Questions and Answers

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Moderated by James Moody

Paper prepared for presentation at the "Biodiversity And World Food Security: Nourishing The Planet And Its People" conference conducted by the Crawford Fund for International Agricultural Research, Parliament House, Canberra, Australia, 30 August – 1 September, 2010

Questions and Answers

Moderated by James Moody

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Panel members:

Dr Cristián Samper
Dr Emile Frison
Dr T.J. Higgins
Professsor Hugh Possingham
Dr Gabrielle Persley
Dr Meryl Williams

Preliminary panel discussion

James Moody: Cristián, what are some of the threads and commonalities of today?

Cristián Samper: The discussions have raised my awareness of issues like micro-diversity and trade-offs or contrasts between say marine systems, terrestrial systems and other elements. I heard from most people that we have to think about food security in a much broader context: not just food production, but other dimensions of human wellbeing, including the concept of ecosystem services. I heard of the not-surprising tensions between preserving biodiversity and food security.

I didn't hear enough about trade-offs between issues like forestry and livestock; or carbon and water. Such trade-offs are interesting, particularly in an Australian setting—Australia is in an interesting position because from a global biodiversity perspective it is an extremely important continent. It has made major advances in food production and food security, and it has some major scientific capacity as well. It may well be in different position compared to say Europe in seeking a balance between biodiversity and food security. I do agree that we can't conserve all biodiversity and at the same time retain the same production systems. Hugh Possingham's title poses a question: 'Can we have our biodiversity and eat too?' My short answer is that we can, but we need a different recipe.

James Moody: Emile, you will talk tomorrow about health and nutrition. Have we introduced those issues adequately today? Are we missing some of the trade-offs or other issues?

Emile Frison: Since I haven't spoken yet, I will talk about things I haven't heard yet in order to whet your appetite for my talk tomorrow morning. I have the impression that we've been talking about food security too vaguely—as if it was just a matter of producing any type of food anywhere in sufficient quantity, almost in macro-economic terms. The real problem is to address the issues that concern the one billion poor people in the world who are not food secure. Most of these people are in developing countries; if we want to address their problems, it's not just about producing any type of food anywhere. We want people to fully develop their capacities, so we must have not only food that fills the stomach, but food that provides appropriate nutrition and permits full development. This recognition has been lacking, not just in discussion today but in the whole debate about food security for the last two decades. Only in the last few years have we seen greater attention to the issue of nutrition. It is important that we go beyond using the term food security as if it was only about producing more food: it is much more complex than that. Producing better food for people will address both poverty and health outcomes.

James Moody: You panellists are broadening this discussion. Australia's unique contribution to food security is more than shipping large quantities of protein and fat around the world. TJ, what have you thought?

T.J. Higgins: I have talked about intensification of food and even fibre production using the best genetics and the best management tools that are available so as to maximise the space for essential biodiversity. But I see a new challenge in the need

for intensive management of biodiversity—a challenge that includes the question, is there a role for genetic modification in the intensive management of biodiversity?

James Moody: Hugh Possingham, some participants have described your views as controversial—what have you gathered?

Hugh Possingham: If the conservation of biodiversity is largely about values, we need to understand people's values. If you don't have enough food to eat, your values are quite clear. But in emerging economies like Indonesia and Brazil where the value system is rapidly changing and the middle classes are growing quite large, how do we work out what their values are? And how do governments work out what those values are? I am not sure if the Australian government knows what the values of the Australian people are—they were not very clear for agriculture, for the environment or for conservation in the recent election.

If we are to consider and possibly accept trade-offs, we need to assess the values accorded by Australian people to competing interests. And what do they perceive as risks?

Another property that we haven't talked about is resilience, especially of ecological systems. Resilience comes into food security: not only total production and quality are important. What is the probability of something going really wrong? How much productivity should be traded for consistency? There is a trade-off between variance and mean in productivity, and in eco-systems as well. We don't really know how people weigh these factors; at almost every conference I attend on conservation I end up feeling that we need more social scientists who can work with us on values.

James Moody: People will be very happy to hear you talk about resilience and the trade-off between efficiency and resilience of complex production systems systems.

Gabrielle Persley: Perhaps I can tell you of a lesson I learned when I was a young bureaucrat in Canberra working with Sir John Crawford. When he would produce brilliant syntheses at meetings, an even younger Denis Blight would say, 'Sir John, I didn't exactly hear them say that' and Sir John would say, 'It's want they would've said if we had just stayed a little longer'. Bob McMullen said this morning that 'there needs to be some choices'. This is particularly necessary when it comes to investment of either public or private sector money; some priorities have to be set and choices made as to what biodiversity to conserve and what sadly will be left to nature to take its course.

