The global agricultural surplus and the case for non-food crops

John Bartle Department of Environment and Conservation and Future Farm Industries CRC. Based on an article submitted to Global Farmer http://www.globalfarmer.com.au/

I recently did a straw poll amongst colleagues to test perceptions about the medium term outlook for agriculture. I did this after having read FAO's perspective on agriculture to 2050 (FAO 2003, 2006a). FAO indicates continuing weakness in the terms of trade for agricultural products and this seemed to be in contrast to the relatively optimistic outlook most of my colleagues expressed about technological advance and the potential for Australian farmers to remain competitive. Furthermore, both of these positions sit uncomfortably with the common perception that food supply remains a factor in combating the problem of global hunger.

Overly optimistic or pessimistic perceptions about future agricultural economic conditions, perhaps more than ever before, could result in misguided global policy settings and substantial under-utilisation of global agricultural lands. I aim here to present a balanced overview of projections for the future of agriculture and demonstrate that there appears to be potential to divert some agricultural land into non-food crops.

To set the scene to discuss these issues lets look at what happened in global agriculture in the period 1960 to 2000.

1. World population doubled from 3 billion to 6 billion. The population growth rate peaked in the 1960s at over 2% and declined to 1.35% by 2000.
2. There was a very strong increase in food commodity supply. The extra 3 billion people were not only fed, but global food production per person increased more than 20% and in developing nations by more than 50% per person. The average calorific intake in food deficient regions increased 31%, although hunger hot spots affecting some 10% of the global population remain. Global consumption of meat (on a per person basis) more than doubled.
3. In 2000 food commodities sold for less than 35% of what they did in 1960. This is part of a much longer term real price decline for food evident in an index constructed for wheat that shows a 90% decline from 1800 to 2000 (Lomborg, 2001).
4. Some 80% of the extra food came from improvement in the intensity (multiple annual crops) and productivity of agriculture, and only 20% came from the development of new land.
5. Europe and the U.S. were forced to 'set aside' up to 20% of their agricultural land to avoid surpluses that might have been difficult to quit on world markets.
6. In the final decade of this period the clearing rate of native forests (for food production and infrastructure) was 13 million ha/year but, corrected for the area of reforestation (for plantations, conservation and natural regeneration), the net conversion was 8.9 million ha/year or about 0.2%/year of the more than 3.9 billion ha of global forests (FAO 2006b).
7. The diversion of food crops to industrial use grew rapidly from a small base, most notably the production of ethanol from sugar cane in Brazil and industrial starch products from maize in U.S.

Looking forward into the new century FAO (2006a) predicts that population growth rate will continue to decline to 1.1% by 2015, 0.7% by 2030 and 0.3% by 2050. Global population will reach 8.9 billion by 2050 and peak at 9.2 billion in 2075, taking about double the time to add the next 3 billion increment as it took to add the previous 3 billion.

So growth in demand for food is declining and may disappear or reverse within a couple of generations. Producing a supply of food for the additional 3 billion, over double the time period as for the last 3 billion, and from the existing area of agricultural land, appears to provide only a modest challenge to the science of agriculture. Indeed it appears likely that a substantial global surplus of land for food production may emerge well before population commences to decline.

This scenario seems to present considerable risk to Australian farmers. It will tighten global competition in commodity food markets and decline in the terms of trade will accelerate. This would inflict particular pain on Australian farmers because our comparatively poor agricultural environment will mean that we cannot benefit from the advances in agricultural productivity to the same extent as our competitors. This suggests a need for radical change by Australian farmers over the next couple of decades.

So lets us look more closely at this future scenario. Many global scale projections of future agricultural land use are available. Here Hoogwijk et al (2003 and 2005) are used because they deal coherently with the combined impacts of new agricultural technologies changing diets and population growth projected to 2050 against a bioenergy background (see Table 1 below). Note that in this analysis:

- the most recent FAO population projections sit between low and medium levels.
- the diets are in 'grain equivalents' in kg/day with moderate (2.4), vegetarian (1.3) and affluent (4.2)
- the agricultural systems are intensive (best technologies available) and low input (organic systems with no chemical fertilizer or pesticides).
- the projections assume universal adoption of the specified diets and intensities of agriculture by the whole global population and food production land area of 5 billion ha (1.5 billion ha mainly cropped plus 3.5 billion ha mainly grazed). They exclude food production from the global forest area of nearly 3.9 billion ha (even though some 0.5 billion people live within forests).

