into its mandate crops – sorghum, millets, chickpeas, pigeon pea and groundnuts. In 1994-95 Australia contributed \$26 million to the CGIAR system, with about \$1.7 million to ICRISAT. Brennan and Bantilan (1999) attempted to quantify the expected benefits to Australia in the immediate future from the sorghum and chickpea research programs. They pointed out that they did not attempt to capture the benefits at the more basic end of the R&D spectrum in terms of the value of ICRISAT's role as a source of germplasm for these mandate crops.

At the time of their report Brennan and Bantilan found that the pigeon pea industry was very small in Australia and that while there were somewhat larger millet and groundnut industries there was little evidence of links with ICRISAT. At that time there was little evidence of ICRISAT material in sorghum and chickpea varieties then being grown, but ICRISAT material was being used in breeding programs and hence was likely to deliver benefits in the future to Australian growers. ICRISAT material was expected to deliver improved midge resistance in sorghum, with average yield gains of about 2.5%. In the WA chickpea industry, ICRISAT material was expected to give yield gains of about 10% through varieties with increased cold tolerance. In eastern states, ICRISAT material was expected to deliver just over 2% in yield gains.

However, ICRISAT varieties have been adopted across the semi-arid tropics and this led to falling world prices. Because Australian farmers have not experienced the same yield gains as others in the semi-arid tropics, the cost savings to Australian farmers from the higher yields

Table 2 The benefits to Australia from ACIAR's funding of three IARCs (2012 dollars)⁹

		Producers (\$ million)	Consumers (\$ million)	Australia (\$ million)
CIMMYT	Wheat	59.8	0.2	60.0
ICARDA	Barley	4.2	1.4	5.5
	Durum	-2.8	0.7	-2.1
	Chickpeas	2.5	0.2	14.1
	Faba beans	13.9	0.2	14.1
	Lentils	11.3	0.0	11.3
	Total		29.1	2.5
ICRISAT	Sorghum	-1.8	5.6	3.8
	Chickpeas	-2.7	3.9	1.3
	Total	-4.5	9.5	5.0
Total		84.4	12.2	96.7

9 Source: Table extracted from Brennan reports and rebased to 2012 dollars. The CIMMYT, ICARDA and ICRISAT reports were expressed in 2003, 2001 and 1996 dollars. The CPI factors to convert these amounts into 2012 dollars were 1.28, 1.35 and 1.5 and the compounding factors to arrive at present values were 1.55, 1.71 and 2.18.

10 The GRDC also began to contribute to research and to the more systematic introduction to Australia of germplasm from the CGIAR Centres.

are likely to have been more than offset by lower world prices. As noted above, the negative results for Australian producers (Table 2) are likely to be reversed when consideration is given to larger losses were no ICRISAT germplasm used in Australia.

THE BENEFITS TO AUSTRALIA FROM ICARDA

ICARDA was established in 1977 at Aleppo, Syria, and its research covers the countries of Central and West Asia and North Africa, which have environments similar to parts of eastern and western Australia. Recent developments in Syria, particularly in Aleppo, have cast doubt on the ability of ICARDA to sustain its work from its headquarter research facilities. However, countries in the region, particularly Turkey, have taken steps to preserve and replicate the genetic resource collections held at Aleppo. In any case, the assessment below predates any disruption to ICARDA's work.

Brennan *et al.* (2002) reviewed the flow of benefits from ICARDA to Australia. While ICARDA has a wide range of research interests including the management of farming systems and natural resources such as water, it is responsible for developing improved varieties of lentils, barley, faba beans, durum and chickpeas. Brennan *et al.* focused on the benefits from a flow of ICARDA germplasm to Australia.

ICARDA barley germplasm is expected to deliver greater drought tolerance and hence be of benefit in the drier areas of South Australia and Victoria with alkaline soils. ICARDA germplasm was being used in the Australian durum breeding program and was expected to be incorporated in new varieties released over the following 10 to 12 years.

For chickpeas, the ICARDA germplasm was expected to deliver ascochyta blight resistance into kabuli chickpeas then being used in Australia. The benefit to faba beans was expected to come through better resistance to chocolate spot and a consequent reduction in the use of fungicides. All lentil varieties used in crop rotations in the Wimmera and Mallee regions of Victoria and South Australia are based on ICARDA varieties.

At the time of their report, most of the benefits to Australia from ICARDA identified by Brennan *et al.* were prospective in nature (as for ICRISAT). They did not disclose ACIAR's investment at that time either in ICARDA or in the IARCs in total.

The IARC durum lines are of value mainly as germplasm because Australian grain quality requirements are highly stringent; most of these lines do not qualify for direct use in breeding and variety development. However, the wide adaptation of the IARC material, high yield and special traits such as drought and heat tolerance are expected to be of great relevance for the Australian breeding programs in the medium to long term.

AUSTRALIAN CHICKPEA IMPROVEMENT

A large amount of ICRISAT material has either been used in the past or is being used in the present in Australian breeding programs. More recently, the chickpea genome decoding by an international consortia led by ICRISAT, which included scientists from Australia, has been a success story. Chickpea improvement in Australia has been heavily dependent upon germplasm from ICRISAT in India and ICARDA in Syria.

Dr Willie Dar, Director-General, ICRISAT

BENEFITS TO AUSTRALIAN SEED SECTOR

Germplasm from the international centres is really what's underpinned the cereal varieties we have in Australia since the time of the Green Revolution in the 1970s – they are the basis of what we now have. The model is changing somewhat as breeders and farmers are using more seeds developed by the private sector, but in many cases even those breeds would have originally come to some extent from the international centre.

Russell Eastwood, Wheat Breeder, Australian Grain Technologies Pty Ltd, Australia's largest, and market-leading, wheat breeding company

THE BENEFITS TO AUSTRALIA FROM CIMMYT

CIMMYT, located in Mexico, aims to improve the productivity and sustainability of maize and wheat systems for poor farmers in developing countries. Semi-dwarf wheat varieties, which have made a major contribution to reducing poverty, were largely developed by CIMMYT. CIMMYT is thus a major contributor to Australia's development assistance programs and objectives. Australians have also contributed substantially to CIMMYT programs (see 'Australia-CIMMYT Wheat Warriors' below).

Brennan and Fox (1995) estimated that by 1994 more than 90% of the area sown to wheat in Australia was sown to semi-dwarf varieties, worth almost \$240 million a year for the period 1974 to 1993.

AUSTRALIA-CIMMYT WHEAT WARRIORS

On the occasion in 2010 of the first meeting in Australia of their Board of Trustees, CIMMYT joined with the Crawford Fund to recognise as CIMMYT-Australia Wheat Warriors the following individuals, who had played key roles as Board members, staff or collaborators with CIMMYT: James R. Syme, Anthony Gregson, Edwina C. Cornish, James R. McWilliam, John M. Dixon, John P. Brennan, Kenneth S. Fischer, Ligia Ayala-Navarrete, Lloyd T. Evans, Paul N. Fox, Paul S. Brennan, Peter J. Ninnies, Richard M. Trethowan, Robert A. McIntosh, Terence Enright, Timothy G. Reeves and Tony Fischer.

BARLEY BENEFITS FROM ICARDA

ICARDA barley germplasm has played an important role in the development of modern barley cultivars for Australia.

The breeding line Arupo was released as the cultivar Kaputar in 1993. A cross to Arupo produced the cultivar Grout, released in 2005, which has been the most popular in the northern grain-growing region of Australia for the past four years. Yagan was released in 1989 for Western Australia from an introduction from the ICARDA barley program. Yagan is a parent of Mundah, released in 1995. Neither cultivar has had a large impact in terms of production area, but they were important in specific production areas. Both Arupo and Yagan have introduced genes for earliness under short-day conditions into Australian barley breeding programs.

The Victoria breeding line VB9104 (Europa/IBON#7.148) is derived from a cross to an ICARDA accession and is in the parentage of several Australian cultivars, Buloke, Flagship, Yarra and Scope. Buloke is currently a popular malting barley cultivar in southern Australia and Scope is a recently released mutant of Buloke.

The other contribution of ICARDA barley germplasm has been the introduction of new genes controlling various agronomic traits and disease resistances. The pre-emptive research on resistance to barley stripe rust has already been noted. Several cultivars and a number breeding lines have resistance to stripe rust even though it has not been reported to occur in Australia. Whole genome profiling with molecular markers has made it possible to trace the origins of other important traits back to breeding lines introduced from the ICARDA barley program. These include maturity, plant height and kernel size genes.

Resistances to powdery mildew, leaf rust, net form of net blotch, barley yellow dwarf virus, scald, the Ug99 pathotype of stem rust and septoria speckled leaf blotch have been obtained from ICARDA germplasm. ICARDA accessions are also a source of tolerance to boron toxicity and drought. Based on the parentages of Australian barley breeding lines that can be traced back to accessions from ICARDA, I assume a number of other traits will be discovered in which the primary source of the desirable allele is an ICARDA accession.