My experience over some years in working with development agencies has been that it is hard to mobilise funds for biodiversity per se. In the current reform of the international agricultural research system, is proving to be quite difficult to keep such funding on the agenda. Because of this difficulty, people make cases that biodiversity is essential for food security; I tend to be sympathetic with Professor Possingham's view that sometimes these links are tenuous at best. Therefore in making the case for investment in biodiversity we need to make a much better case for the broader values of biodiversity, and not claim in every possible case it is absolutely essential for food security, because in fact it's not. We are not doing the cause of conserving biodiversity justice by pretending that it is always essential for food security. Once we do make that case as a community and set the priorities, we have quite a challenge to communicate these to decision-makers. This conference is the start of making that case, rather than an end in itself.

James Moody: There is the whole question of who will pay for this. Does it just have to be linked with food security?

Meryl, you know of some compelling things around what Australia has done overseas. What were the threads that you drew out of the speeches today?

Meryl Williams: I'd like to offer two reflections. First, we need a better framework to conceptualise biodiversity and the world food system. Food security is a subset of the issues in the world's food system and it can't be dealt with in its own right. Any better framework will have to go across the scales from microbial to natural systems to cultured systems and cultured species, and incorporate the necessary connections between these levels. The reason it is important to have this framework being developed is that when the new international panel on biodiversity and ecosystem services gets going (the interested countries have now all agreed that they will do it), a lot of details have to be worked out as to how it will be done. This will be an IPCC-type process for global biodiversity and ecosystem services, the latter being a follow-up to the Millennium Ecosystem Assessment. Then agriculturists need to be ready

to tap in or to contribute to the IPSS process with some clear thinking about how biodiversity and the food systems fit together.

The second point is very much an aquatic matter. Within 50 years agriculture will dramatically increase the already horrendous nitrogen and phosphorous outputs, most of which is wasted—50% has been mentioned. I'm working with the scientific and technical advisory panel of the Global Environment Facility (GEF) on hypoxia in coastal zones, and I can tell you we don't want more of these outputs in the water. Hypoxia is already causing tremendous and increasing problems; the hardest parts to tackle are the agricultural and livestock sources. Sewage, industry and other sources are somewhat more tractable if you have the money. The good news for biodiversity with hypoxia and anoxia is that there is tremendous biodiversity in hypoxic and anoxia water—but it is all based on totally different ways of living. It's like getting back to four billion years ago, before there was oxygen in the world. This biodiversity is all at the microbial level.

James Moody: Meryl, you may be able to answer the question Cristián posed, of balance between different parts of the system: the livestock, the plants, the microbial, the marine—have we got that balance right, and if not where've we got it wrong?

Meryl Williams: Each sector—and scientists around each sector—has to look very broadly. I've often found agricultural specialists—whether they're industry or farmers or scientists—think that that term 'off farm' means the nearest river or little stream, rather than out in the ocean, 100 or even 1000 km away, which is where a lot of the farm ends up. Each sector really needs to be engaged with the others. If you are the sector that's emitting, you my not care too much until the sector that is receiving (often fisheries) complains about what's been emitted. It becomes a victim's role to remind the emitter that there are problems. This is one of the things we are grappling with in the hypoxic work at the moment. How do we get to agriculturalists to tell them we don't want their nitrogen and phosphorous: keep it on the farm?

Everybody has to take a broader view than generally they have been taking.

Question from the audience

Q1. Unidentified member of audience: *This conference didn't tell us enough about the state of biodiversity in Australia, but two speakers, Professor Sly and Dr Lum, said there is a great shortage of taxonomists here to assess the wide range of biota present. Large increases in global population were noted without much discussion. The UN has classified Australia as a least developed nation because of our rapid population increase. What has the panel to say about food supplies, region by region, rather than globally? Each region has to look after itself, surely?*

James Moody: We have a question about taxonomists … Cristián?

Cristián Samper: Taxonomy is clearly part of my business; we are facing a problem with taxonomy and taxonomists in developed nations including the United States of America. Universities and science have changed and people are not addressing fundamental taxonomy; it is being taken for granted. Fortunately in some countries, like Brazil, there is a stronger, younger taxonomic community than in the United States. This question may be amenable to a more regional approach, and fortunately advances in communications technologies assist this. The paradigm of global centres like the Smithsonian or Natural History Museum in London has shifted; we need to build capacity in different regions of the world.

James Moody: Who will pay? Expenditure is declining …

Cristián Samper: The short answer is we all pay—this is one of the lessons I have learned as a mentor. I grow up in Columbia, and it was interesting trying to be a biologist in a developing country. Some of the things I have at my reach right now, what Columbians have in their reach right now, are very different from what they were 20 or 30 years ago. Not only have we made tremendous partners in say training taxonomists, but in building the institutions where those taxonomists can work. There are certain elements of biodiversity where private industry will invest, but some public funding will also be necessary because there are many elements of biological diversity that don't have a direct application. Public–private partnerships will be significant, as well as overseas development assistance for building capacity in developing countries.

