Food versus energy: Crops for energy

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Abstract

The global production and use of biofuels have increased dramatically in the past few years due to volatile and increasing oil prices, and environmental concerns. The main feedstocks for ethanol are sugarcane, maize and, to a lesser extent, wheat, sugarbeet and cassava. Biodiesel oil-producing crops include rapeseed and oil palm. All divert land away from food production to energy production. This has in turn triggered the food versus energy debate, with several studies attributing the rising food prices to the feedstock diversion to biofuels, hurting poor consumers and net food-importing countries. To overcome the food–fuel trade-off several countries are promoting feedstocks that can grow on marginal lands and hence do not compete with food production. At ICRISAT we launched a global pro-poor 'BioPower Initiative' focusing on biomass sources and approaches that do not compete with, but rather enhance food and nutritional security. Sweet sorghum is one such 'smart' multipurpose crop that does not compromise on food security while producing energy. The grain is used for food and the stalk is used for juice extraction for bioethanol. It is encouraging that the Western Australian Government in partnership with Kimberley Agricultural Investments has plans to grow sweet sorghum on 13,400 hectares of land for processing into bioethanol. Further, the use of sweet sorghum in existing sugar mills as biofuel feedstock provides a win–win situation for both farmers and industry. Data from India, the Philippines, China and Brazil indicate that sweet sorghum is an economically viable, socially equitable, environmentally sustainable and resilient smart crop.

This paper is about food versus energy, highlighting potential crops for energy without compromising food security. The context is the challenge of providing for almost 9 billion people by the year 2050, and producing 60% more food, 50% more energy and 50% more water than today.

ICRISAT and its work

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is one of the 15 centres of CGIAR. The centres' work is supported by funds from development investors brought together by the CGIAR Fund Council. ICRISAT focuses its work in dryland tropics of Asia and sub-Saharan Africa, and our vision is for the dryland tropics to be prosperous, food secure and resilient.

ICRISAT and the Crawford Fund have shared goals and responsibility to feed the world. We started an Ambassador program in ICRISAT last year, and we are very pleased to have Hon John Kerin AM, Chair of the Crawford Fund, as an ICRISAT Ambassador of Goodwill. John Kerin will be highlighting the work of ICRISAT that focuses on the poor and the smallholder farmers of developing countries.

The headquarters of ICRISAT are in India, and we have eight locations in sub-Saharan Africa, including two regional hubs. We work to improve sorghum, pearl millet, chickpea, pigeon pea and groundnut or peanut, and as several of these crops are also important to Australia we are collaborating with a number of universities in this country. ICRISAT has benefited from the strong support of the Australian Centre for International Agricultural Research (ACIAR) for many years. They have championed our work on crops research, particularly on dryland cereals and grain legumes production.

These crops are grown not just for food security but also because they are highly nutritious. ICRISAT has begun a Smart Foods campaign to highlight the nutritional value of the crops we are mandated to improve. One example that we are promoting around the world including in Australia is 'Smart Brkfast', a single serve ready-to-eat breakfast cereal made from sorghum and pearl millet flakes. We are developing crops that are not only drought tolerant but also environmentally sustainable and highly nutritious. We are aiming for a food system that provides carbohydrates and also a balanced diet of proteins, minerals, vitamins and essential fats, wherever possible.

Our major responsibility is strategic research, and we have developed a new strategic research framework that we call 'Inclusive Market-Oriented Development' or IMOD (Figure 1). It has three components. The most important is the harnessing of markets. You may know that most smallholder farmers in the dryland tropics are trapped in poverty: 60% or 70% of them are at subsistence level. In the long term we want them to have better access to markets, such as through links to existing markets or new markets, or by helping these farmers become entrepreneurs.

The second aspect of smallholder agriculture in the dryland tropics is risk management (see Figure 1). Smallholders face risks from factors such as droughts, poor soils and weak institutional arrangements, so it is necessary to set up 'safety nets' for them. Over time we help smallholder farmers build resilience so they are able to cope with these challenges.

The third component is the engine of growth, the technologies or innovations that fuel development (see Figure 1). As subsistence farmers become self-sufficient, and then move from self-sufficiency to dealing with a market economy, they need this engine of growth through innovation so that they can reinvest gains from farming.