*Jerome D. Franckowiak, Senior Plant Breeder (Barley),
Crop & Food Science, Agri-Science Queensland,
Department of Agriculture, Fisheries and Forestry*

Dr Jim Syme, who was designated ‘Wheat Warrior of Warriors’, marked the occasion with the following comments on the benefits to Australia from collaboration with CIMMYT:

The recent death of Norman Borlaug gives us cause to reflect on the legacy of this man whose appetite for hard work was only exceeded by his passionate vision and generosity. So many of us take an abundance of food for granted, forgetting those who live with hunger every day. Borlaug had these people in mind when he established what became known as CIMMYT,

the first internationally focused plant breeding centre, in Mexico. Borlaug’s vision and the generosity of its funding donors enabled an injection of vitality into wheat genetic improvement that had repercussions around the world. The ‘Green Revolution’ in developing countries of the 1960s received well-deserved publicity, but less well known is the important contribution it made to our own Australian wheat production. It was Borlaug’s spirit of generosity that I and other Australian wheat breeders tapped into, through the importation of thousands of accessions to be used as parental lines.

Dr Albert Pugsley at the Agricultural Research Institute, Wagga Wagga, NSW, made the first introductions in 1962, but we soon realised that major modifications were required to meet the quality standards that Australia’s local and export industries had built up over many years, as well as the need for resistance to local disease problems. The 1970s saw the first of the new varieties, Condor, released from the Institute at Wagga, soon followed by Banks, Oxley and Cook from the Queensland Wheat Research Institute at Toowoomba, Queensland, where I worked. We had recognised the advantages of the shorter, awned wheats with a superior partitioning of their photosynthesis into more grain and less straw. Wheat farmers were literally reaping the benefit, and the added value to our yearly export income was, and still is, enormous. The challenge to feed the world’s expanding population is still with us today. Let us hope our young agricultural scientists will meet the challenge with their own visions, that they will be funded with generosity, and that they in turn will be as generous in their science as Norman E. Borlaug.

At the time of the analysis of the benefits to Australia from CIMMYT by Brennan and Quade (2004), benefits were being realised (rather than being prospective) because the first semi-dwarf varieties based on CIMMYT material were released in 1973. “By the end of 2003, 193 varieties had been released in Australia incorporating CIMMYT genetic material, either as direct CIMMYT introductions (3%), Australian varieties using a CIMMYT line as a parent (20%), or Australian varieties with some CIMMYT ancestry in at least one of the parents (77%)” (Brennan and Quade, p.vii). Brennan and Quade estimated that by 2001 yield gains attributable to CIMMYT averaged 4.6% across Australia.

They also noted that world wheat yields from CIMMYT germplasm increased on average by 12.2% and world wheat prices were estimated to be 7.4% lower. Had Australia not acquired the CIMMYT material, but other nations had, the costs to Australian growers would have been even larger (Table 2): Australian farmers would have experienced the price falls without the benefits of the yield gains. Hence there have been substantial net gains to Australia, of almost \$60 million a year, from the use of CIMMYT material.

Brennan and Quade (2004) noted that ACIAR's funding of CIMMYT activities averaged about \$2.0 million a year. It seemed as though other Australian institutions, including the GRDC, made contributions almost as large (Appendix B in Brennan and Quade).

There is another point to be made on access to the benefits of international agricultural research: the important contribution of Australian breeding programs to adapting the CIMMYT material. This contribution is clear from the figures in Table 2. Capturing spillover benefits from the international centres such as CIMMYT requires not only investment in the international centres but also strong domestic research institutions.

This leads on to a question about the extent to which participation in international agricultural research might contribute to the strengthening of Australian research institutions, an issue which is examined in the following chapter.

BENEFITS TO AUSTRALIA FROM THE CONSERVATION OF GLOBAL PLANT GENETIC RESOURCES

At the Crawford Fund's 2008 Parliamentary Conference on Agriculture in a Changing Climate, Dr Cary Fowler, then Executive Director of the Global Crop Diversity Trust, put the case for conserving biodiversity this way:

There is no more important natural resource on Earth for humans than crop diversity. There is also no resource upon which nations and people are more interdependent. This interdependence is worldwide – data indicate that Italy, where I now live, and Ghana are equally dependent on crops that originated outside those countries. The dependence is at the varietal level and at the pedigree level of our modern crop varieties. Luckily, along with being the most important resource, crop diversity is among the easiest and cheapest to conserve. It's a matter of freezing seeds. Despite the simplicity, though, we have no efficient coordinated global system for conserving this most valuable natural resource. When a cyclone put about a metre of water and mud into the Philippines National Gene Bank in September 2006, destroying a number of distinct, unique crop varieties, a number of varieties became extinct because of the absence of an effective global storage system. The resources that became extinct that day in the Philippines may be exactly the resources needed in the future to breed a climate-ready crop in Australia, in Ghana or elsewhere. Now more than ever before we are our brother's keeper.

Later, Fowler drew attention to the contribution of AusAID and the GRDC to the global seed vault in Svalbard. He said:

The Svalbard Global Seed Vault forms only part of a rational global system for conserving and using crop diversity. Had it been built 10 years ago, it would probably have been used 10 times already to restore seeds to seed banks because the conditions in normal

TAMING OF DIVERSITY

The wheat, barley and pulse germplasm received from international centres such as CIMMYT, ICARDA and ICRISAT has significantly impacted crop breeding and crop production in Australia. In the case of wheat, the materials have been either released directly, reselected and released, or crossed to local materials and the derived lines released. Economic assessment earlier put the cost–benefit ratio based on Australian aid investment in CIMMYT at 1:40. The link with the international centres is vital for Australia as the centres have access to key genetic diversity that Australian breeders do not. One of the main tasks of the centres is taming this diversity: in other words, they make the crosses that Australian breeders either cannot make or cannot afford to make. The taming of diversity involves taking genes from unadapted related or wild species and transferring these into better adapted intermediate materials that can be used as parents in a commercial breeding program. Without this flow of genetic diversity for yield, disease resistance and quality, genetic progress in Australia would have been considerably slower and there is compelling evidence that the wheat sector would be much smaller and less profitable than today. The need for unencumbered access to genetic diversity will be as important to Australian breeders and farmers in future as it is now.

Professor Richard Trethowan, Professor of Wheat Breeding, University of Sydney

THE FMD OF WHEAT

Since 1999 when a pathotype of wheat stem rust evolved in Africa (known as Ug99), Australian breeders and pathologists have joined a global effort to ameliorate the threat. When it was first detected, this virulent new strain was capable of parasitising the majority of Australia's wheat varieties. Now, after a decade of international research and screening of Australian breeding lines in Africa, our breeders could confidently tackle an incursion by this strain into Australia with a wide array of resistant lines.

Professor Andy Barr, Australian farmer and Chair of CIMMYT

seed banks are so deplorable in so many countries. We really have to prepare for the storm that is coming. With support from the Australian Grains Research and Development Corporation (GRDC) the Trust has mobilised scientists and specialists worldwide to develop crop strategies that identify the most genetically important collections in the world. We know now what remaining diversity needs to be collected. We know how to conserve it, and we have begun to make long-term conservation grants that secure the most important collections – 15 crops at

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BENEFITS FROM THE WORLD VEGETABLE CENTER

The World Vegetable Center (AVRDC) provide substantial benefits not only for Australia but for Australian farmers. For example, mung beans have been grown across much of tropical Queensland and northern Australia for many years; those mung beans are, in fact, derived from AVRDC's breeding program for mung beans. Unfortunately, over the past few years there has not been much importation of genetic material of mung beans; recently, however, quite a few new lines are being introduced to Australia. The Australian Grains Research and Development Corporation may be able to incorporate into this germplasm new lines for the improvement in the Australian mung bean industry. In the case of tomato, where tomato yellow leaf curl virus has been a major challenge recently in Queensland, it is necessary now for Australia to use genetically resistant material which is available at AVRDC; that's going to take a bit of time to be able to get those lines into that preferred commercial material, but they are freely available and Australian farmers will benefit in the long run from prevention of this major disease which is found worldwide, and I believe is a major challenge, not only to the Queensland field tomato industry, but also to the glasshouse tomato industry in Victoria.

Dr Dyno Keatinge, Director-General, AVRDC

the moment. We have a competitive grants program for screening the collections for useful traits, and we have another program for rescuing collections that are in bad shape – principally in developing countries. We think that between 100,000 and 150,000 distinct crop varieties will be rescued in the next couple of years.

Dr Tony Gregson, an Australian farmer and member of the task force, described the importance of the Svalbard seed vault in the following terms:

The Svalbard Global Seed Vault is very important to Australia for several reasons. First, it allows back-up storage for the precious and unique germplasm that Australia has in its own genebanks. Australia has already deposited its first box of 343 samples of its most unique seed samples; another 10 boxes are to be shipped to Svalbard in February 2014. Second, because of the multilateral nature of the Treaty, it ensures Australia has instant access to any of the germplasm stored in the vault. Australia's strong support for the Treaty, the Trust and the Global Seed Vault has guaranteed Australia's place in the global multilateral plant genetic resources community with all the benefits of sharing germplasm and information.

Australia has wild relatives of sorghum, soybeans, mung beans and particularly rice that may possess valuable traits and are worthy of conservation for both the short and long term in our own seedbanks and globally. Dr Bob Lawn, Professor of Tropical Crop Science at James Cook University, Honorary Fellow with CSIRO Plant Industry and a mung bean collector explains:

Australia is a major centre of diversity for the wild mung bean, with many unique adaptations to various climatic, edaphic and biotic stresses that will prove useful in breeding resilient mung bean cultivars for difficult environments in Australia and internationally.

CABI AND BIOLOGICAL CONTROL IN AUSTRALIA

CABI has played a significant role in supporting biological control programs of pests and weeds in Australia, including the biological control of the rubber vine weed, one of the most successful biological control programs against an invasive weed in Australia (see below). CABI's role has been to identify and test potential biological control agents at its research facilities around the world before their safe introduction to Australia.