Hugh Possingham: Having chaired the Australian Biological Resources Study for a few years and tried to get taxonomy more money, I found it was a big problem, partly because the taxonomic community is not the best marketer of its science. The importance of taxonomy for biosecurity has been illustrated very well in the talks this morning. In biosecurity, prevention is clearly better than cure, but we never spend enough on prevention—this is true for public health, for the environment and for biosecurity. This is a global policy problem of the capitalist system—somehow we cannot work out the institutional processes to get the balance correct between prevention and cure. For every dollar spent on taxonomy there is almost a ten-fold benefit, but that return has been impossible to sell to the government.

Q2. Walter Jehne, from Healthy Soils Australia: *I have a question for Hugh about trade-offs. To what extent is this a problem of homo hubris? The fact is that we have a mind set, because if we look at ecology and the evolution of our biosystem it has obviously optimised processes by improving efficiency via the development of biodiversity. As niches get more and more sophisticated we get more and more species with more and more efficiency. If we are going to have integrity in our food system, when are we going to start employing these concepts rather than the simple issue of 'we have to trade-off the very things that drive the productivity and resilience of the systems that we need to survive on'.*

Hugh Possingham: If I understand the question, you are saying, why can't we manage complicated systems and harvest them?

Walter Jehne: No, you are saying there is a trade-off. I'm simply saying that in fact biodiversity drives the efficiency on which our food security and the integrity of production depend. We don't have to trade it off; we have to build on the symbioses and the functional efficiency that biodiversity gives us.

Hugh Possingham: But how much biodiversity do we need? There may be 4000 bacteria in a gram of soil: how much do we need?

Walter Jehne: If we only know 0.1 of them, how do we know what we don't need?

Hugh Possingham: That is always a question: how do we know what we don't need? We have many examples where far less diverse systems of soil or plants function productively and we have successful monocultures. There are a couple of examples from sugar cane where crop failures seemingly occur because the soils are just structurally full of biodiversity—but only very few. Arguably we haven't pushed systems to completely fail because of lack of biodiversity. This gets back to resilience: how do you know when you are about to cross the threshold? By the time the threshold is crossed it is too late. Thresholds are hard to measure. We don't have enough data on most of those issues.

Emile Frison: The issue brought up here reminds me that the whole ecology discipline has focused to a large extent on wild biodiversity, and there has been much too little interaction between ecology and agriculture. There are cases where the threshold has been crossed, in particular in soils that have been degraded and that will be very difficult to restore. There are a lot of potential synergies to be gained from better interaction between ecology and agricultural sciences. The whole agricultural education system has been geared towards a single model of agricultural intensification—monocultural, industrial agriculture. It is much easier to do an NPK study on one variety on one particular type of soil than it is to look at the complex interactions between different species in an agricultural ecosystem—and farmers do manage complex agro-ecosystems. We have been trying to simplify that complexity, and any success has been possible only because of external inputs—nitrogen and phosphorus, for example. The sources of those inputs, however, are finite. We have to better understand agriculture ecology, so I make a strong plea for much better integration of those disciplines.

Q3. Bob Redden, Australian Gene Bank[1], Victoria: *We have in Australia thousands of years of history of aborigines surviving off the land as hunters and gatherers. Hundreds of different species were used as 'bush tucker'. I know that the biodiversity of under-utilised crops has been investigated in many countries, but such work may not have has not received the emphasis in Australia that it could have. Is there a need to collect these Australian materials for gene banks, and are there deficiencies in the present organisation of Australia gene banks?*

Cristián Samper: We have been discovering biodiversity for thousands of years. Although the food production systems that we tend to think of

[1] Australian Temperate Field Crops Collection, Horsham

are largely driven by just a few crops, the fact is that a wide range of plants are used. Probably one out of every ten plants species that have been described today are being used by humans for food, medicine or other purposes, and very few of those have actually undergone domestication. A key issue is how to document traditional knowledge, because we are losing a lot of that extremely rapidly, along with linguistic and cultural diversity. Of the some 6000 languages in the world, we estimate probably 80% will disappear this century. There are probably 2000 languages that are spoken by less than 1000 people. The loss is of not just the language, it's all the knowledge and experience of past generations. It's not just the species and it's not putting it into a seed bank. It's all the production system, and knowledge of how it adapts and responds to change.

An interesting example is from the Arctic region where we are gathering traditional knowledge of the use of these resources and assessing the effect of global climate change and how the production system and the extraction system are responding to this. The opportunities to gather and use traditional plants and knowledge have been understated during this conference because we are focusing on contemporary western production systems.

James Moody: TJ, nature is a pretty good designer—should we be spending more time on biodiscovery rather than gene manipulation?

T.J. Higgins: They really go together—you have to do one before you can do the other. Meryl gave me a very good idea: to build on the two and half billion years of evolution in the oceans by finding and using genes for dealing with potential problems that we will encounter in the next 50 years, such as eutrophication of waterways and the oceans.

