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**Climate Change, Sustainable Agriculture and
The Research Road Ahead**

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Paper prepared for presentation at the “Agriculture In A Changing Climate: The New International Research Frontier” conference conducted by the Crawford Fund for International Agricultural Research, Parliament House, Canberra, Australia, 3 September 2008

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Climate Change, Sustainable Agriculture and the Research Road Ahead

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I feel genuinely honored to contribute to the annual conference of the Crawford Fund. Few organisations have done so much to promote international agricultural research. And few have pursued that aim so persistently.

As this conference makes clear, the Fund continues to show visionary leadership in shaping the research agenda and in mustering support for it — not just in Australia, but also by activities in other parts of the world.

As a Vice President of the World Bank, therefore, and as Chair of the Consultative Group on International Agricultural Research, I especially appreciate having this opportunity to discuss the intersection of climate change and sustainable agriculture, and the implications for the research road ahead, particularly with respect to the CGIAR.

Renewing the research agenda

When the organisers of this conference invited me to attend, they asked me to talk about the need for

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a *new* agenda of agricultural research. While some elements are new, many items that must appear on that agenda are hardly novel. Rather, they are central components in a longstanding program of research for sustainable agriculture which must be re-emphasised.

Therefore, what is most needed now is a **re-newed** agenda for agriculture research — one that will place sustainable agriculture and the reality of climate change at the forefront of our development thinking.

No one showed a better grasp of the central importance of agricultural research than the Crawford Fund's founding director, Professor Derek Tribe. His 1994 book *Feeding and Greening the World* charted a clear path forward. Yet, just as the journey was getting under way, stagnating support for agricultural research for development drastically slowed its progress.

The results have been made dramatically evident in the past few months as the international community deals with a global food prices crisis. While there were, and remain, multiple factors that led to the crisis, a fundamental element was the lack of capacity to supply more food when the world demanded it.

If there is a silver lining to this food crisis, it is that there is now a heightened awareness among many decision-makers that it was an error to have neglected investing in agriculture research for so long. There is also a greater realisation that agriculture's many value chains for food, feed, fibre and industrial uses all depend on research-based innovation. This was certainly one of the main messages of the World Bank's *World Development Report 2008: Agriculture for Development*, which detailed how much this lack of investment and lack of interest in agricultural research has cost us.

Climate change and agriculture — making the link

Before describing key features of the renewed agenda in agricultural research, I'd like to emphasise the complex link between agriculture and climate change. You may know that the World Bank Group is just now finalising a Strategic Framework on Climate Change and Development. This over-arching approach will guide our actions on climate change and development for the foreseeable future.

One key area we've focused on is agriculture since it plays such a large role in economic growth and poverty reduction in so many developing countries. The multiple interconnections between food security, energy, security and climate change have become increasingly evident.

Developing countries are likely to suffer the earliest — and the most — from climate change. Fundamentally, for those of us in the international community, the challenge is to help poorer countries grow their economies and improve living standards despite the higher costs of development inflicted by what some are calling 'climate chaos'.

The impact on agriculture

Despite the imprecision inherent in predicting the future, especially regarding global warming, we know that climate change will significantly affect agriculture and forestry systems.

Extreme weather, major changes in precipitation patterns, droughts and flooding will increase in coming decades and will have a major negative impact on land-production systems in some regions. Rising temperatures will create heat stress in some species of livestock and less stable crop yields, and lead to more frequent outbreaks of pests and disease. This will further complicate our efforts to control diseases, including those which are passed directly from livestock to humans and those which move from wildlife to livestock to humans.

Pasture production and grazing lands will also be affected, and the competition between crops for food versus animal feed, already being felt, could be exacerbated.

But the impact of climate change is not always certain — and not always negative. There is some evidence that higher atmospheric concentrations of carbon dioxide could actually increase plant

growth and improve water use efficiency, particularly in wheat, rice, soybeans and potato. These results have not yet been verified in the field, where limiting factors such as pests, soil and water quality, and crop-weed competition exist.

We should also acknowledge that agriculture not only copes with the impact of climate change — it is, and will remain, a contributor to it. Agriculture is a major user of land and water resources, and a significant source of greenhouse gases — an estimated 10–12% of all GHG emissions resulting from human activity.