Much of CABI's work of direct benefit to Australia is funded from sources outside the aid program. Its ability to undertake this research, however, depends on the critical mass of resources and expertise it is able to sustain through its diverse array of funding sources and partnerships. There is a scarcity of economic studies of biological control due to the long period between commencement to full field studies, difficulties in assigning monetary values to biodiversity and social impacts, and difficulties in assessing impacts of biological control. According to McFayden¹¹, however, an economic impact assessment of all weed biological control undertaken in Australia since 1903, including successes and failures, demonstrated annual benefits of \$95.3 million delivering a cost-benefit ratio of 23:1. Even with the enormous economic impact of the prickly pear excluded, the cost benefit ratio was 12:1.

No effort has been made to attribute a share of these benefits to the contribution made by CABI but the value of CABI's role can be assessed qualitatively in at least one case study from the series of projects – rubber vine weed (see page 23).

11 *Proceedings of the 12th International Symposium on Biological Control of Weeds*, La Grande Motte, France incorporated in CAB Abstracts.

LIVESTOCK GERMLASM¹²

International research collaboration has led to the exchange of livestock germplasm as well as crops. Collaboration linked to the International Livestock Research Institute (ILRI) proved the potential of indigenous livestock breeds and as a result several indigenous cattle (for example, Afrikaner, Boran, Tuli, Drakensberger, N'guni, Indu-Brazil) and sheep breeds (for example, Dorper) have been imported by Australian livestock producers, primarily from Africa and South America. The Boran has proven very suitable to conditions in central Queensland. Provided proper precautions are taken to control disease transmission, importation of livestock and crop germplasm has proven to be critically important to Australian agriculture. The imported cattle breeds have significantly improved the productivity of Australia's livestock industries. For example, a study by Burrow *et al.* (2003) on beef cattle showed that changing the northern Australian Brahman herd to a tropical composite herd comprising 25–35% genetics from tropically adapted *Bos taurus* breeds (that is, those from southern Africa or South America) increased gross margins by \$76 for each adult equivalent. At the northern industry level, changing 25% of the herd from Brahmans to composites over 10 years equated to an annual benefit in 2013 of \$61 million or a NPV of \$342 million.



LIVESTOCK PRODUCTION AND BIOSECURITY

International agricultural research of course benefits Australian producers as many research findings are as applicable in Australia as they would be in Africa or Europe. There are many examples of this in both livestock production and biosecurity. From a health perspective, the global eradication of rinderpest and the underpinning international research collaborations that led to this, while directly benefiting those countries where the disease still occurred, removed this as a risk to Australia, both from a direct threat to our livestock as well as the trade implications had the disease occurred here. Similarly, innovations in foot and mouth disease (FMD) vaccine design and improved diagnostics, continue to reduce the threat to Australia. This is the reason why Australia conducts much of its research on FMD offshore with international partners in Vietnam, South Africa, Argentina and the UK and is a key member of the Global Foot and Mouth Research Alliance (GFRA). Even with an Australian-specific disease, Hendra, the identification of the virus attachment site on infected cells through international research collaboration between Australia and the US, directly led to the development of an effective vaccine and improved diagnostics for this deadly disease of horses in Australia. As a final example, research at the Australian Animal Health Laboratory (AAHL) that may lead to an avian-influenza-resistant bird is conducted through international partnership with others research scientists in a number of countries. If successful this would benefit not just Australia but the poultry industry throughout the world, including producers in the poorest parts of the world, while additionally reducing the risk of a pandemic of influenza in humans.

Professor Martyn Jeggo, Director, GCEID (Geelong Centre for Emerging Infectious Diseases) and former head of AAHL

RUBBER VINE WEED

The control of rubber vine with rust is considered one of Australia's best biological control successes. CABI undertook the research on the rust before its release in Australia in 1994. The potential value to Australian agriculture was estimated to be between \$295 million and \$528 million accrued over a 20-year period (Chippendale 1991) and invaluable to Australian ecosystems. Actual benefits to agriculture in Queensland to 2004 have been estimated at \$232.5 million with a cost-benefit ratio of 108:1 (Page and Lacey, 2006). The benefits of control of this weed are ongoing.

12 This example is not drawn from the review undertaken for the task force by Mullen but is included for reasons of balance to represent the broader array of activities undertaken by the CGIAR and other centres.

V. Strengthened Australian research capacity

IN THIS CHAPTER we ask whether Australia's participation in international agricultural research has the potential to enhance Australia's agricultural research capacity and output. We make use of feedback from Australian researchers themselves to comment on these issues. We also address the risk that participation might be a drain on our limited resources.

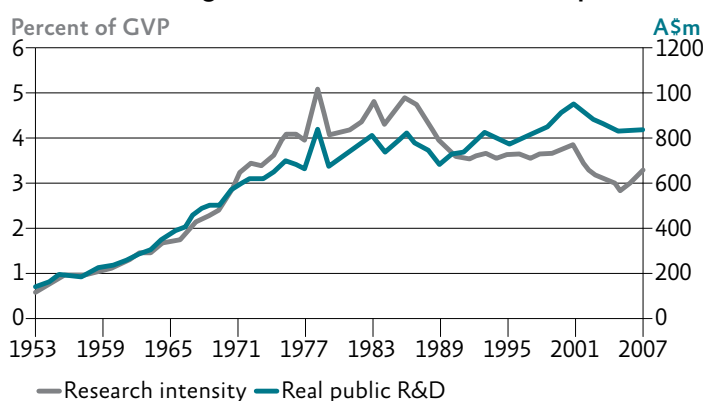
AUSTRALIA'S BENEFITS RELY ON STRONG DOMESTIC RESEARCH INSTITUTIONS

Australia's ability to receive maximum benefit from international agricultural research depends on it having strong domestic research institutions. Enhanced research capacity in Australia contributes to the depth, breadth and relevance of expertise in Australia that is available to ACIAR and the international agricultural research system. All of this helps to build enduring linkages between Australian research institutions and their international counterparts, keeping Australia within the circle and enabling access to global knowledge and product innovation networks.

The independent review of ACIAR identified "some decline in Australia's overall agricultural research capacity". This comment is reinforced in Figure 2, which shows the decline in research intensity in Australia over the past 30 years.

A strengthened Australian capacity is a benefit of international agricultural research that improves Australia's ability to contribute to such research. It follows that the strengthened capacity will serve Australia's national interests more broadly and those of its farming community. This is "doing well by doing good".

Figure 2 Australian public spending on agricultural R&D is declining as a share of the value of output.



The task force felt it important, therefore, that it should seek to assess, at least in a qualitative way, the benefits gained to Australia's agricultural research capacity through involvement in international agricultural research.

INTERNATIONALISING SCIENCE

In our survey and consultations we were told that internationalisation is a strategy of all universities and has widely recognised mutual benefits. Universities, which derive revenue from international student enrolments, also believe that international agricultural research adds a valuable dimension to teaching students and improves the teaching of agriculture to Australian and international students.

The task force was advised that ACIAR projects increase the capacity of South Australian institutions to train and support overseas postgraduate students. Similarly, during the consultations, one participant made the observation that "international agricultural research helps the internationalisation of science in Western Australia".

Four ERA (Excellence in Research for Australia) criteria are vital for university researchers. Murdoch University, for example, has found that "international agricultural research strongly underpins its research performance and ERA rankings".

Capacity can also be strengthened through 'on the job' training of Australian scientists who are exposed to new techniques and approaches to research across a wider variety of plants, animals ecosystems and food safety issues than they might encounter in Australia.

SUPPLEMENTING RESOURCES

According to our survey, ACIAR funding supplemented other sources of funding and allowed universities, state agriculture departments and agencies such as CSIRO to explore broader areas of research while creating the critical mass needed for research teams to be more effective. In some cases, without the ACIAR funding, some research units might well have been closed down.

ACIAR projects also provide for additional professional and technical human resources to be engaged for project tasks and to build on the capacity of the experienced staff already in the Australian partner, thus providing an immediate boost to its research capacity. In addition, the projects enable further training for postgraduates engaged in the project.

Consulting, commercial research and international education constitute significant Australian export industries. While we have not yet tested this thesis, it also seems to us that the private sector could exploit its projected increased involvement in ACIAR programs in much the same way that Australian agricultural consulting firms

gained entry to the global aid market through their early project design and management work for AusAID and its precursor organisations. ACIAR projects (for example, in India and China) lead to continuing cooperation financed by other means and, potentially at least, to trade in services.

ENDURING LINKAGES

Participation in ACIAR and other international agricultural research projects can initiate enduring linkages with research institutions in developing countries. We have seen clear evidence that Australian research institutions, once introduced via ACIAR projects, are well placed to participate in projects funded by other sources. It is instructive, for example, to see the number of joint India/Australia activities that began as ACIAR projects and that continue as self-funding partnerships. China appears ready to finance joint projects.

Participation by Australians in joint training activities helps create networks of researchers, facilitating the exchange of knowledge and materials. Such networks can also test and develop methodologies in a cost-effective and more comprehensive way, covering a wider variety of ecosystems than an individual researcher could attempt to sample. All scientists participating benefit from the acceleration in learning and the more robust research methods that result.