Q4. Dan Etherington, founder of a social enterprise called Kokonut Pacific: *The floods in Pakistan have highlighted a critical issue regarding food security and climate change: resilience. Many of the most productive semi-subsistence smallholder irrigated farming systems are in large river deltas, but these deltas are particularly vulnerable to sudden change. The issue of food security cannot ignore the question of resilience. Speakers have drawn attention to population growth from 6.9 billion to 9 billion, but sudden changes such as those that occurred in Pakistan have left two million people in absolute crises and 20 million severely disturbed. If the same thing happens to Bangladesh we have a very, very grave situation. How does the panel view this?*

Meryl Williams: We do seem to be confronting larger and larger crisis as the decades go, in part because more people and more infrastructure is being affected by the various crises. This year extreme events such as the Pakistan floods, the fires in Russia and high temperatures in the Northern Hemisphere are leading people to say 'This looks to be more than coincidence'. Maybe we need to start now to identify what places are vulnerable and get into better planning. When an event as extreme as that in Pakistan occurs, effective response is very difficult. China has been better able to cope with some disastrous events, but I'm sure that country is rethinking how it is going to cope in future with major catastrophes. A risk assessment planning process is really needed.

Gabrielle Persley: Following some of these catastrophic events—be they climatic or due to civil strife—the international community has been able to respond fairly quickly. In Rwanda, for example, it was possible to reintroduce local varieties of beans after the civil disasters there. Part of the planning processes is to not only to understand what might happen but also have a plan of how to respond fairly quickly.

Q. Peter Stoutjesdijk, ABARE–BRS: *TJ, you talked about benefits that might accrue if we could secure nitrogen from new sources. How is the quest to transfer the capacity for nitrogen fixation from legumes to other crops going?*

T.J. Higgins: Gene technology is great at deploying a small number of genes, whereas fixing nitrogen from the atmosphere involves several hundred genes. The addition of nitrogen fixation through the use of bacterial symbionts to say, wheat, is a very big technical ask. A better option is to increase our use of legumes as part of our sustainable crop rotation system. The other is just a dream too far.

Q5. Pennie Scott, Healthy Soils Australia: *As I am a social scientist, I have been delighted to hear reference to spiritual and cultural values. One of the first descriptions of a new taxonomy I'd love to see is the description of an ecological community—we have very many descriptions and ideas of what that is, but no common definition. It appears that it's quite difficult to provide a holistic description of what we are talking about with biodiversity and providing continuous high-quality supplies of food to nourish everybody on*

the planet. I suggest that rather than just increasing crop yields and moving those yields and products around the globe, we can enable people to grow more food on a much more local basis using traditional knowledge of biodiversity inherent in communities. This would be an enabling, enriching and resilient way to provide some solutions to what we all think of as a global issue.

James Moody: The ecological community might even see how it fits in the world's food system. The other question is about local production.

Hugh Possingham: I brought up the issue of cultural services, and showed several graphs of the trade-offs. The Millennium Assessment included assessment at both global and local scales. We found that the relative importance of different value categories changes with scale. Cultural, spiritual and aesthetic values become increasingly important at local scales—that's where those choices are being made. In contrast, commodities trade at a global scale. The scale of the context in which decisions are made and managed is a key issue. To what extent are we going to invest in developing some of these global commodities, increasing food yields, putting more nutrients in them, and to what extent should we develop whole systems locally, based on traditional knowledge and biodiversity? One of the scenarios I mentioned briefly this morning was what we call the adaptable mosaic. That's exactly the kind of solution the questioner proposes—developing local production systems that may not have necessarily have the biggest yields but may have major implications for other dimensions of human wellbeing that go beyond food security. That's the other issue that we don't want to lose sight of. It is easy to focus on just access to food or on nutrition—but good livelihoods for people go well beyond that, for example in freedom of choice and other dimensions that are fundamental and are not necessarily being addressed now by agricultural policy.

Emile Frison: I wish to link the issue of resilience with that of local production. If we focus on addressing the poverty that I mentioned, you have to start asking the question of what people do want. Want is a people problem and requires a participatory research approach and recognition of local diversity. You realise that there is much less emphasis on the major staples and that much greater diversity is used, which also affects resilience. In the more diverse systems you don't put all your eggs in the same basket; this also applies to resilience of the production system. By starting with traditional knowledge and marrying that with scientific knowledge, diverse systems that satisfy varied needs including the cultural dimension can be devised or improved. This is again something that has been totally under-researched and under-invested in, and which should receive more attention in future.

Gabrielle Persley: I offer comment on food security and local production in East Africa during the recent global food price crisis. In an analysis of what happened, it became evident that the effects of the crisis were not uniform; indeed countries which were less dependent on imported food survived much better. In Uganda, for example, in which a large proportion of the population were eating locally produced food—a wide variety of bananas for example—there was much less pressure on food prices, particularly for poor people, than in Kenya which was dependant on a lot of imported maize. This has now had a policy effect on decision-makers, who've seen the actual value of much more local production of indigenous foods rather than being too dependent on imported grains.