Expansion of the agricultural frontier through land clearing and slash and burn contributes even more, with the total impact of land use and forestry changes contributing almost one-third of GHG emissions in all developing countries.

This indicates that while adaptation to the impacts of climate change is a priority for agriculture, mitigation is also important. We must accelerate our search for new knowledge and technologies in both areas. We must exploit the significant synergies between adaptation and mitigation in agriculture to counter increased risks of climate change impacts.

Finally, the social dimensions of the relationship between climate change and agriculture cannot be ignored either. Farmers, fishers, foresters and herders in the 21st century will need to overcome significant challenges. These will arise largely from the need to increase the global food and timber supply for a world growing to 10 billion people or more, while adjusting and contributing to responses to climate change.

Success in meeting these challenges will require a steady stream of technical and institutional innovations, as well as adaptation and mitigation strategies that are consistent with efforts to safeguard food security and maintain ecosystem services.

CGIAR achievements

Before defining our road ahead, I'd like to mention one or two achievements in agricultural research. They are an indication of the foundation on which renewed research on agriculture and climate change will be built.

Improved seeds for major cereal crops were central to the success of last century's Green Revolution, and they will play a role just as important in this century's revolution in sustainable agriculture. The good news is the

advanced guard of a new generation of climate-ready crop varieties is already reaching farmers' fields. Among them is a flood-tolerant variety of rice called 'Swarna-Sub1', developed by CGIAR scientists and their partners. In Bangladesh, it is rapidly displacing a popular but flood-susceptible version of the same variety, which is grown on six million hectares. The new variety enables farmers to obtain yields two to three times those of the susceptible version under prolonged submergence of rice crops.

In another example, more than 50 drought-tolerant maize varieties are already spreading rapidly in eastern and southern Africa. Developed by the CGIAR in collaboration with national partners using farmer-participatory methods, the new varieties are being grown on about one million hectares.

Our future agenda for agricultural research must draw on our experience and take into account the complex and unpredictable nature of climate change, and the agriculture – climate change nexus.

The road ahead for agricultural research and climate change

Looking ahead, there is a huge potential for developing more of these resilient crop varieties, and in a number of areas. There is a huge potential to push the frontiers of agricultural research to respond to climate change: the challenges that threaten and the opportunities that beckon.

Let me outline six areas where our work is leading us:

First, more research is needed to enhance the hardy varieties already available. Tolerance to stresses such as drought, heat and high salinity must be combined with other valuable traits, such as better nutritional quality.

Second, we must increase the flow of hardier varieties for a wider range of staple crops. Rice, wheat and maize are critically important. But the poor also depend on many other cereals, as well as roots, tubers and grain legumes.

Third, to make plant breeding more effective, we must make a more determined push to apply powerful new tools from molecular biology. Molecular genetic maps, for example, together with crop performance data from diverse sites, are critical for identifying areas of crop genomes that are linked to stress tolerance.

This use of new tools for crop improvement must go hand-in-hand with more vigorous evaluation of plant genetic resources. The traditional varieties and wild relatives being conserved are a rich source of genes needed to enhance stress resistance. To date, however, only about 10% of the 600 000 plant samples held in CGIAR gene banks have been characterised.

Fourth, we must focus on under-utilised crops. To adapt effectively to climate change, rural people will need to draw on an even wider range of biological diversity. That is why stronger efforts must be made to explore the commercial and food security potential of under-utilised plants, such as tropical fruits, medicinal herbs and certain agro-forestry species. These plants can play an important role locally in the diets and livelihoods of the poor.

Fifth, the development of hardier crop varieties must form part of an integrated approach, based on prudent management of crops, bio-diversity, soil and water. This will offer farmers their best hope for delivering larger harvests, despite the stresses brought on by climate change.

Developing and promoting integrated approaches for crop and natural resource management is complex, knowledge-intensive work. Taking full advantage of the income-enhancing potential for farmers and workers all along each value chain adds to the complexity — but the returns are substantial.

A notable case is the spread of minimum tillage in South Asia's rice and wheat systems. About a half million farmers now use this resource-conserving technology on more than 3.2 million ha. The resulting economic and environmental benefits are estimated at more than \$100 million US annually.