ENABLING STUDY OF BIOSECURITY THREATS

In the area of biosecurity to protect Australian agriculture from dangerous plant and animal diseases, joint training held overseas enables Australian scientists to study the pathogens and control measures without bringing the diseases to Australia. It can also help prepare Australia to deal with pest and disease incursions. The training helps overseas scientists to diagnose and manage the diseases, reducing the incidence and hence the likelihood of spread to Australia. One example of the benefits to Australia from joint training is the recent Crawford Fund Master Class on Huanglongbing (citrus greening) held in Yogyakarta.

USING INTERNATIONAL INFORMATION SERVICES

Agricultural and applied life science research institutions in Australia subscribe to CABI publishing and information services. Pearce and Monck (2006) estimated a value for two widely used CABI products – CABI Abstracts, a comprehensive bibliographic abstracting and indexing database covering the applied life sciences, and CABI Compendia, an encyclopaedic-type reference presenting forestry, crop protection, animal health and aquaculture information using multimedia tools. As our researchers' publications are recorded, our reputation grows.

Information services such as the CABI products are

inherently difficult to value. Pearce and Monck based their valuation on estimates from surveyed scientists about time saved reviewing literature from using CABI products rather than alternative information services. At least conceptually, these gains in efficiency in research processes lead to an increase in the rate of return to agricultural research. Pearce and Monck estimated the value to Australia of these CABI products at \$2.2 million.

ACCESS TO ADVANCES IN CROP AND ANIMAL BIOTECHNOLOGY

Research on the use of biotechnology and its application in the developing world occupies an important place in any consideration of the question of benefits to Australia from international agricultural research.

First, it is an important scientific breakthrough resulting from decades of high quality research, mostly in North America but also elsewhere – including in Australia where Professor Alan Kerr AO made a particular contribution including seminal discoveries in biotechnology that led to the successful biological control of crown gall disease on fruit trees in Australia, the US and Europe.

Second, much of the research and its application have been funded by investment from the private sector, including from the multinational life science companies.

Third, it is only because of Australia's active participation in the international science world and its networks (through scientists such as Professor Alan Kerr and Dr Jim Peacock of CSIRO) that Australia has been in a position to understand the scope of the new technologies and to exploit their application on our farms.

Fourth, while so far the technology has not been fully exploited by the international agricultural research centres, to the extent that public/private partnerships are encouraged to grow and flourish and public awareness and regulatory frameworks (where Australia has best practice systems) are put in place, it could make a significant contribution to the food security goals that sit at the heart of the system's purpose.

Australia's investment in international research will help Australian agriculture through access to innovations such as drought resistance, with the proviso that some new traits may be heavily protected by patents.

OPPORTUNITY COSTS OF RESEARCHERS' TIME

Concerns have been expressed that with the reduction in public funding for agricultural research domestically, international agricultural research may divert scarce scientific resources from a focus on the domestic research agenda. However, it is also clear from the foregoing that ACIAR and AusAID investments help maintain R&D capacity and may provide support that fills gaps in the disciplinary mix needed for state agriculture departments

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SHAPING THE GLOBAL FOOD AGENDA

We found that Australian policy makers and scientists were very interested to collaborate with us. I think there are four reasons for this. The first is the extreme events that have hit Australia in the past decade or so. We found a lot of interest from scientists in the various index-based insurance schemes that we're implementing as an example. The second reason is that climate change is expected to really hit Australia hard in the coming decades and thus scientists and policy makers in the agricultural area are really interested in transformative adaptation. The third area that we find there's an interest in collaboration is on the whole food system. Australia is a major player in the global food system and as we've seen in the past decade it has been characterised by some bad pricing stability. So we work on mechanisms to try to stabilise prices. The other issue with climate change is that it's expected to increase displacement and migration of people and these are issues which are very close to Australia's concerns, so this is another whole area of collaboration. The fourth reason perhaps relates to our hosting of major global events and various international processes. So this gives a forum for Australians to shape the global food agenda.

Dr Bruce Campbell, leader of CGIAR Program on Climate Change, Agriculture and Food Security and formerly with Charles Darwin University

BANANA BACTERIAL WILT

I can give just one example of research done by Bioversity International that is of direct relevance to Australia and that is on banana diseases. Banana bacterial wilt is an important threat to banana cultivation and research we are doing in Indonesia, where very violent strains of the disease are present, is directly relevant to the banana industry in Australia.

Dr Emile Frison, Director-General, Bioversity International, which focuses on agricultural biodiversity use and conservation

and CSIRO to address the full suite of current and potential problems facing Australian producers.

We make savings through participation in global scientific networks. Bodies such as the GRDC, which attains very high returns for its research investments, do so in part because of their access to progress in international grain and oilseed research undertaken by the relevant global scientific human resource base.

Ultimately, the best way to address the skills shortage is to 'grow the pie' so that Australian farmers can access the latest research based on the best domestic and international endeavours.

MEASURING THE INSTITUTION-STRENGTHENING IMPACT

While some of these benefits appear to be intangible, just maintaining some capacity in important research fields ensures that Australia can stay 'in the game' and import new technologies as they become available. Although the concept of social capital applied to scientific cooperation and science networks has not been studied in detail, there is a good case for more research in this area so that intangible benefits of international research collaboration can be better defined and the benefits better managed.

We suggest that ACIAR consider studying the training and institution-strengthening effect that participation in international agricultural research has upon Australian institutions and scientists. A suitable methodology could be adapted from an ACIAR study¹³ on assessing impact on training and institution strengthening in developing countries.

13 See IAS 44: *Impact Assessment of capacity building and training assessment framework and two case studies.*

VI. How might Australia, and developing countries, benefit from global private sector spending on agricultural research?

THE INDEPENDENT REVIEW of ACIAR encouraged the Centre to explore the scope for partnerships with the private sector in the conduct of its programs. The NFF, with whom the task force has consulted, has also expressed a close interest in the role of private sector research. Accordingly, the task force examined how such partnerships might be leveraged to deliver benefits to Australia as well as to developing countries. In brief, we concluded that the issue might be best progressed by suggesting that ACIAR address the question in its formulation of a response to the Independent Review.

It is important that it does so as some 40% of global spending on agricultural research is conducted by the private sector but mostly by multinational firms in North America and Europe – where the big agro-chemical and seed companies are based – and for the large markets in those parts of the world. Research is also undertaken on individual farms, including in Australia, but this is rarely captured in the statistics.

The Crawford Fund has already recognised the potential of private sector research in agriculture for food security in the developing world. Its 2009 Parliamentary Conference – World Food Security: Can Private Sector R&D Feed the Poor – was an effort to raise the profile of the issue. In his introduction to the proceedings of the Conference, the Hon Neil Andrew made the following observation:

While there are sound examples of private sector research and development contributing positively to food production in developing countries, the Conference found it difficult to quantify its overall impact. It was, however, strikingly evident that the long-term objective of increased food production, outlined in the Millennium Development Goals, will only be met through maximised cooperation between the public and private sectors.

MASTER CLASS ON HUANGLONGBING DISEASE OF CITRUS

Huanglongbing, also known as citrus greening, is a disease of citrus that is widespread in Asia and North and South America. In Florida, the disease has caused such devastation that whole counties have ceased citrus production. In Brazil, millions of citrus trees have been destroyed. The Crawford Fund organised a Master Class with the University of Western Sydney to train scientists from 13 Asian and Pacific countries in the diagnosis, surveillance and management of the disease. Nine Australian scientists, at their own expense, also attended the Master Class. Australian organisations represented included State and Federal quarantine, plant health and related agencies. Because of the risk that the disease might be accidentally introduced into Australia it is only through courses conducted abroad that Australian scientists can gain first-hand experience of the disease and its characteristics.

Others have also recognised the important contribution of the private sector and of public-private partnerships. In his presentation at the same Conference, Dr Marco Ferroni, the Executive Director of the Syngenta Foundation for Sustainable Development (the Syngenta Foundation), said:

Ultimately it is the private sector that must deliver inputs to farmers. Can private R&D distribution channels reach small farmers, the group that produces most of the food consumed in less developed countries?

The answer is straightforward: millions of small farmers are reached commercially every day as they buy seeds and crop protection products, fertiliser, cell phones, machinery, and tools taking advantage of the science and technology embedded in these products. The market for agricultural inputs is large, and the role of the private sector as a purveyor of technology and services is growing.

Dr Ferroni pointed to what he described as “new reality”:

Given the lay of incentives and comparative advantage, partnerships between the public and the private for-profit and not-for-profit sectors are needed to reach large numbers of small farmers.

Dr Philip Pardey, a renowned Australian agricultural economist, in his presentation at the same Conference warned that:

The actions of the for-profit private sector are shaped by commercial realities that will limit their role in many, but by no means all, developing country markets for years to come. Thus, a complementary public-private strategy will be the key to success.

Australia by itself, as is the case for many developing countries as well, is a small market. So the business case for multinational private investment targeted at the Australian market alone may be relatively weak. In Australia’s case, the main factor is the total number of farmers – fewer than 150,000; developing countries have many more farmers but each with only limited purchasing power. Australia and developing countries by and large have to be content with the spillover benefits from research conducted for the bigger markets and through adaptation of outcomes by local firms and institutions. In Australia’s case, the rural research and development corporations often take the lead in this adaptation, highlighting their importance.

The NFF sees increasing private investment in rural research and development as an emerging need, given the current slowing of farm productivity in Australia. The NFF is looking to progress the issue through advocacy of a policy and taxation environment that encourages private/philanthropic (both domestic and foreign) co-investment in agricultural RD&E.