Hugh Possingham: A related but broad issue is that of decentralisation: I mean a connection with nature. We don't like vast monocultures, where the cotton fields go far into the distance, but they exist in western Queensland and 98% of the people who live in Brisbane have never seen them and they don't want to go and see them. They are completely disassociated from the way their food, fodder and fibre is produced. Few would know how to grow a plant any more, and that number is declining rapidly. So ultimately are Australian cities, which are incredibly centralised already. People are looking at computers. They're not going to the garden and they have no idea what a cow is. Ultimately the only solution to that, probably, is decentralisation. Australian governments haven't said that word for probably 25 years, and you would be called a communist if you did. Victoria had a decentralisation policy for a while and they put a railway system around the state, so rural centres worked. The Queensland Premier is acutely aware of these issues, and believes that Queensland just can't continue filling the south-eastern corner with people. We need to get rural communities growing and spreading to provide opportunities for people to become much more attached to their local places than is possible in the vast suburban deserts of Brisbane. But that requires real leadership by a

government, state or federal, and incentives to get people decentralised.

Q6. Tony Fisher, Crawford Foundation and Honorary Fellow at CSIRO: *I actually like large cornfields and wheat fields. I think they're ascetically quite pleasing. I suppose I belong to the techno garden group. I want to take issue with Bob McMullen who said we have a difficult choice between the short-term benefits of intensified agriculture and the long-term costs. I think we've heard too many negative views about modern agriculture. Most of the world's food is produced in mechanised monocultures—not just in the developed world but also in the developing world. In China, in Asia, South Asia and South America. Only Sub-Saharan Africa hasn't moved in that direction and they're in big trouble. We are not going to turn that around. This is the agriculture that has saved at least a billion hectares from the plough. We need to be realistic about where we direct our research dollars. Do we seek out these fancy new soil, healthy cropping systems of all these new 30 000 edible plants that haven't been researched much? Or do we continue to put heavy emphasis on our existing systems and our 6 to 8 or 10 staples? I think we can make those existing systems even more sustainable than they are. They're quite diverse at the genetic level in the crops—that's what really counts—and they can be made more sustainable and many of them are quite sustainable. We need to be careful that we don't 'throw out the baby with the bath water' and go overboard chasing many of these other fancy notions that we've heard about today.*

Emile Frison: No 'one size fits all'; it is true that large areas of industrial agriculture will not be turned into the diverse systems that are seen in many smallholder farms in Africa—but we are missing out on the potential of better tapping the interactions between different species. In China, five million hectares of intense intercropping are being used to find better ways of mobilising phosphorous from the soil to maximise the benefits of interactions between cereals and legumes in nitrogen fixation, whereby the cereal stimulates greater nitrogen fixation by the legume, than if the legume is grown alone. Such synergies can lower inputs to intensified agriculture. Models based only on high inputs are short-term, unsustainable solutions. We have to tap the power of interactions between different components of the system. In addition, there are big differences between Australia and most countries in Africa. In Uganda, for example, 70% or more of the population is still in agriculture and a common farm size is half a hectare. Do we want to push Uganda towards Australia's position, with 2% of the population in agriculture?

James Moody: There has also been discussion about scale and biodiversity … Lindsay, what are your thoughts about that?

Lindsay Sly: We cannot dismiss the microbial scale. From a microbiological point of view, we have seen degradation of our agricultural soils to the point where many are almost a simple matrix to which we have to supply considerable inputs. That's fine while we can afford those inputs, but with restrictions on nitrogen application and declining petrochemical and phosphorous resources we might need microbes to mobilise phosphorous or to fix the nitrogen. Thus there is certainly a need to investigate ways of improving soil health and the role of micro-organisms, as well as getting more organic matter back into soils.

Q7. Richard Everington, Kokonut Pacific: *Can you comment on the nutrient density of food and its improvement? I can see that the key domesticated six–ten species of plants that we derive 90% or more of our energy from are going to remain with us, but what are the opportunities among vegetables, where there is a lot more biodiversity?*

Emile Frison: I will be giving some examples about that tomorrow. In East Africa traditionally more than 200 species of leafy vegetables were used—some cultivated, many picked from the wild. These show differences in nutrient (especially micronutrient—vitamin A or iron or zinc) content of ten- to a hundred-fold compared with what used to be the most common green vegetable, cabbage. This contrast has been a characteristic of most of the improved species. Nutrient density of species that have undergone a lot of genetic improvement has not been taken into consideration at all, and they have been bred only for yield and energy efficiency. A lot of the genes responsible for nutrient density may have been discarded. No vegetable is likely to satisfy all needs, and so trying to make a miracle single crop that has it all is unrealistic—it is better to tap into diversity again.

Gabrielle Persley: Amongst the most nutrient dense-foods are those sourced from animals. There was a reason why mothers always told their children to drink a glass of milk. One has to look at a balanced diet, and that's part of the develop-

ing Africa–Australia partnership in which nutrition is a high priority. It includes not only things like the African vegetables—which indeed are important sources of micronutrients—but also increasing consumption of animal-sourced foods. Just small increases from very low levels can have a very high impact, particularly on mothers and children.