Table 1: Projected percentage of global agricultural land surplus to food production in 2050 using a food security factor of 2 (ratio of production to consumption to account for supply chain losses) for three diets, three population projections and two intensity levels for agricultural practice (adapted from Hoogwijk et al 2003).

Type of diet	Vegetarian			Moderate			Affluent		
Population growth rate	Low	Med	high	low	med	high	low	med	high
Intensive agriculture	74	72	66	52	48	38	16	9	3
Low input agriculture	26	20	3	0	0	0	0	0	0

Table 1 says that we would all need to become vegetarians if we wish to conduct agriculture at the low intensity level defined by Hoogwijk et al (2003). On the other hand, if we are to aspire to an affluent diet we could accommodate it on the existing area of agricultural land, but only if we universally adopt intensive agricultural technologies. However, the forces of global economic competition and issues to do with human health and environmental sustainability (amongst other things!) are likely to push us into adopting moderate diets and the best of technology. In this case the very striking consequence is that it will only require about half of the current area of agricultural land for food production.

Of course there will not be any future actual surplus of agricultural land. Universal adoption of moderate diets and intensive agriculture is unlikely to occur. Also, as the terms of trade for food products declines, alternative enterprises will emerge. The most likely large scale use for surplus agricultural land will be to produce feedstocks for industrial products and bioenergy. The attraction of industrial commodities is that demand is linked to economic growth (~4% projected to 2012, ABARE 2007) whereas food demand is constrained by population growth (<1.3% over the same period and declining). There is rapidly emerging interest in bioenergy (FAO, 2006a). This is now apparent in global and US grain markets with a recent sharp lift in prices due to diversion of grain into ethanol production, especially in the US. Set-aside land in the US corn-belt is now being withdrawn to go back into production.

Hoogwijk et al (2003) showed that if 50% of world agricultural land was diverted into growing crops to produce biomass for energy (i.e. bioenergy) this could provide more than double the current world primary energy consumption from all sources. Even with only a moderate surplus of agricultural land it seems likely that globally significant bioenergy industries could develop - without infringing on the prerogative of food. This possibility seems to be commonly overlooked by policy-makers world wide and in Australia.

Within this global context Australian farmers have the potential to become substantial producers of industrial and bioenergy feedstocks. However, this potential is poorly recognised even though there are important national issues at stake including:

- large scale economic diversification of agriculture to provide some respite for farmers from persistent decline in the terms of trade in food products;

- introduction of a range of perennial woody crops that would complement conventional annual crops and bring better environmental performance to agricultural systems;
- agricultural systems with considerable potential for carbon sequestration and reduced carbon emissions;
- creation of a new class of processing industries that incorporate integrated harvest and processing to fully utilise feedstocks through multiple product industries, e.g. a single harvest of whole crop biomass with the wood fraction going to higher value manufactured products and the leaf and twig residue for bioenergy (Bartle 2006);
- the new woody crops all require local value adding for viable export products thus locking in regional economic development;
- regional and national energy security.

The risk is that Australian farmers might be tempted to settle for a brief period of improved gain prices driven by the rapid escalation in grain ethanol production. In this pursuit they may miss the parallel opportunity to be building a more viable long term component to their bioenergy options. The problem is that grain does not have a very attractive energy ratio, i.e. the ratio of energy content in the grain to energy input to growing that grain. This ratio is less than 10 for grains whereas Wu et al (2006) showed that for a perennial woody crop like mallee the ratio was greater than 40. As the competition in energy markets intensifies the advantage of the system producing four times the energy product for the same energy cost will be irresistible. The only impediment is that the technologies for conversion of woody biomass (consisting of cellulose, hemicellulose and lignin, commonly called ligno-cellulosic or just cellulosic biomass) to biofuels are not yet commercially well established. But the momentum is gathering rapidly (Regauskas 2006, Schubert 2006). Too large an investment in grain ethanol may be short sighted! In its review of biofuels options Single Vision Grains Australia (2006) strongly supported 'second generation' cellulosic ethanol development in the medium term.

The opportunity for Australian farmers is that given their propensity for rapid adoption of new technology they could become world leaders in developing new woody crops, the new sustainable agricultural systems incorporating these crops and in the industries that process them. The new Future Farm Industries CRC will have a program dedicated to facilitating the emergence of these new non-food crops and industries.

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