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The future of agriculture – a dependence on science

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Agriculture is a vital sector for Australia and occupies a significant place in global agricultural trade. Agricultural production accounts for a modest 4% of Australia's gross domestic product, but farm outputs underpin the food processing and service sectors, which represent about 20% of GDP.

Around 64% of agricultural production is exported and this accounts for about 20% of Australia's merchandise exports. In 2005, agrifood exports were worth almost $24 billion, while food imports were $6.5 billion – a significant trade surplus. Agricultural export industries have continued to hold their own against highly subsidised international competitors and, in the face of emerging lower cost competitors, have successfully countered the continuing decline in terms of trade.

The agrifood industries are significant employers. Overall, approximately 4% of Australia's population is employed in the agricultural, fisheries and forestry industries. Food manufacturing, which is Australia's largest manufacturing enterprise, employs some 15% of all workers in manufacturing industries.

So where is our agribusiness heading and what is the role of science in the future Australian agriculture industry?

Agricultural productivity levels have been steadily increasing over the last three decades averaging approximately 3% increase per annum. (water permitting). Much of this growth has been achieved because Australian producers have a strong innovation culture. They are very receptive to new findings of research and this is especially the case in areas such as: enhanced plant and animal breeding techniques; improved management of the production enterprises; adoption of sustainable production practices; and improvements in handling, storage and distribution systems.

The agricultural sector has one of the highest degrees of connectivity between industry practitioners and researchers engaged in increasing the knowledge base, both in the solution of problems and in the provision of new opportunities.

Today's agriculture is a high-tech, market-responsive business, but it certainly cannot stand still. It is important for Australia that we maintain a competitive edge against countries which are investing heavily in their agribusiness systems; for example Canada, the US, Brazil, Argentina and several European countries. Many of these, because of their research investment opening up new opportunities, will be even more vigorous competitors to Australian agriculture than they have been in the past.

As well as being dependent on effective market information and performance, agricultural success depends on the interaction of three major components at the production level. At the farm level it depends on the genetic makeup of the production organisms, the management skills of the producers themselves and on environmental issues, primarily climate, soil and water.

Climate change is something that agriculture needs to address in a serious way and plan for the future. I think it is generally recognised now that average temperatures are rising and this will affect different regions in Australia differentially. You have probably seen in recent media coverage that agricultural industries should consider moving northward as rainfall reduces somewhat in the southern parts of Australia, both east and west. We need to look at regional climate predictions in detail. We will have much more information on this in the coming year. The international body considering climate change will be reporting early next year and then Australian information on regional expectations will be available at a far more detailed predictive level than we have had in the past.

In regard to the simplistic notion of moving agriculture north, there are a few things I'd like to say. First of all, one of our major crops, cotton, can fit into a more tropical production region. Over the last several years, researchers have developed a very satisfactory management system for a cotton industry in northern Australia. The new system differs markedly from that which was employed in the failure of cotton in the Ord in the late 1960s to early 1970s.

Cotton would now be grown in the dry season, not the wet season; irrigation and fertilisation systems have been worked out. We have the advantage of insect and weed protection systems built into the modern transgenic varieties. Good yields and quality can be achieved. The major blocks are the lack of infrastructure and the difficulties surrounding land rights. These issues can be overcome and Australia has the potential to develop a significant new area of cotton production in northern Western Australia, the Northern Territory and Queensland. Why aren't we moving on this?

For other crops from the more temperate regions, such as wheat and canola, research is needed to explore the temperature limitation thresholds and the thresholds for other environmental factors for any projected move northwards.

Recently I heard of the development of a sugar beet variety which could be grown successfully in tropical areas; this has been trialled extensively in India. I wouldn't like to say for any of our crops that the climate and environmental limitations have been fully explored. We need to initiate a focused research effort to define the potential of different crops – some will have biotic and abiotic limitations and most will have reduced yield potential relative to those applying to the temperate regions. There are not large areas available so the crops would necessarily be of high value.

Another approach is to adapt our various crop species to the changing situations in the regions where they are currently growing. There's a good deal of flexibility in the development of new tolerances to water and climate challenges, especially as a result of new knowledge of the developmental and functional performance of plants, which has been derived from the new biology in the last decade. Ingenuity and management creativity of the farmer will also play a large role – already the plantings of water efficient crops such as sorghum are increasing.

Plant breeding has traditionally made great use of genetic variation from wild populations of crop species and from the wild relatives and progenitors of crop species. This has been particularly important in the acquisition of genes providing resistance to pests and pathogens in many crops. The new DNA technologies and knowledge of genome compositions promise us much greater access to the extensive ranges of natural variation which exist. It is likely that the genetic composition of our production species will be able to be adjusted to cope with the challenges presented by changing climate.

In most crops, and it is much the same in animal agriculture, the improvements in yield and value over the years mostly are 50% due to improved genetics and 50% due to improved management. Management improvements have depended on the greater capacities for researchers to transfer information to farmers. The deployment of decision support systems which provide an optimisation of research information in a convenient way have been important.

My prediction is that the genetic component of improvement in yield and value will dominate over management in the next few years. Let me give you a couple of reasons why.

We are entering an era where agriculture and the production of food can be expected to be an important component of public health and preventative medicine. The new biology, as it translates into the new agriculture, can provide us with the means of contributing to the health condition of populations both in developing countries and in developed countries such as Australia.