Q8. Sadanandan Nambiar, Honorary Fellow at CSIRO: *Most of us would probably appreciate that it makes sense that food is produced at the local, sub-regional or regional level, in the right quantity and with the right nutrients. That's a nice model. I want to comment, however, on the popular comparison of so-called 'monocultural industrial food production' with the agriculture based on 'local , traditional knowledge'. If you look at world experience, there is no question that the local knowledge model has a high dose of romanticism. It was quite clear in my work in plantation forestry that the traditional forestry model does not necessarily serve poor people very well at all. Those societies worldwide that have come out of poverty and become able to feed themselves have succeeded largely because they adopted 'modern technology', however wrong its applications may have been sometimes. So can we actually bring welfare, wellbeing and good health to those people if they remain dependent only on local knowledge and tradition? There are many instances in which it has resulted in perpetual poverty.*

India's food supply and nutrition has been mentioned. My question is about food production as much as forestry. If you look at India's green revolution and the under-nutrition of many Indian people, it is not proven that this can be alleviated by going back to traditional knowledge and practice. This is a risk that we must be aware of. It is easy to brand modernisation as a form of colonial domination. We need to be very cautious when assessing the new-found virtues of 'traditional ways', and unintentionally perpetuate the idea that modernisation is wrong.

Unidentified panel member: One reason I raised the issue of local people and local knowledge is that in some cases of increased colonisation in rural systems there have been positive impacts on poverty, but in many cases people in rural areas have been marginalised. As you observed in forestry cases, often people have not benefited. The challenge is to engage rural indigenous people in a more participative way, to understand first of all what their needs are regarding food security and their spiritual needs; these vary a lot between different countries because different countries have different values.

I worked in the Pacific where some people wouldn't have a bar of having a logging company on their land; they didn't need that money. In Indonesia cultural values may be different and often there is deforestation. There is no solution that fits all circumstances, but we need to create space for local needs. However, unless there are more democratic systems in place, I don't think that is going to happen. That again was one of my reasons for focussing on decentralisation and democracy—we can't work just at the project level; sometimes it is necessary to be more systemic. There's no easy solution, but I am positive we can get there.

Emile Frison: It's not about opposing romantic traditional knowledge with modern technology. I was really talking about a marriage of traditional knowledge that has values and an intrinsic understanding of some of the ecological process (though not necessarily in a scientific way) with sharp scientific knowledge. It's not about being romantic about the past, but looking to go beyond a purely technological approach that has not been addressing the issues of poverty. The world hasn't solved the poverty issue; economically (as measured by GDP) we have improved in some cases by a factor of six, but in India, which has enjoyed the success of the green revolution, 50% of the children today are malnourished. Where is the progress? We have to see how modern science, which is absolutely necessary, can embrace other neglected dimensions like traditional knowledge.

James Moody: Hugh, is there somewhere a solution that incorporates development and poverty reduction as well as biodiversity and food security, with ecosystems services?

Hugh Possingham: Some interesting papers have recently been submitted to *Nature* and *Science* about the relationships between poverty alleviation, biodiversity and conservation. And the jury is out. If you can get people over particular humps, perhaps they all become rabid greenies. Industrial agriculture has been a big part of getting people over the short-term food supply hump, and they have started to conserve biodiversity—but there may be no causal relationship. It's a correlation in history. Although some of the countries which have moved have big middle classes, it's not completely clear that they will be as green as

us, nor that we are as green as I'd like us to be. This is a global experiment with no replication.

Q9. Albert Rovira, The Crawford Fund: *I would like to defend broad-acre farming systems. When I was in CSIRO, I worked with a sugar industry that was burning every bit of organic matter between crops. That industry has completely changed now to 'green-stick' farming—retaining all residues and building up the soil with organic matter. The CSIRO found a dramatic increase in the number and variety of earthworms in those soils. Further south there has been a revolution in cereal growing with the retention of stubble and direct drilling; again there has been a buildup of organic matter and biodiversity in the micro-organisms in the soil. We should not condemn monoculture if it is managed correctly.*

Q10. Sadanandan Nambiar: *My previous question was about food production as much as forestry. If you look at India's green revolution and the under-nutrition of many Indian people, it is not proven that this can be alleviated by going back to traditional knowledge and practice. This is a risk that we must be aware of. It is easy to regard modernisation as a form of colonial idealism. We need to be very cautious when assessing new-found virtues of traditional ways, and avoid any idea that modernisation is wrong.*

James Moody: This is all about progress, not moving backwards.

Q11. Jill Gready, Australian National University: *I will bring together a number of threads in this discussion and offer another perspective. Assumptions have been made in all the discussions that the social structure and the population distribution in developing countries in 2050 will be something like it is now. Without giving away too many of my esteemed sources, there was an article in the magazine of the Weekend Australian a couple of weeks ago that speculated that by 2050 most people in developing countries, as they became more prosperous, will have moved to the cities to create a much more urbanised world. This is happening in China now. With only a relatively small proportion of people in the countryside producing food, there may then be large areas of crop in monoculture or something similar. This seems very likely in areas of Asia, although Africa may be different.*

James Moody: I'm reminded of the comment that 2009 was the first year in which there were more people living in urban than in rural environments, and the projection of current trends is that the 50% will become 80% by 2050.

