Food versus the environment - and the winner is?[1]

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The unequal distribution of food and conflict over control of the world's dwindling natural resources present a major political and social challenge to governments and policy makers, likely to reach crisis status as climate change advances and world population expands. Essentially, global agricultural production must be increased substantially to meet rising demand, but it must be achieved with a decreasing impact on natural resources and the environment. This is perhaps the greatest challenge yet to face agricultural science. To avoid the emerging food crisis without further and increased damage to the environment, at a time of rising costs for energy within a spectre of climate change, we need substantial reform to the nature of the agricultural sciences coupled with a major injection of both national and international investment in these reformed sciences. This urgent need has apparently slipped from our gaze.

Wheat, corn and rice prices have more than doubled in the past two years (Sachs, 2008). Global cereal demand is projected to increase by 75% between 2000 and 2050 and global meat demand is expected to double (IAASTD, 2008). Global cereal reserves have fallen to their lowest levels for thirty years (ACIAR, 2008) Oil prices have more than tripled since the start of 2004. Food riots are not uncommon. Higher incomes, urbanisation, and changing preferences are raising domestic consumer demand for high-value products, shifting consumption from grains to meat and diary (von Braun, 2007). Throw climate change and high energy prices in to the mix and we have a conundrum.

Historically, the answer was to bring more land under cultivation. This solved issues of population growth and market expansion. Increasingly, in the more densely populated parts of the world, the land frontier is closing (World Bank, 2007). In other areas, pressure on food supplies is driving expansion into more marginal areas, as well as rainforests, wetlands, peat lands, savannahs and grasslands, meaning further loss of biodiversity. The planet's ecological function will receive further damage into the future at a time when the mitigation of climate change requires repair of this function and increased carbon sequestration.

The relationship between climate change and agriculture is a two-way street. Climate change is also increasing production risks in many farming systems. Factors such as changes in temperature, precipitation, carbon dioxide fertilisation, climate variability and surface water runoff will all affect productivity (World Bank, 2007). Climate change is also predicted to affect the distribution of plants, invasive species, pests and disease vectors.

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"GREEN REVOLUTION" IS FADING

More recently, in the 1960s, the solution was a Green Revolution, based on high input systems sustained by a suite of new seed varieties, pesticides and fertilisers. Evidence is now mounting that the productivity of many of these systems can not be sustained. Productivity is being undermined by pollution, salinisation, soil degradation and pest and weed build-up (World Bank, 2007). Today, almost 2 billion hectares and 3 billion people are affected by significant levels of land degradation (IAASTD, 2008). So, the Green Revolution won't give us the get out of jail free card. We are losing land as quickly as we can find new areas to farm (Williams et al., 2004). Just when we need to magically increase productivity, the very land we rely on is under threat.

Aside from environmental considerations, price is quickly becoming a constraint. The price of fertiliser is going through the roof, due to global demand as well as rising energy prices. Monoammonium and Diammonium Phosphate, two fertilisers of choice for Australian cereal crops, have recently hit $1600 a tonne, more than double the price 12 months ago. Round-up has gone from $4 a litre last October to $13 today. Even the cost of things like tractor tyres are expected to rise as the costs of raw materials and production go up.

It is clear that the mounting crisis in food security is of a different complexity and potentially different magnitude than the one of the 1960s (IAASTD, 2008). There is a limit to the world's resources. At current rates of usage, phosphorus reserves may become depleted in as little as 50 years (Lewis, 2008). The unequal distribution of food and conflict over control of the world's dwindling natural resources present a major political and social challenge to governments and policy makers, likely to reach crisis status as climate change advances and world population expands from 6.7 billion to 9.2 billion by 2050.

How then do we achieve the seemingly unachievable? How do we increase agricultural productivity and yet protect the natural assets that will underpin production into the future?

WHOLE SYSTEMS SCIENCE AND TECHNOLOGY SOLUTIONS URGENT

We've got to look at ecological, energy and water systems as a whole to appreciate the impacts or the footprint of our food on our natural resource base. This was a core message from the recent International Assessment of Agricultural Science & Technology (IAASTD) report – an ambitious inter-governmental undertaking seeking to bring together Northern and Southern perspectives to drive the agenda for agriculture for the next fifty years. It's clear from this substantive if controversial work by Professor Robert Watson and his team supported by World Bank and UN Food and Agriculture Organisation that business as usual is not an option.