One of the major public health concerns in developing and developed countries is diabetes II. This is a major threatening epidemic of this 21st century. It's already increasing rapidly in frequency in India, Bangladesh and some African countries as well as in the United States and Australia. It is a major problem in the Oceanic and Pacific regions.

The conservative expectations suggest that by 2025 there will be well over three hundred million cases of diabetes II and when you add on the pre-diabetic conditions, we're talking about a billion people.

This particular health problem leads to a debilitation in the general economic potential of a country since many of the sufferers are in their prime working age. It's a very serious problem.

So how can agriculture help? One of the main diet causes of diabetes II is the consumption of high glycemic index carbohydrates. Rice is a good example. It's the staple food of approximately more than a third of the people in the world and these people suffer from a number of nutritional deficiencies. You are probably aware of the vitamin A deficiency and the iron deficiency of people eating rice as a staple food. Both of those diseases are being tackled by genetic modifications to rice which should provide a sufficient level of vitamin A precursors and bio-available iron in the grain. In addition, the main cause of the high glycemic indices of rice grain is the nature of the starch. We now know a lot about the biosynthesis of the starch, and we can predict and select for changes in starch structure and composition such that a low glycemic index is achieved.

Starch can also be adjusted to provide a higher proportion of resistant starch molecules – this has positive influences on the health of the colon. Colonic cancers are another of the advancing diseases of our society. These modifications in cereal grains, in wheat, maize, and barley, as well as in rice, will deliver huge benefits to large numbers of the world's population and will provide large reductions in the burgeoning health expenditures in many countries.

There are other shortfalls in many of the cereal grains such as level and composition of protein. Breeders have been able to make some nutrition adjustments; maize is probably the best example of enhanced protein value but it's the new tools of genomics, proteomics and metabolomics that are providing us with the ability to adjust grain makeup so that it's optimised to human nutritional requirements.

In telling you about this is I have implied that we will be using genetic modification technologies to ask questions and define what needs to be done and how it might be achieved. True. But in many cases once this is done in the laboratory we will produce sophisticated diagnostics which will enable the new objective of high nutritional value to be achieved with non GM technologies - conventional breeding technologies. I don't think this is widely realised. I believe it will be of great value in our future agriculture.

Some adjustments that we should make will require GM technologies, so I don't want to minimise the necessity for our society to realise the great benefits that can be achieved with GM crops and food. Unfortunately, much of the disquiet around GM crops in Australia and elsewhere results from misinformation and the failure of decision makers in agriculture and politics to realise that the benefits vastly outweigh the risks, which for the most part have been proposed without any justification.

There are other opportunities for future agriculture. There has been a lot of recent discussion around biofuels. These will certainly add a new facet to agricultural production, although in my view they will be relatively minor, local area contributors in the energy production portfolios of the country.

Plant systems will also be used for the production of valuable pharmaceuticals and industrial proteins. They will certainly be of high value, but they won't involve large production areas.

So modern agribusiness and plant biotechnology are at an interesting impasse. We have an embarrassment of technological wealth for increased profits and for social and ecological benefits, but we do not have general societal acceptance.

It is hard to find good scientific reasons why GM technology has not been universally embraced. The widely publicised objections of damage to human health through allergens or of damage to the environment have been soundly rebutted and relegated to the status of urban myths by careful experimentation. All of the products from the transgenic crops which now are grown, over 90 million hectares across the world, have not caused any human health problems or any environmental or ecosystem problems. On the contrary, all the data suggest that the new agriculture is changing agricultural production systems for the better, both in developed countries and in countries where agriculture is operated at a sustenance level.

So why do we only have one transgenic crop in Australia at the moment? Well I think the reasons extend beyond the science. Certainly science practitioners may not have done a good enough job in explaining what they are doing, why they are doing it. We have failed to get across a general level of understanding that the risks have been assessed by the regulatory bodies and found to be negligible and that there are great benefits. This will become more obvious when the benefits apply to the consumer rather than just to producers and the environment.

Another important reason why transgenic cotton was accepted and transgenic canola wasn't is that communication about new developments must be co-managed with the scientific progress. The cotton industry has better cohesion than the oilseed or wheat and barley industries. It is up to organisations such as your own to be more proactive and to be involved in a partnership mode in the major research programmes directed towards our agriculture.

We've had wonderful support for research in Australia from the agricultural sector and there's wonderful acceptance of new findings from research.

But we need to increase the integrated involvement of the industry at all levels of the business chain with the research community.

One criticism I have of the otherwise successful R&D corporations and their role in supporting research relates to the end-point decisions on competitive research grants. It's been my impression that these decisions are resting increasingly heavily on decision-making processes which over-emphasise the opinions of the agricultural practitioners. Please don't get me wrong, one of the strengths of the R&D corporations and their boards is the participation of farmers and researchers in the boards. But hopefully, the researchers are the people who should have the final decision about which projects have the priority for support. You can't expect researchers to be able to tell farmers how to do their business on the farm and I think that the reverse is something that needs to be remembered as well. The interaction of farmers and researchers is critically important in planning and policymaking, but somehow I believe we've gone a little too far in ensuring that farmers have their say on which research proposals deserve to be funded.