Q12. Tom Nicholas, Healthy Soils Australia: *Industrial agriculture as we have known it is dead. Innovative farmers are using biology and understanding of how plants and animals interact to drive holistic production systems that are environmentally sound and creating biodiversity. They are attaining high production of nutritionally dense, high quality food. We need only small amounts of nitrogen and phosphorus at the right place at the right time. We don't have to reinvent the wheel.*

Panel overview

James Moody: Panel, we have a whole range of issues from monoculture to urbanisation to the death of industrial agriculture and what we can learn from microbiology. I invite your comment.

Gabrielle Persley: I'll respond on the urbanisation of Africa. It's true the trend across many countries of Africa is of people moving to the cities. Regretfully they don't move because they're doing well, they move because they're poor, they can't get employment on farms and the productivity of the farms is too low to be able to support all the families. So there are two development issues:

First, how should we cope with the problem of the increasingly urbanised populations of large cities? If Hugh thinks of Brisbane as an urban desert landscape, he should visit Nairobi, where challenges include infrastructure, clean water and reliable power. Secondly, there is a variety of approaches to agricultural development across Africa. Over coming decades some countries, where there is sufficient land and fairly small rural populations, will develop broad-acre agriculture. Others—the majority—will seek to intensify crop and livestock systems by a combination of local knowledge and improved technology. We must be open to using all available knowledge, whether it is indigenous knowledge, GM technology or new ways to use microbial biodiversity.

Emile Frison: There is no point in keeping barriers between romantic traditional knowledge and industrial agriculture. Similarly the debate regarding GMO is often unnecessarily sterile. We have to make the best of all forms of knowledge, and especially go beyond the disciplinary borders that have had too much prominence in the past. We should marry agricultural science with ecology

and other supporting knowledge from areas such as evolution and taxonomy.

James Moody: Meryl, your ideas around world food systems seem to have anticipated a lot of the questions that we just had.

Meryl Williams: I agree that all systems have a role. We need a large amount of industrial agriculture—whether we like it or not—because most people will be living in cities, as the lady from ANU pointed out. Also, fewer and fewer people anywhere in the world—even in developing countries—are now connected with agriculture. So there is a need for much greater reaching out and re-education. Many of us of the older generation here had parents or grandparents who were on the farm; some may even have come from the farm themselves—but these days most people, including a lot of politicians, don't have that connection within the memory of living relatives. The system is a complete mystery. So educating people about how food is produced in all of its ways is very important.

Just as we've had some defence of the extremes of both large-scale industrial operations and production based on traditional knowledge, urbanisation can be defended. It's not necessarily a terrible evil. It's one of the more efficient ways of coping with the large populations that we've got, and particularly with the ones we will have by the time population peaks. Waste treatment, health services and education can't be delivered to great numbers of people unless they are living close together. Urbanisation has to be done well and a lot of things have to be worked out, but it is not necessarily an evil. It has to be embraced positively because we really do need efficiency.

Unidentified panel member: The issue of urbanisation is not simple. You could be weakening the strong by moving people unless there are governance systems that ensure that new arrivals have jobs. People who are carrying machetes and hoes for farming would probably love to make more money by making toys sitting in Nairobi if they could, but that is not the case. They may move only to be dependent on others, with the result that the economy doesn't grow and people do not make more money.

Life abhors vacuums. For example, pastoral systems in arid lands are being destroyed not because the indigenous knowledge system has not worked but because it was not replaced by appropriate policies. People had animals that were productive and indigenous governance systems that were sustainable, but if those systems are dismantled without balances the entire environment may be destroyed and the result blamed, inappropriately, on failure of the indigenous systems. Likewise in small-holder systems, when changes are imposed without any extension system being in place to inform the people of correct culture and husbandry, there is no knowledge system to replace what they knew. People treat the farm as a mine, for example by removing all crop residues and manure. What do you expect? Yields decline instead of increasing. We need to be holistic rather than simplistic.

Hugh Possingham: If I was a politician or a senior bureaucrat, what would I want to know from these discussions? Is urbanisation good or bad, is intensive agriculture going to undermine agricultural productivity? I think it's going to be always around.

I'd want to know the consequence of policy decisions. At the moment we make full projections on economic issues to assist policy decisions. We may have good forward projections on things like food supply, but maybe not enough about food durability.

Who has seen a forward projection of the consequences of agriculture policy for biodiversity? There is only continual speculation.

All we know is that we are losing it at 1000 times the current background rate. Only a couple of people in CSIRO have actually made forward projections about biodiversity. That's why policy makers never care about it. Has anybody seen some forward projections about agricultural policy and human happiness? Until ecologists and biodiversity people and social scientists can build the models to make forward projections, they will not be at the table. This is a big challenge; the systems are complicated and the variables hard to measure. But ultimately the solution to the policy management puzzle is being able to build credible forward projections of things that are very difficult to understand and measure, above and beyond GDP that has driven global policy for far too long.