The NFF is also looking to progress the issue directly, through an innovation working group as part of the *Blueprint for Australian Agriculture*¹⁴. The newly established group involves key agriculture industry bodies and is jointly chaired by multinationals Bayer and Syngenta. The group hopes to find ways to integrate private sector investment and broader public and industry interests into agricultural research and development. The task force is pleased to note that the Director of ACIAR is part of the group.

One approach is to see whether the multinationals might be encouraged, through whatever policy incentives might be available, to undertake research in Australia, for Australian conditions but with reasonable expectation that the outcomes might be suitable for a broader international market, especially in the Australian region, and for countries with similar agricultural conditions. Further

consultation with the multinationals will be needed but the task force notes that Nufarm has just set up a research facility for seeds in Horsham in Victoria.

There could be a case for ACIAR to consider whether a co-investment in research undertaken in Australia and directed primarily at the regional market might be consistent with its mandate. Among issues to be examined would be the return on investment to ACIAR itself, both in terms of benefits to developing countries measured by independent impact assessment and a financial return to the organisation for reinvestment in its purpose. As always, ACIAR’s policy should reflect the effectiveness and sustainability of this approach compared to a continued focus on public sector research.

Another approach may be to look for synergies with the Cooperative Research Centres (CRCs), which often involve effectively leveraged partnerships between the public and private sectors. One international centre, CABI, is a member of the Plant Biosecurity CRC because of shared interests in the control and management of invasive species. ACIAR worked with the Beef CRC on a project in Southern Africa.

The Crawford Fund is entering a joint project with the Syngenta Foundation on market-led research.

ACIAR AND THE PRIVATE SECTOR

ACIAR already engages with the private sector. Its list of current collaborators includes some 13 private Australian companies, including a number of associations but also Mars Asia Pacific and Masterfoods Australia/New Zealand. The projects involving these two companies relate to: improving the sustainability of cocoa production in eastern Indonesia through integrated pest, disease and soil management in an effective extension and policy environment; rehabilitating cocoa for improving livelihoods in the South Pacific; and improving cocoa production through farmer involvement in demonstration trials of potentially superior and pest/disease resistant genotypes and integrated management practices.

Other projects in partnership with Applied Horticulture Research encompassed: a preliminary study to improve income and nutrition in eastern and southern Africa by enhancing vegetable-based farming and food systems, including in peri-urban corridors; and integrated crop management to enhance vegetable profitability and food security in the southern Philippines and Australia. ACIAR has also partnered with Rice Research Australia Pty Ltd on improved rice germplasm in Cambodia and Australia and improved rice establishment and productivity in Cambodia and Australia.

14 *Blueprint for Australian Agriculture*, National Farmers’ Federation, February 2013.

VII. Indirect benefits

INDIRECT BENEFITS TO Australia from international agricultural research include contributions to: regional security and peace based on improved food security; increased trade through better relations; the enhancement of Australia's standing in international fora as a good international citizen; and improvements to Australian researchers and research/educational institutions as discussed in Chapter V.

REGIONAL PEACE, PROSPERITY AND SECURITY

The food riots that derived from the 2007–08 spike in food prices reminded policy makers of the importance to regional security of ensuring developing country populations have access to affordable food. This topic was explored in detail at the 2000 Crawford Fund Conference – Food, Water and War: Security in a World of Conflict.

Summarising the outcomes of the Conference, the Hon Tim Fischer wrote:

The conference signalled a new shift in our understanding of what security is. Fighting for food is a stronger driver than allegiances and politics. Australia must be prepared to do more to maintain peace and security in our region, and our keynote speaker advocated a multidisciplinary approach – a 'whole-of-nation' approach as he termed it – to peacekeeping and conflict resolution in our region of the world.

Ultimately, a major cause of conflict in developing countries is poverty, and the best way to overcome poverty is through economic growth. The Crawford Fund firmly believes that agriculture is the engine that drives economic growth, and helps create peace in order for developing countries to grow and take an equal place in the world. Helping the agricultural sector to grow is essential to human destiny in the 21st century.

RAISING AUSTRALIA'S INTERNATIONAL STANDING

Australian leadership in international agricultural research enhances Australia's international standing so that, for example, the standing of our scientists enables Australia to participate with authority in intergovernmental processes such as phytosanitary protocols, which have important implications for our access to markets and similarly for our ability to protect against biosecurity threats.

The CGIAR is at something of a crossroads as it seeks to reform itself. As a major contributor and beneficiary of the system, it is crucial that Australia continues to contribute to this reform process. As a funder of the system,

BENEFITS BOTH WAYS

If we can't deal with these issues of food security in many of our neighbouring countries and elsewhere around the world, we're going to see increased civil commotion, uncertainty, disturbances, and sometimes that may lead to government changes which are not for the best. And as we've seen elsewhere, that has led to mass out-migration from some of these countries, which is putting great stress on our borders. So, I think there's sort of national imperative here that, as a wealthy western country, we should be investing money in food security because benefits are both ways.

Dr Colin Chartres, former Australian Director-General, International Water Management Institute

INTERNATIONAL LANDCARE

Landcare Master Classes, an innovation supported by the Crawford Fund, has been a key launching pad for the development of Landcare in countries such as the Philippines, Kenya, Tanzania, Uganda, Rwanda and others. Throughout these Master Classes, we've been able to build a cadre, a group of professionals who have taken back what they've learned and now are engaging their colleagues in their countries throughout the world. They're sharing the Landcare ethic, the Landcare values, the Landcare technical expertise, and Landcare as a grassroots international organisation and innovation: just as it has served Australia so well.

Dr Dennis Garrity, Former Director General, World Agroforestry Centre and head of International Landcare

Australia sits on some of the important councils of the CGIAR, giving it the opportunity to ensure that the process continues on a path constructed on evidence-based policy of mutual benefit to Australia and developing countries.

By introducing Australian undergraduates in the agricultural and related sciences to the economic, farming and social conditions in developing countries of the Asia-Pacific region, the New Colombo Plan should strengthen our people-to-people and institutional relationships. It could also provide the basis for rewarding careers in international agricultural research.

TRADE BENEFITS – INCREASED AUSTRALIAN EXPORTS

Dr Kym Anderson (1987) has written about the now well-established economic benefits from trade that derive from growth in agricultural production in developing countries. In the 20 years before 1983, developing economies increased grain production by 3.3% and meat and milk production by 2.5% but their total food consumption grew by 3.5%.

Anderson found that, provided second-round as well as first-round effects of increased spending by producers of non-tradables are taken into account, the positive correlations between agricultural output growth and agricultural imports are not surprising. He concluded that selling or giving away agricultural research and management skills can be beneficial to Australia, even from a narrow economic point of view.

The success of our export efforts depends, in part, on the strength and character of the national policies of the countries to which we export. Through joint research, policy analyses and training projects, international agricultural research and training can help such countries build a strong cadre of highly skilled food security, science and technology policy makers. This cadre will be capable of formulating optimum food security options, including free trade policies and regulatory frameworks suited to each country to make farming more profitable everywhere, including in exporting countries such as Australia.

A comprehensive review of distortions where developing countries directly or indirectly taxed the agricultural sectors of their economies is available in *Distortions to Agricultural Incentives: A Global Perspective, 1955-2007*. According to Anderson, who edited this review, taxing export-oriented farmers in developing countries cuts off their opportunity to contribute to economic growth and export their way out of poverty (Anderson 2009).

The International Food Policy Research Institute (IFPRI), one of the centres under the umbrella of the CGIAR, has played a major role in policy-based projects of this nature, including in Indonesia and China.

There is another more direct trade benefit for Australia: the export of agricultural research, technology and education services. Australia has built a solid reputation for quality in the area largely due to the work of ACIAR and the training of large numbers of foreign scholars in the field through AusAID. Just as the Colombo Plan led to trade in educational services, it should be possible to build on our track record in agricultural services to make the transition to trade. A start has already been made with India and China, where substantial funding for joint programs is derived from contributions from agencies in those countries that have graduated from aid recipient status.

Australia's technical cooperation with emerging econ-

omies such as Thailand, India and China will increasingly be one of partnership, co-investment and regional cooperation, leveraging capability to address challenges in less well-developed nations. As part of its efforts to develop more innovative partnerships, ACIAR has begun to build some trilateral research partnerships with certain developing countries, for example involving Indonesian researchers in Timor-Leste and Thai researchers in other Mekong countries.

OTHER INDIRECT BENEFITS

There will certainly be other indirect benefits to Australia from investment in international agricultural research. One area is included here as an indicator: benefits to Australia's fishing industry from ACIAR support to South Pacific Island countries. Another might emerge from ACIAR's support for coffee and cocoa industries in Indonesia, PNG and the South Pacific Islands.

ENSURING FISH STOCKS FOR THE SOUTH PACIFIC ISLANDS AND FOR AUSTRALIA

Pacific Island countries are, on average, the most fishery-dependent countries in the world, in terms of per-capita consumption of fish and in economic dependence on the lucrative tuna and inshore fisheries. Although the Pacific tuna fisheries are managed internationally as migratory stocks (by national governments and the Western and Central Pacific Fisheries Commission and its enabling Convention), 80% of catches are taken from within the Exclusive Economic Zones of the Pacific Island countries. Through their own fishing fleets and through licensing of foreign fleets, the countries earn a significant share of their national budgets from fish.

Australia's national interests lie in ensuring that the fish stocks and the industries that surround them are sustainable in the long term as many Pacific Island countries are so reliant on them. To this end, Australia has been a critical supporter of the Forum Fisheries Agency, the Western and Central Pacific Fisheries Commission and the Secretariat for the Pacific Community, as well as projects in individual countries for decades.