Biofuels

Turning to biofuels and why they matter, we need to promote biofuels to reduce greenhouse gas emissions, mitigate climate change, improve energy security, and reduce dependence on oil imports. At present, fossil fuels provide

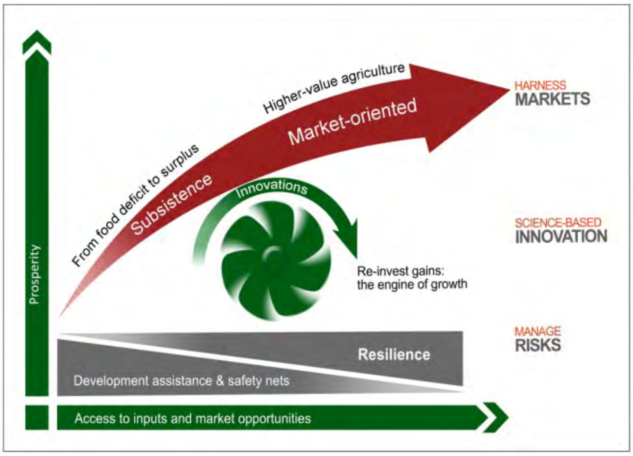

Figure 1. ICRISAT's Inclusive Market-Oriented Development (IMOD) framework.

95% of the energy used in the transport sector globally, but price volatility in fossil fuels has jeopardised the economies of many developing nations in the recent past. In contrast, a biofuel industry offers immense employment opportunities and can enhance the livelihoods of poor and small farmers in developing countries.

The major biofuel feedstocks include corn, sugarcane, sugar beet, cassava (Figure 2) and newly emerging crops such as sweet sorghum which ICRISAT started to develop and promote as early as six years ago.

Compare the use of United States corn and Brazilian sugarcane as feedstocks, in relation to food prices (Figure 3). In less than one decade world biofuel production has increased by a factor of five, from less than 20 billion litres per year in 2001, to over 100 billion litres per year in 2011 (Bastianin *et al.* 2013). The biofuel and food price debate is long standing and controversial, with wide ranging views. The relative strengths of these positive and negative impacts differ

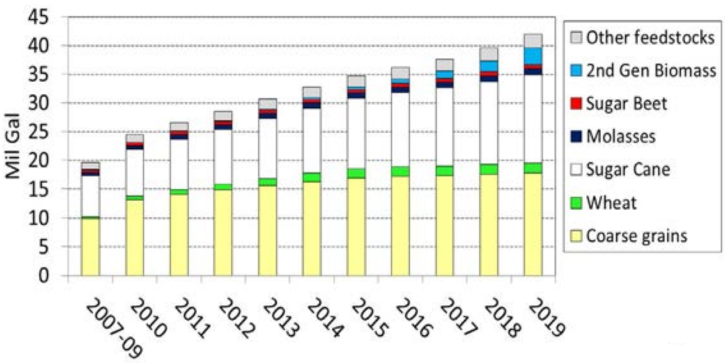

Figure 2. Major biofuel feedstocks for ethanol production. Source: OECD/FAO.