James Moody: That really points to both a multidisciplinary approach and also to the question that TJ posed: what are some positive views at the end of all this?

Cristián Samper: This will really be a closing comment. The emergence of agriculture marked one of the major transitions in human evolution. If

it hadn't been for that development our society wouldn't be what it is today. Agriculture was a solution but now is also a huge part of the problem. We've seen the development of different kinds of extractive systems, production systems, on land and in the sea. We need to recognise virtues of both intensive agricultural systems and traditional systems. One size will definitely not fit all. We do need to explore trade-offs. Too many decisions have been narrowly based on just one or two parameters, omitting issues like ecosystem services and social dimensions. The world is not homogeneous; different societies have different values and different choices. We need to respect that.

Food security must be viewed in the context of human wellbeing. It is not only about having nutrition or food or health, it is also about empowering people to make the right choices and to give them the freedom of choice to do that, including of food production. This will start building those bridges across disciplines.

T.J. Higgins: I will finish by paraphrasing the anthropologist Richard Leakey when he said that 'you have to be well fed to be a conservationist'. My point today was that if the former can be provided the latter will follow. Food security has been our mantra, but it is clear from this conference that we need to extend that to say 'food security **and** ecological security' will build a resilient society over the next half century.

Emile Frison: The theme of this meeting is food security, but the real objective that we have in mind is to allow a healthy human development in all its dimensions, with health including broader wellbeing dimensions. This will require outreach beyond both sectoral and disciplinary boundaries.

James Moody: Hugh, you posed the question whether we can have our biodiversity and eat too. I would like to ask you that question.

Hugh Possingham: I think we can, but not the way the current policy world is structured. It's too antagonised by different sectoral interests. Part of the green movement pushes a very narrow line. Everybody's got to broaden out their understanding and to see the forward projections of different issues. We should all come from the same informed base; unfortunately at the moment we have lots of information about the economy and jobless rates, but we're not getting information about the consequences of decisions on biodiversity for human wellbeing. The Millennium Assessment attempted this, but it didn't make a ripple in Australia. Things done in 2005 have to be brought out, revisited and people have to be clear of the consequences. What were those forward projections? Until everybody is informed about these things various sectors just keep arguing about their narrow interests.

Unidentified panel member: The conceptual framework the Millennium Assessment was useful, but the real value was in the local assessments. So here is a challenge: have Australia do its own Millennium Assessment.

James Moody: Good idea. Meryl?

Meryl Williams: I think it's a very good idea. I wasn't in Australia at the time the Millennium Assessment came out. The extent of local attention would have been influenced by the number of Australians involved and their roles in the system, and whether they brought things to the attention of or got support from local agencies. It's a very good idea and if the IPBES process[1] gets going it will provide the next opportunity to do it.

I want to discuss how the diverse needs of different countries can be effectively addressed. ACIAR plans its work at the country level, offering knowledge and skills in selected areas of agricultural expertise in talks with national and local agency partners as to what their needs are. It then puts assistance packages together. The sets of projects for each country differ remarkably because each is based on what a country needs.

This is a process that addresses Cristián's concern for action at local and regional levels—levels at which things happen. At this meeting and at the other Crawford Fund conferences in the last few years we have been very well informed of the blockbuster global pictures that have come out from various assessment studies, and papers in *Science* and *Nature* and so. Sometimes the inevitable simplification in these broad accounts is not ideal: it can be too simple. For example, the marine one shown this morning [page 44 …] will be considerably changed next month when the Millennium Ecosystem Assessment puts its picture of marine biodiversity out. It is very useful to have work at both local and global levels.

[1] http://www.iucn.org/about/work/programmes/ecosystem_management/ipbes/

James Moody: I think ACIAR's approach has had huge impact. Gabrielle, you get the last word. What are some solutions?

Gabrielle Persley: Though we have a great deal of information and knowledge on the table, not much has been said about setting priorities and who will pay. A message to take out of this conference is that we need more work on what a global agenda might be in some areas. An example that is working fairly well and that has an international framework is the conservation of agricultural crop biodiversity. Some other areas such as livestock, fisheries and microbes don't have that sort of helpful international structure.

A second area is lessons learned about successful approaches to conserving biodiversity in specific countries. Switzerland springs to mind, where incentives are provided to farmers to actually conserve biodiversity in their local environment, with both cultural and economic results. As Meryl said, lessons from the local scale may come together to produce an overall strategy. This can make a more compelling case for both public- and private-sector investors who will actually contribute to conserve biodiversity.

James Moody: We've heard a lot of different thoughts on very complex issues. The intersection of biodiversity and agriculture reaches further I and many others had thought—it reaches into productivity health; food security, climate, environment, population, wellbeing, ecology and development, to name just a few.