Indonesia and the Philippines, critical bilateral partners of Australia, are also major players in the Pacific tuna fisheries and countries that Australia has been highly instrumental in involving in regional fisheries management arrangements.

Australia shares some fisheries stocks with the adjacent countries, and so has self-interest in the management of these stocks, such as tuna and billfish in the Coral Sea and stocks that cross borders with PNG and Indonesia.

Australia, in helping protect its own shared stocks and helping Pacific Island and neighbouring South-East Asian countries manage their fisheries and marine resources, has been highly instrumental in aiding the countries to improve fisheries and vessel data collection for fisheries management (ACIAR and AusAID), and in understanding the impacts of climate change on the fisheries (see Bell *et al* 2011, SPC major study on this).

Projections show that Pacific Island fisheries resources are becoming inadequate to meet growing demand and, in addition to improved fisheries management, aquaculture will need to be promoted where feasible. ACIAR and WorldFish have been developing technologies and options for aquaculture, including tilapia in PNG and Fiji, and giant clams, sea cucumbers, pearl oysters and other species in other countries.

Australian support, through ACIAR and AusAID, thus serves an important Australian interest in helping this important industry for the South Pacific Island nations. At the same time, this helps protect our shared fish stocks, which are important to our fish processing industries. Some useful references are available¹⁵.

COCOA, OIL PALM AND COFFEE INDUSTRIES

Other indirect benefits to Australia not studied here but worthy of further consideration are the scope for international agricultural research to help secure supplies of commodities such as cocoa and palm oil for the Australian food manufacturing industry and assistance that will help developing country industries to make more effective use of Australian materials such as wool. ACIAR has sustained investment in many commodities of vital importance to smallholders in our region. In Indonesia, for example, where the centre partnered with a subsidiary of Mars Pty Ltd, ACIAR investments are said to occupy a unique space. The Crawford Fund's Victorian Committee has supported cocoa training for cocoa growers in Vietnam and PNG.

We suggest that ACIAR contemplate the potential benefits to Australian food-processing and manufacturing industries from enhanced oil palm, cocoa and coffee production in the region, although we recognise any initiatives must rest with the industries themselves.

PLANT DOCTORS FOR BIOSECURITY

In collaboration with the Plant Biosecurity CRC, we have been helping to train and implement remote microscopy networks so that plant protection officers in South-East Asia and Africa can link with experts in Australia to get accurate, real-time diagnosis of pest and disease incursions. Plantwise plant clinics have been developed by CABI with funding from ACIAR and other donors. They train local extension workers to be 'plant doctors', providing practical, local advice to rural smallholder farmers in developing countries to help them improve the quality and quantity of their harvests. But they also act as a powerful vigilance mechanism to spot new or spreading plant health problems.

Dr Trevor Nicholls, Chief Executive, CABI

A WEALTH OF NETWORKS

ICRISAT itself has such a diversity of staff. People of more than 35 different nationalities work for ICRISAT and we work on the ground hand-in-hand in these developing countries. We work with the national systems, with government, with NGOs, with women's groups, with farmer associations, with the local universities; we're closely working with these organisations all the time. Also, being an international organisation, we're very strongly networked at an international level and with regional organisations. So, by Australia working closely with ICRISAT and other CGIAR centres it gives an immediate connection to this wealth of networks on the ground overseas and Australia has been able to tap into that and it's been a great advantage.

Australian Joanna Kane-Potaka has worked for four CGIAR centres and is currently with ICRISAT



¹⁵ FAO/SPC reference on fish consumption: *Pacific Food Security Toolkit: Building resilience to climate change*, module on 'Pacific Fisheries',

<http://www.fao.org/docrep/013/am014e/am014e05.pdf>

J. Bell *et al.*, *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change*: <http://www.spc.int/climate-change/fisheries/assessment/e-book/>

Full details on the skipjack fishery of the Pacific: <http://www.asiapacfish.org/index.php/species/item/5-skipjack-tuna>

VIII. The way forward

The task force has examined sympathetically the proposition that international agricultural research programs funded by the Australian aid program, and which are mainly delivered through ACIAR, should place more emphasis on benefits to Australian farmers and to Australia's agricultural research capacities.

ACIAR'S TWIN ROLES

In order to ensure a focus on ACIAR's core business we needed to be clear on:

- The purpose of international agricultural research in the aid program
- The relationship of ACIAR's programs to the priorities of Australia's farmers and agricultural research capacities.

According to the recent independent review, ACIAR is an integral and highly effective component of the Australian aid program. That review found that the primary direct beneficiaries of ACIAR's investments are overwhelmingly, as they should be, farmers in developing countries, with their national economies growing as a result and poverty diminishing. We concur in this finding.

But, as the review also noted, ACIAR depends for its success on the cooperation of Australia's agricultural research institutions and the support of the Australian farming community. The institutions afford such cooperation because they see that doing so serves both their institutional purpose – which includes especially delivering outcomes of value to Australian farmers – and the professional interests of their scientific staff. ACIAR's programs draw on and add to the experience and expertise of the institutions. In this sense, it is a small but important part of Australia's agricultural innovation system. It is no doubt for this reason, that ACIAR's mission is expressed as follows:

FEEDING POLICY AND RESEARCH

The work that we do in partnership with Australian research institutions, and the co-developing of technologies and solutions, is a win-win for both of us. We benefit from the investments and research that have happened in Australia and we can draw on those; but the work we can bring to the table around improved aquaculture feeds, perhaps, the ways in which fisheries management work or some of the lessons that we are learning from working in other places, stimulate and feed the research community, and the policy environment in Australia as well.

Dr Stephen Hall, Australian Director-General, WorldFish

To achieve more productive and sustainable agricultural systems, for the benefit of developing countries and Australia, through international agricultural research partnerships.

ACIAR brings its two roles together by forming partnerships between elements of Australia's agricultural innovation system and their counterparts in developing countries and in the international agricultural research system. It conducts thorough and extensive consultations to identify shared priorities between these partners. Pursuit of the twin roles requires highly skilled leadership and design capable of understanding, explaining and exploiting shared interests and priorities among the parties. ACIAR is a unique Australian organisation capable of performing these tasks with a high degree of professionalism. It should stay as a separate authority.

INTERNATIONAL AGRICULTURAL RESEARCH IS AID THAT WORKS

ACIAR's approaches have delivered strong outcomes for Australian aid:

1. Australian aid well serves our national interests of regional peace and security by alleviating poverty and by enhancing food security and economic growth in developing countries.
2. Agricultural R&D is an effective way to meet these goals. It is delivered by the Australian Centre for International Agricultural Research (ACIAR) and it, in turn, relies on cooperation with other Australian agricultural research institutions; their willingness to cooperate reflects a view that international agricultural research also serves their institutional purposes.
3. A review of ACIAR's bilateral research program (about 70% of its budget) found that the rate of return on investment by ACIAR and its Australian and developing country partners – from a sample of projects (about 10% of the total bilateral program) – was between 50:1 and 70:1, depending on whether benefits judged to be convincing or plausible are included. This return greatly exceeds total investment in bilateral research since ACIAR's inception 31 years ago. The return is mostly in the form of increased farm incomes in developing countries.

INTERNATIONAL AGRICULTURAL RESEARCH DELIVERS AID TO AUSTRALIAN FARMERS

ACIAR has also delivered important benefits to Australian farmers and to Australian agricultural research:

4. Bilateral research programs providing most benefit to Australian agriculture included:
 - a) Biosecurity gains from understanding mite pests of honey bees (Australian partner was CSIRO)
 - b) Access to the Japanese mango market through post-harvest treatment of fruit fly (Queensland Government)
 - c) Development of the sandalwood industry in Indonesia and the Ord River (Western Australian Government)
 - d) Incorporation of ICRISAT germplasm in the Australian sorghum breeding system.
5. Germplasm from international centres (particularly CIMMYT, ICRISAT and ICARDA), supported by ACIAR and institutions such as the GRDC, has helped to keep Australian farmers competitive in world markets by increasing yields or reducing costs. The flow of benefits to Australia from the three centres has been of the order of \$100 million a year from an annual contribution of just \$10 million. Benefits also flow from the Global Crop Diversity Trust and other international centres.

AID CONTRIBUTES TO KNOWLEDGE AND RESEARCH CAPACITY

To pursue their national goals for Australian farmers, Australian scientists must be part of the global scientific community: to stay abreast of modern science; to be aware of agricultural conditions and developments elsewhere including pest and disease outbreaks, especially species that may invade our shores; and to share in knowledge about breakthroughs and discoveries.

6. The cooperative work of scientists in Australia and developing countries, supported by ACIAR and its partners, has made a major contribution to scientific knowledge and capacity in Australia and globally. Fellowships for hundreds of developing country scientists, many of whom undertake research in Australia, have also added to the stock of knowledge. The value of these gains, which has not been quantified, includes:
 - a) Advanced research on Australian agriculture
 - b) Development and acquisition of scientific tools and experience in developing countries which proves valuable in Australian agriculture
 - c) Forewarning and experience of biosecurity risks
 - d) Ongoing cooperation between Australian and international research institutions
 - e) Recognition of Australia's scientific credibility in international scientific forums.