For too long, the emphasis of agricultural science has been on delivering innovation and technologies to increase farm-level productivity. Little attention has been paid to a more holistic integration of natural resource management with food and nutritional security (IAASTD, 2008). Fortunately, there is increasing recognition that this current mode of operation requires revision.

We are beginning to realise that, today, more than ever, we need science and technology systems that enhance sustainability whilst maintaining productivity (Williams and Saunders, 2005). To do this, we desperately need improved understanding of the landscapes in which we farm. We need to better appreciate soil-plant-water dynamics and the agro-ecological function of mosaics of crops and natural habitats.

PRICING FOOD FOR SUSTAINABILITY

Where we do get the science right, organisation capacity and the right policies are still required, otherwise we take two steps forward and one step back.

We need governments to adopt policies that create incentives for sustainable practices and result in costs to the environment being internalised. Traditionally, food prices do not include the cost of environmental damage. The natural resource base (land, water, biodiversity) for agriculture continues to suffer. We can't afford to keep running down the systems that feed us. For as long as the cost of maintaining and improving the natural resource base in agricultural systems is not included in the price of food, farmers will never be able to farm sustainably and profitably. This may mean dearer food, but it will also mean ensuring that we can continue to produce enough food.

We need market and trade policies that remove perverse subsidies. Rewarding the provision of ecosystem services is a good start. We need investment in the economic valuation of ecosystem services. With a market for these services, farmers in the future will not only be paid for the goods they produces but also for the services they deliver through the management of healthy landscapes, rivers, wetlands and estuaries for the public good (Williams & McKenzie, 2008).

Agriculture, by its very nature, exploits the natural resource base. The nutrients in our food were once part of an ecosystem. It doesn't have to be an endless cycle of more and more synthetic inputs to offset ongoing land degradation. The irony is that the break this endless cycle, we need to create another. We need a system that has a closed loop, one that is resilient, that can cope with a certain amount of nutrient harvesting and yet stays healthy. Stepping off the treadmill is hard but it is necessary if we are to have both healthy and productive landscapes. Can we find new and maybe rediscover agroecosystems where nutrient loss beyond that in the food or fibre is zero? Does achieving such agroecosystems mean a lower rate of productivity to close this loop? Is this a measure of the cost of food when the resource base is maintained?

Advances are being made in tapping nutrient sources that do not depend on fossil fuels but there is much more to be done (World Bank, 2007). We need biological substitutes for agrochemicals and biocontrols of current and emerging pests and pathogens. We must address agricultural production as an agro-ecosystem that is part of the larger-scale ecosystem and landscape processes. New crop and forage species that are bred for specific conditions will be important. However, these alone won't be enough. Improved genetics for yield cannot be expressed if nutrient, water and disease are constraints. New industries and land uses are required that can deliver economic as well as ecological benefits. There is a feedback between production and consumption, supply and demand. Addressing economic and market failures goes a long way to redressing the degradation of our agro- ecosystems.

NEW CHALLENGES FOR AGRICULTURAL SCIENCE

Finding solutions to biophysical problems posed by building a resilient agriculture are scientifically demanding. They require new ways of doing science within the imperatives of rural communities facing radical environmental, social and economic changes.

In an industry where inputs are increasingly expensive and climates continually variable, surviving is all about both precision and resilience. There are serious deficiencies and problems with our scientific understanding of the ecology of the rehabilitation process in many ecosystems and the environmental impacts of specific actions on the farm. We can't afford to keep ignoring the need for the research and development of farming systems that integrate productive land uses into the landscape in a way that is compatible with the ecological, hydrological and biogeochemical processes operating there (Williams, 2005).

In early June, a Summit convened by the UN Food and Agriculture Organization made a declaration calling for governments to do more to help the world's smallholder farmers adapt to climate change. In particular, they declared support for "the establishment of agricultural systems and sustainable management practices that positively contribute to the mitigation of climate change and ecological balance".

Investments in publicly funded agricultural research and development in many industrialised countries has stalled or declined and has become a small proportion of total spending on science and technology (IAASTD, 2008). Spending public funds on research that the private sector can undertake profitably, such as developing novel seed varieties, doesn't make sense. Public investments in science to address environmental shortcomings that have ramifications for society at large do.