The benefits have come from higher crop yields, lower production costs and large savings in water and energy. In addition, the practice of leaving crop residues in the soil has led to lower greenhouse gas emissions. The success of minimum tillage in South Asia is due in large part to the inclusive style of technological innovation used by CGIAR scientists and their national partners.

Simplified versions of that technology — referred to more broadly as 'conservation agriculture' — are being developed for smallholders in Africa's dry lands. One option centers on the use of so-called 'planting basins.' These are shallow

depressions that farmers form in the soil during the off-season. The basins help concentrate moisture and nutrients around the base of the plant. That, in turn, leads to better establishment of improved varieties of diverse crops — such as sorghum, millet and cowpea. Farmers may then further improve soil fertility through cereal-legume rotations, partial ground cover with crop residues, and fertiliser micro-dosing.

An estimated 50 000 farmers have tested the planting basin method so far, mainly in Zambia and Zimbabwe. Although it raises labor requirements this has not constrained adoption, and the method has doubled or even tripled returns on labor. Fertiliser micro-dosing alone has been shown to increase profits from millet production in West Africa by a factor of four.

Sixth, another major challenge for research will be to provide the means to quickly diagnose local conditions and shape new crop and resource management practices accordingly. So accurate and timely diagnosis is important.

In our rush to act on climate change, we run the risk of grasping for simple recipes for success. This thinking would be counterproductive. The impacts of climate change in agriculture will vary greatly over time and across locations. Strategies for adapting to climate change must be carefully targeted.

CGIAR scientists have made great strides in devising tools that make better targeting possible. The new tools consist of geographic information systems linked with computer models that simulate changes in crops, weather and other conditions.

In one pioneering application, CGIAR scientists predicted the impact of climate change on maize production in all of Latin America and sub-Saharan Africa. Another recent study used computer models to predict how climate change will affect 23 staple and cash crops worldwide. Our scientists project that by mid-century the area of land suitable for the cultivation of more than half of those crops will have shrunk, in some cases dramatically.

CGIAR Challenge Program

While these results are impressive, there remain large gaps in our understanding of precisely how and where climate change will impact agriculture, as well as gaps in our ability to finance the necessary research.

One additional creative attempt to fill these gaps which holds great promise is the new 'CGIAR Challenge Program' on climate change, agriculture and food security. The program is being constructed jointly with the Earth System Science Partnership.

The Challenge Program is structured around several major research themes:

- **Assessing agriculture's vulnerability** and using sophisticated research tools to better target interventions;
- **Developing macro policies** to stimulate investment in climate change adaptation and mitigation;
- **Continuing and expanding the dialogue** between researchers and stakeholders on policy and intervention options;
- Thinking through current and future **adaptation pathways** for coping with climate change. One key question for research concerns the institutional arrangements that are needed to deliver information to support risk management, and the options immediately available to support diversifying agriculture;
- **Stimulating research on technologies, practices and policies** that might reconcile conflicting aims. How do we, for example, mitigate the impact of agriculture on climate change, help agriculture adapt to climate change, and also raise rural incomes? Carbon markets could offer rural people new opportunities to achieve both aims by giving them stronger incentives to manage natural resources more sustainably.

Accelerating the agricultural research agenda, however, will take more than one Challenge Program. The six-point plan I listed will require nothing less than a complete revitalisation of agricultural research. All agricultural research actors across both public and private sectors will need to work more closely together if we are to achieve this revitalisation, and truly realise the promise that research holds.

Conclusion

Agriculture has once again come to the forefront of our development agendas at a time when the importance of addressing climate change could not be more pronounced. This is an opportunity to renew both the program of agriculture research and our call for increased action.

By itself, though, the call will remain just that: a plan, an intention. Real progress in dealing with the issues which lie at the intersection of climate change and agricultural policy will depend on decisions and actions taken by many people —

including you, whether you are a member of the industrial, farming, scientific, government or civil society communities in Australia.

We can all appreciate that this ambitious and timely CGIAR research agenda will not be easy to implement, nor will it be successful at every step of the way. But we must undertake this journey ... for ourselves, for our children, and for the poor of the world in developing countries — and **their** children — who are looking to us to act.

We owe them no less.