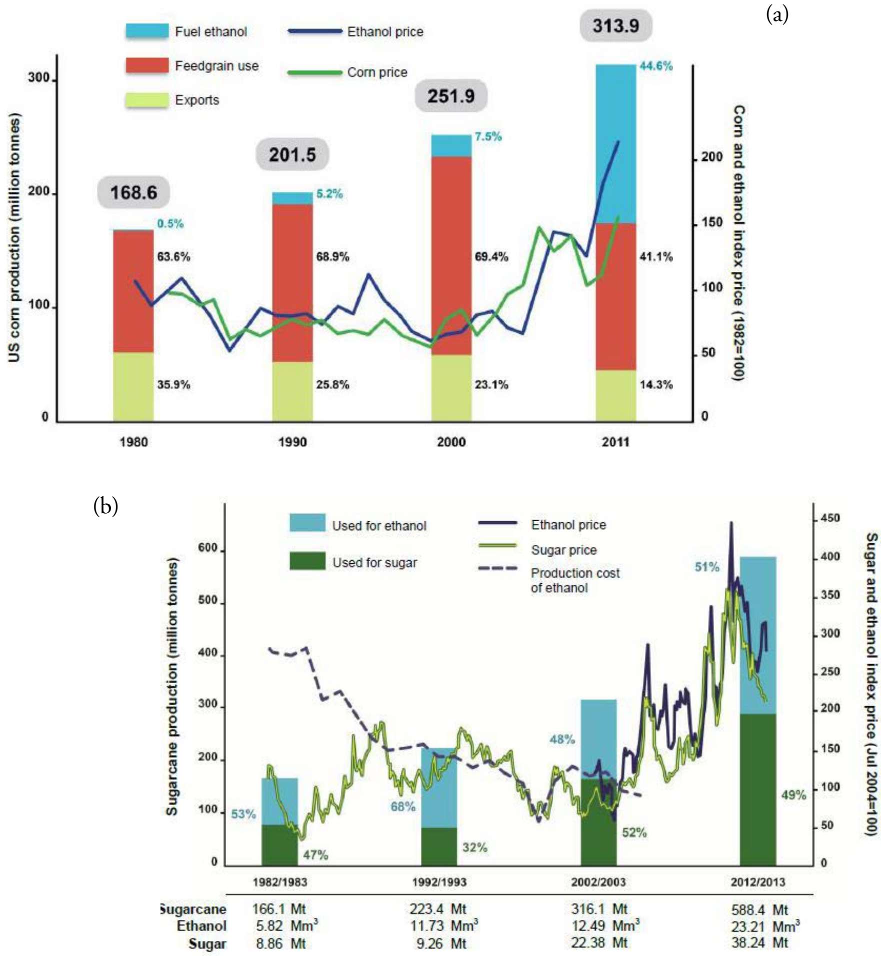

Figure 3. US corn and Brazilian sugarcane vs food prices. Source: Bastianin *et al.* 2013.
(a) Biofuel demand affects food commodity prices: blue line = fuel ethanol price; blue bar = corn (megatonnes) used in fuel ethanol; green line = corn price; brown bar = corn (megatonnes) used as feed grain.
(b) Biofuel demand has a moderate effect on sugar prices: blue line = ethanol price; blue bar = sugarcane (megatonnes) used for ethanol; green line = sugar price; green bar = sugarcane used for sugar.

between the short term and the long term. Diversion of corn to ethanol in the United States, which produces 4% ethanol, has played a significant role in the price rise.

By comparison, sugarcane use in Brazil has a moderate effect on the sugar price. Similarly palm oil used for biodiesel production is a concern for vegetable oil importing nations, such as India, China and the European Union.

Biofuel production competes for land with other agricultural activities, hence both direct and indirect land use change have significant impact on the food system. It is estimated that with the current technology 2–3% of global arable land is required to produce 100 billion litres of biofuel, but the land needed for dedicated biofuel production varies widely from region to region. For example, 3% of cropland is required in Brazil, while 72% of cropland is required in the European Union to implement a 10% biofuel-blending program. We need to pursue complementary land use arrangements to meet food and energy security.

Ethical principles of biofuel development

The ethical framework for biofuel development must consider the following principles:

- should be environmentally sustainable;
- should contribute to a net reduction of greenhouse gas emissions and mitigate global climate change;
- development should not be at the expense of people's essential rights;
- the biofuel value chain should invariably involve women farmers and smallholder farmers, who form the majority in many developing countries; and
- biofuel development should be in accordance with trade principles that are fair and just, including labour rights concerns.

Australia is the world's 9th largest energy producer but the 17th largest consumer of renewable energy. The Australian energy portfolio comprises 96% fossil fuels and 4% renewables – a biofuel : gas ratio of 0.4% (Figure 4). The bioethanol production capacity is 440 million litres using feedstocks such as wheat flour, red sorghum and sugarcane, and 350 million litres of biodiesel were produced in the last year from used cooking oil; that is, used canola, poppy and vegetable oil.