SKILLED LEADERSHIP AND SOUND DESIGN ARE NEEDED TO PURSUE TWIN GOALS AND NEW BENEFITS

7. There are other potential benefits to Australia that are still to be fully explored or exploited. ACIAR has substantial investments in commodities such as cocoa, coffee and oil palm. Increasing production in Indonesia, PNG and the South Pacific will benefit many poor farmers and their national economies. Increased production may provide trade opportunities for Australian food manufacturers.
8. As the independent review of ACIAR found, ACIAR and the international agricultural research it supports are integral to Australia's aid program and it is part of Australia's innovation system. Pursuit of these twin roles and new opportunities requires highly skilled leadership and design directed at understanding, explaining and exploiting shared interests between Australian research institutions and their international and developing country counterparts. These skills are crucial in securing benefits for Australia as well as developing countries.

CONCLUSIONS, SUGGESTIONS AND POSSIBLE NEW APPROACHES

The task force concludes that international agricultural research:

1. Is highly effective aid with real and significant benefits to Australian farmers
2. Enhances Australian research capacity, delivering greater Australian productivity and that this
3. Leads to more Australian food exports, as well as to increased agricultural productivity in the developing world, contributing to global food security.

The task force suggests that:

4. ACIAR remain integral to Australia's aid program and part of its innovation system.

In looking for refinements to ACIAR's approach that might deliver more to Australian agriculture, without in any way detracting from its primary purpose, we suggest ACIAR consider:

5. A closer relationship between ACIAR's planning processes and the *National Primary Industries Research, Development and Extension Framework* (see explanation below). The framework clearly provides a broad guide to Australia's agricultural research interests and expertise, and hence the areas where we can best contribute to and benefit from international partnerships. It should therefore serve as one element of a research priorities framework for ACIAR's consultations with its Australian and developing country partners.

6. We believe that participation in international agricultural research strengthens the capacity of these institutions but we also suggest:
 - a) ACIAR consider supplementing its impact assessment series to measure this capacity-building impact on Australian research institutions.
 - b) The Australian Government consider ways to increase the supply of agricultural scientists to ensure the nation retains its strong research capacity. We are conscious that a number of measures are being explored but suggest that ensuring that Australian agricultural undergraduates are given the opportunity to participate in the New Colombo Plan may help.
7. A more active participation on ACIAR's part in the recently formed NFF innovation working group – especially in relation to the scope for attracting more private sector investment in Australian-based research aimed at serving Australian farmers and their regional counterparts. An examination of closer linkages between a number of its longer running programs in commodities such as oil palm, cocoa and coffee and the potential interests of Australia's food manufacturing industries, recognising that such linkages will require the industries themselves to take the initiative. It could also consider the extent to which it could help in the export of Australian produce such as wool by research to strengthen processing technologies and practices in key markets.



The task force also suggests that:

8. Aid funding for Australia's international agricultural research should grow at least at the pace of inflation and faster once regular reviews show an increasing contribution to Australian and developing country agricultural productivity.

State and Federal Governments have, over an extended period now, formulated a broadly agreed National Primary Industries Research, Development and Extension Framework. A recent statement from the Queensland Government suggests that this framework is being used by state governments in setting research priorities. RD&E plan the Queensland Government stated Queensland's agriculture strategy was: "linked into the National Primary Industries Research Development and Extension Framework that encourages greater collaboration, preventing duplication and promoting continuous improvement nationally". The Queensland Government's agriculture plan "will focus on the areas where Queensland has a competitive advantage, including beef production, sugarcane, subtropical forests, summer cereal grains, tropical and subtropical horticulture". The task force understands that other state and territory governments have already made or are making similar use of the framework.

TASK FORCE MEMBERS

The following background information is provided on the chair and other members and support staff of the Crawford Fund's Doing Well by Doing Good Task Force:

The Hon Neil Andrew AO FTSE is chair of the task force. He was brought up in the South Australian Riverland, where his family, and later he himself, had interests in horticulture. He was an active participant in the SA Agricultural Bureau movement and was Chairman from 1980 to 1982. In 1975, he was awarded a Nuffield Agricultural Scholarship to make an overseas study tour. In 1983, he was elected to the Australian Parliament as the member for Wakefield in the House of Representatives. With changes in the boundaries of his electorate, he later moved to Gawler. He held various positions including that of Government Whip from 1997, and from November 1998, became Speaker of the House of Representatives. Neil retired from the position and from his seat in November 2004. He now lives in Adelaide and became Chairman of the Crawford Fund on the retirement of the Hon Tim Fischer in June 2005.

Dr Denis Blight AO, Chief Executive of the Crawford Fund has had a career including positions as an Australian diplomat, aid administrator and public servant. His association with international agricultural research began in earnest some 25 years ago when he joined ACIAR on its establishment. Prior to working for the Crawford Fund, he was Director-General of CABI, an intergovernmental body in research, training and publishing in the life sciences, and spent 15 years with IDP Education Australia, including holding the position of Chief Executive, the international development program of Australian universities and colleges, that led Australia's successful engagement in international education.

Dr Eric Craswell, Director of Training and Master Classes at the Crawford Fund has had a career including 13 years as Research Program Coordinator for Plant Nutrition and Land and Water Management with ACIAR, two years of which he spent seconded to the Secretariat of the Technical Advisory Committee of the CGIAR at FAO in Rome. He was Director-General of the International Board for Soil Research and Management, led the Cambodian Agricultural Research and Development Institute Assistance Project (an AusAID-funded project) and was Executive Officer for the Global Water System Project, based at the Centre for Development Research at the University of Bonn. He is currently also a Visiting Fellow at the Fenner School of Environment and Society, Australian National University, and Senior Editor for the journal *Food Security*.

Dr Terry Enright is a Western Australian grain and livestock producer and was chairman of the Grains Research and Development Corporation (GRDC) for five years. He has served in a number of agricultural-related positions, including as a commissioner of the Export Wheat Commission, a member of the standing committee on national research priorities and member of the panel to conduct an independent review of ACIAR in 2012. In 2008, he was awarded an Honorary Doctorate of Science in Agriculture from the University of WA. He is an Independent Director of the Australian Livestock Export Corporation (Livecorp), Director of Grain Producers Australia, and Chair of the Western Australian Crawford Fund Committee and a member of the Board of Directors.

Dr Tony Gregson AM FTSE is a grain grower from Victoria's Wimmera region with an extensive science and corporate research management background. He has degrees in science (PhD and DSc) and is an Adjunct Professor at the University of Ballarat. Tony is Chairman of Plant Health Australia, the Victorian Committee of the Crawford Fund, a board member of the Crawford Fund, Chairman of the University of Melbourne's School of Botany Foundation and a Director of Rural Industries Skills Training. He is a former Chairman of Bioversity International and two CRCs, a former inaugural member of the CSIRO and GRDC Boards, and a former member of the CIMMYT, ANSTO and Rural Finance Corporation of Victoria boards.

Cathy McGowan AO is an Australian politician and independent federal member for Indi. In 2004, she was made an Officer of the Order of Australia "for service to the community through raising awareness of and stimulating debate about issues affecting women in regional, rural and remote areas". Cathy was also a recipient of the Centenary Medal in 2001. She has a Masters in Applied Science in Agricultural and Rural Development from the University of Western Sydney and is a former President of Australian Women in Agriculture.

Professor John Mullen is an Adjunct Professor at Charles Sturt University and a former Principal Research Scientist in the NSW Department of Primary Industries. His research interests include the economics of research and productivity growth in Australian agriculture. John has more than 30 refereed journal papers. His first degrees are from UNE and he has a PhD from Texas A & M University in the US. He is a Distinguished Fellow of the Australian Agricultural and Resource Economics Society (AARES) and has been President of AARES and co-editor of the *Australian Journal of Agricultural and Resource Economics*.

Cathy Reade is Director of Public Affairs and Communication with the Crawford Fund. She spent her early career working for a range of Canberra-based lobby groups. In 1989 she started with the Crawford Fund, setting up its public awareness program. Cathy also developed and manages a Crawford Fund Master Class in Communication with Stakeholders for scientists in developing countries. Additionally, she ran a consultancy concentrating on the not-for-profit sector around agriculture, development, S&T and environment policy, issues and events. Over 25 years with the Crawford Fund and as a consultant, she has developed a broad network in the Australian and international agricultural scenes and with media, which she uses to spread the word of impact and benefit. Cathy also sits on the Board of the World Vegetable Center.

Marchien van Oostende joined the Crawford Fund early in 2009, after eight years of working for ACIAR. She migrated from the Netherlands in 1999, where she worked as a Management Consultant in Social Security before starting her own business as an editor. Marchien has a BA in linguistics and is active in Landcare.

HIGH LEVEL ADVISERS

The Hon Tim Fischer AC FTSE is the former Deputy Prime Minister of Australia and was the Australian Ambassador to the Holy See for three years until January 2012. A former Chair of the Crawford Fund board, Australian Army Officer, NSW State Parliamentarian, Leader of the National Party and Minister for Trade, Tim is also a consultant, company director, author, broadcaster and multiple patron. Since leaving the Department of Foreign Affairs and Trade, he has served on two Advisory Boards (Cognita Singapore and the Global Crop Diversity Trust). He is also Australia's Special Envoy to the Kingdom of Bhutan, having stepped down as Envoy to Eritrea and South Sudan.