Agriculture is not just about putting things in the ground and then harvesting them. It is increasingly about the social and environmental variables that will in large part determine the future capacity of agriculture to provide for eight or nine billion people in a manner that is sustainable.

Agriculture is being faced by what may be its greatest challenge yet. In a nutshell, global agricultural production must be increased substantially to meet rising demand, but it must be achieved with a decreasing impact on the natural resources and environment at a time when the cost of energy will continue to rise.

It is possible to create resilient agricultural systems – to have both healthy and productive landscapes. It isn't easy, but it is essential. The present path of agricultural science is unlikely to achieve development goals for global food production and security whilst improving or at least maintaining the condition of the natural resource base and the global environment. But there is a magnificent foundation on which to build and invest in the agricultural science needed to address these pressing issues. We need both reform of agricultural science (Kiers et al., 2008) and a significant increase in national and international investment (Mackenzie, 2008) in new directions for agricultural science.

Now is not the time for Australia to turn its back on the rest of the world (Cribb, 2008) and allow our investment and international commitment in agricultural science to decline further. This country has a tradition of leadership in agricultural science, and has much to contribute to this global problem. The challenge of producing more food by farming without harming the natural resource base and environment in an era of increasingly expensive fertilizer, pesticides and energy coupled with the spectre of climate change is formidable. It is a wake-up call to our civilisation. We must find ways to increase food production and not deliver the natural resources and environment of the planet a period of further increasing damage. We must truly seek out ways to farm without harming.

But will we find ways so that both food and environment win?

REFERENCES

ACIAR, 2008. *Food prices on the rise.* Australian Centre for International Agricultural Research. http://www.aciar.gov.au/node/8549

Cribb, J., 2008. 'CSIRO erodes its own grand place in the world' in *The Canberra Times*, 9 June 2008. http://canberra.yourguide.com.au/news/opinion/editorial/general/csiro-erodes-its-own-grand-place-in-the-world/785452.aspx

IAASTD, 2008. *The International Assessment of Agricultural Knowledge, Science and Technology for Development.* See at http://www.agassessment.org/

Kiers, E. T., Leakey, R. R. B. , Izac, A., Heinemann, J. A., Rosenthal, E., Nathan, E. and Jiggins, J., 2008. 'Agriculture at a Crossroads' in *Science,* Vol 320, 18April 2008, 320-321,

Lewis, L, 2008. 'Scientists warn of lack of vital phosphorus as biofuels raise demand' in *The Times*, 23 June 2008.

Mackenzie, D., 2008. 'World food price crisis blamed on government neglect' in *New Scientist*, 29 April 2008. See http://www.newscientist.com/article.ns?id=dn13801&print=true

Sachs, J. S., 2008. 'How to End the Global Food Shortage' in *TIME Magazine,* Thursday, Apr. 24, 2008 http://www.time.com/time/magazine/article/0,9171,1734834,00.html

von Braun, J., 2007. *The world food situation: new driving forces and required actions.* Food Policy Report. International Food Policy Research Institute. Washington DC.

Williams J., Bordas V., and Gascoigne H., 2004. 'Conserving Land and Water for Society: Global Challenges and Perspectives' in *Proceedings 13th International Soil Conservation Organization Conference,* Brisbane. http://www.icms.com.au/isco2004/

Williams, J. and Saunders, D.A., 2005. 'Land Use and Natural Ecosystems' in *Search for Sustainability* (Eds J.Goldie, Bob Douglas & Bryan Furnass), CSIRO Publishing, Melbourne, 2005. See http://www.publish.csiro.au/nid/20/pid/4790.htm

Williams, J., 2005. *Sustainable Agriculture in Australia: some ways forward.* The Farrer Memorial Oration for 2005, Farrer Memorial Trust, Annual Report 2005, May 2006, Sydney, Australia,pp11-25. See: http://www.wentworthgroup.org/docs/Farrer_Oration_JWilliams.pdf

Williams, J. and McKenzie, F., (in press). 'Agriculture' in *10 Commitments: Reshaping the Lucky Country's Environment.* Lindenmayer, D.B., Dovers, S., Hariss Olsen and Morton, S. (eds). CSIRO Publishing, Melbourne.

World Bank, 2007. *Agriculture for Development: World Development Report 2008.* The International Bank for Reconstruction and Development / The World Bank. Washington DC.