The Hon John Kerin AM FTSE is the Chair of the Crawford Fund Board of Directors. He worked at the Australian Bureau of Agricultural and Resource Economics before being elected to the Commonwealth Parliament as Australian Labor Party member for Macarthur in 1972. He served as Minister for Primary Industries (1983–1987), Minister for Primary Industries and Energy (1987–1991), Minister for Transport and Communications (1991), Minister for Trade and Overseas Development (1991–1993) and Treasurer (1991). Since leaving politics, John has served with bodies including the Australian Meat and Livestock Corporation, CSIRO, the Poultry Cooperative Research Centre, the Australian Weed Research Centre, the Tropical Savannas CRC, UNICEF Australia and the National Ovine Johne's Disease Advisory Committee.

THE INTERNATIONAL AGRICULTURAL RESEARCH CENTRES

The world's key international agricultural research centres are grouped within two key consortia. They are listed below with a short explanation of their work.

CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH (CGIAR) CONSORTIUM INCLUDES:

Africa Rice Center is a leading pan-African rice research organisation committed to improving livelihoods in Africa through strong science and effective partnerships. It is also an autonomous intergovernmental research association of African member countries.

Bioversity International is a research-for-development organisation working with partners worldwide to use and conserve agricultural and forest biodiversity for improved livelihoods, nutrition, sustainability and productive and resilient ecosystems.

Center for International Forestry Research (CIFOR) is dedicated to advancing human wellbeing, environmental conservation and equity by conducting research that helps inform decisions about the use and management of forests.

International Center for Agricultural Research in the Dry Areas (ICARDA) focuses its core activities on the critically important work of getting agricultural research innovations into use in the dry areas, especially since these regions cover 40% of the Earth's surface and are home to 2.5 billion people – a significant percentage of the world's population.

International Center for Tropical Agriculture (CIAT) is dedicated to developing technologies, innovative methods and new knowledge that better enables farmers, mainly smallholders, to improve their crop production, incomes and management of natural resources.

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political organisation that conducts agricultural research for development in the drylands of Asia and sub-Saharan Africa.

International Food Policy Research Institute (IFPRI) identifies and analyses national and international policies and strategies for meeting the food needs of the developing world on a sustainable basis, with particular emphasis on low-income countries and on the poorer groups in those countries.

International Institute of Tropical Agriculture (IITA) works with public and private sector partners to enhance crop quality and productivity, reduce risk to producers and consumers, and generate wealth from agriculture.

International Livestock Research Institute (ILRI) works with partners worldwide to enhance livestock pathways out of poverty, principally in sub-Saharan Africa and Asia.

International Maize and Wheat Improvement Center (CIMMYT) works to sustainably increase the productivity of maize and wheat systems, and thus ensure global food security and reduce poverty.

International Potato Center (CIP) is a root and tuber research-for-development institution that delivers sustainable solutions to the pressing world problems of hunger, poverty and the degradation of natural resources.

International Rice Research Institute (IRRI) develops new rice varieties and rice crop management techniques that help rice farmers improve the yield and quality of their rice in an environmentally sustainable way.

International Water Management Institute (IWMI) is a non-profit, scientific research organisation focusing on the sustainable use of water and land resources in developing countries.

World Agroforestry Centre (ICRAF) generates science-based knowledge about the diverse roles that trees play in agricultural landscapes, and uses its research to advance policies and practices that benefit the poor and the environment.

WorldFish is dedicated to reducing poverty and hunger by improving fisheries and aquaculture.

THE ASSOCIATION OF INTERNATIONAL RESEARCH CENTRES FOR AGRICULTURE INCLUDES:

The World Vegetable Center (AVRDC) works on the alleviation of poverty and malnutrition in the developing world through the increased production and consumption of safe vegetables.

Centre for Agricultural Bioscience International (CABI) improves people's lives by providing information and applying scientific expertise to solve problems in agriculture and the environment.

Tropical Agricultural Research and Higher Education Center (CATIE) contributes to rural poverty reduction by promoting competitive and sustainable agriculture and natural resource management through higher education, research and technical cooperation.

Crops for the Future (CFF) helps partners to generate, synthesise and promote knowledge on neglected and underutilised crops for the benefit of the poor and agricultural sustainability.

International Center for Biosaline Agriculture (ICBA) works at achieving greater water, environmental, income and food security through research and development that aims to improve agricultural productivity and sustainability in marginal environments.

International Centre for Integrated Mountain Development (ICIMOD) enables and facilitates the equitable and sustainable well-being of the people of the Hindu Kush–Himalayas by supporting sustainable mountain development through active regional cooperation.

International Centre of Insect Physiology and Ecology (ICIPE) helps alleviate poverty, ensure food security and improve the overall health status of peoples of the tropics by developing and extending management tools and strategies for harmful and useful arthropods.

International Fertilizer Development Center (IFDC) focuses on increasing productivity across the agricultural value chain in developing countries by the creation and transfer of effective and environmentally sound crop nutrient technology and agribusiness expertise.

International Network for Bamboo and Rattan (INBAR) improves the well-being of the producers and users of bamboo and rattan within the context of a sustainable bamboo and rattan resource base.

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YOUTUBE VIDEO LINKS



These videos are from a set of presentations provided by researchers, farmers and others as part of the Fund's 'Doing Well by Doing Good' Task Force on benefits to Australia from agricultural research for development. See <http://www.crawfordfund.org/trends/doing-well.html>

Dr Emile Frison, the Director General of Bioversity International, one of the 15 CGIAR research centres, outlines some of the very significant benefits of the work of the CGIAR to Australia in terms of delivering improved genetic resources and advanced breeding lines which have been vital in addressing a range of issues such as disease resistance. See <http://youtu.be/rykjkHfknPI>

Dr William D. Dar, the Director General of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) highlights the benefits that have flowed to Australia through the development and release of improved varieties of crops such as chickpeas and sorghum. See http://youtu.be/5d9-1su2_K0

Dr Colin Chartres, former Australian head of the International Water Management Institute (IWMI) talks about various benefits of Australia investing in international agricultural research including being able to provide advice on what we have learnt about increasing food production and dealing with environmental problems; creating goodwill between governments and attracting students to come to Australia for training; and improving national security by helping countries build their own food security. See <http://youtu.be/As4cz-oyzEU>

Professor Tim Reeves, the Australian who was formerly Director of the Mexico-based International Maize and Wheat Improvement Centre (CIMMYT), talks about the benefits of interacting with researchers from developing countries. He says this is both scientifically stimulating for Australian scientists, and also very beneficial to Australia. He highlights the value of these international alliances to Australia's current plans to increase exports to Asia. See <http://youtu.be/5A2RvZ136Co>

Dr Dennis Garrity, former Director General of the World Agroforestry talks about how Australian Landcare has benefited significantly from the vibrant links made with recent overseas Landcare initiatives. The Landcare model is a unique global public good from which all Aussies can identify and obtain a sense of deep pride. See <http://youtu.be/aruYpO7Pkxl>

Dr Tony Gregson, an Australian grain grower who has served on international and Australian boards relevant to agricultural research and deposited the first Australian seed to the 'Arctic doomsday seed vault' talks about the importance to Australia of international agriculture research centres for breeding

better crop varieties. In Australia, where all crops grown are exotic, we are particularly dependant on germplasm from other parts of the world to improve traits such as disease resistance and quality. See <http://youtu.be/B6Lr0spen60>

Dr Trevor Nichols from CABI talks about benefits to Australia from CABI research and publications. CABI helps Australia in identifying and controlling pests and diseases, both within Australian (like rubbervine weed and waterweeds) and in neighbouring countries on pests Australia does not (yet) have. CABI works together with CSIRO, DAFF, Queensland Government and the Plant Biosecurity CRC. See <http://youtu.be/RzHFQvHrDUA>

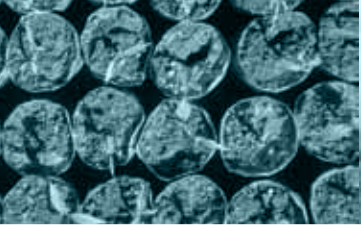
Dr Bruce Campbell, formerly with Charles Darwin University and now Director of the CGIAR Program on Climate Change, Agriculture and Food Security, talks about the significant nexus of issues including the globalisation of food as a commodity, the migration and displacement of people expected under climate change, and why as a major food trader Australia can contribute to and benefit from research on these issues. See <http://youtu.be/eOQ8-pG20Wo>

Marie Haga, Executive Director of the Global Crop Diversity Trust which has been supported in its conservation efforts through Australia's aid program and the Grains Research and Development Corporation, highlights the need for access to and conservation of crop diversity to enable agriculture to adapt to new climatic conditions, and also to fight pests and diseases in Australia and globally. See <http://youtu.be/CVnz4tCqTlk>

Joanna Kane-Potaka, an Australian who has worked for four different CGIAR research centres, highlights two of the many ways Australia has benefited from partnering with CGIAR centres. First, is the ability to tap into a wealth of networks, and secondly, is the rich source of complementary knowledge that Australia gains access to. See <http://youtu.be/dYwsgvxSIRs>

Dr Dyno Keatinge, Director General of the World Vegetable Centre, explains the benefits to Australia from their work around nutrition security and vegetables. See <http://youtu.be/WiQ0YJ2sskc>

Dr Stephen Hall, the Australia Director of The WorldFish Centre talks about the win-win aspect of the work the Centre does in partnership with Australian research institutions in co-developing of technologies and solutions. He highlights the benefits to Australia of their work on improved aquaculture feeds, fisheries management, and the lessons that they have learnt from working in other places, which stimulate and feed the research community, and the policy environment in Australia. See http://youtu.be/LQ1_yQrsVTk



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