Australia's biofuel production facilities are concentrated in New South Wales, Queensland and Tasmania, with isolated facilities in Western Australia. The Australian Government's Clean Energy Future Plan has committed $17 billion

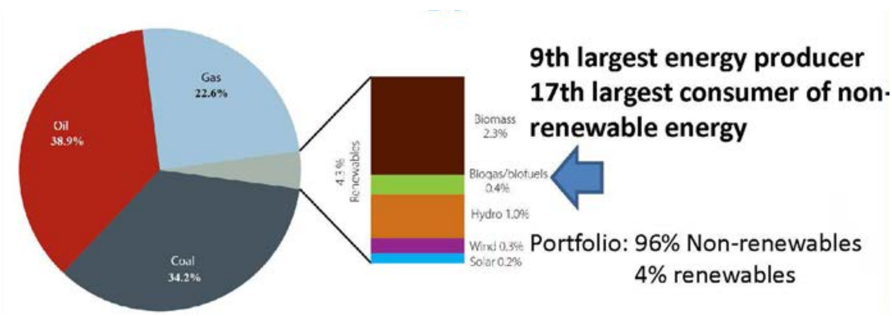

Figure 4. Only 4.3% (pale grey sector in pie) of Australia's energy use comes from renewable sources: 2.3% biomass, 1.0% hydro, 0.3% wind, 0.2% solar and 0.4% biogas and biofuels. Source: 2013 Australian Energy Statistics.

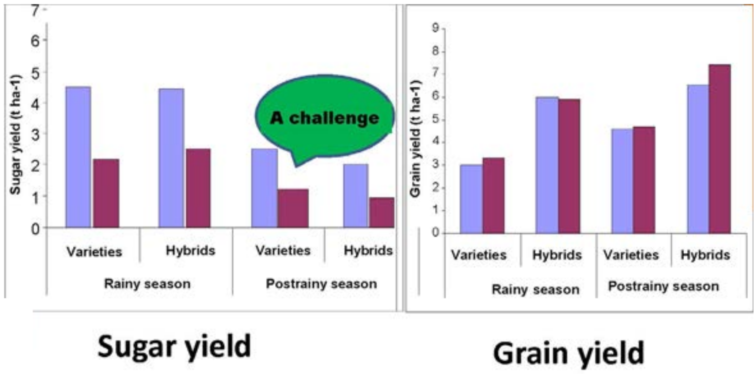

Figure 5. Results of ICRISAT sweet sorghum trials, 2011–13. Blue bars = sweet sorghum; purple bars = grain sorghum. Source: Rao and Kumar 2013.

over the next 10 years to research for development of clean technology, including $20 million for advanced biofuels. The New South Wales State Government has increased its mandate for ethanol inclusion to 6%. The Queensland Alliance for Agriculture and Food Innovation is working on sugarcane, eucalyptus, pongamia and sorghum, and in Western Australia more than 13,000 hectares of land in the Ord River area has been identified to commercially grow sorghum for biofuel production.

ICRISAT has a pro-poor BioPower Initiative, focusing on yields of biomass, juice and grain. It enables the dryland poor to benefit from emerging bioenergy opportunities, with larger smallholder incomes. Also, for the last six or seven years we have been developing and promoting the potential of sweet sorghum for use in bioethanol. Areas where water is availabile can produce three crops per year because sweet sorghum matures in 120 days. Sweet sorghum as feedstock has the potential to provide food–feed–energy security in the world's semi-arid tropics. Researchers at ICRISAT compared the grain and sugar yields of improved grain sorghum and sweet sorghum varieties in the rainy and post-rainy seasons during 2011–13. In general, sweet sorghum out-yielded grain sorghum in sugar content in both seasons without compromise on grain production (Figure 5).

In developing nations, ICRISAT has found that biofuel production is profitable when subsidies on fossil fuels are low to medium. Low feedstock prices are important in the overall cost of biofuels. Studies in India, China and Brazil show that using the whole sweet sorghum plant as well as the by-products of processing leads to positive economic and environmental results.

Several cases provide proof of concept for sweet sorghum and opportunities for partnerships for the poor. For example, ICRISAT's Agri-Business Incubation program has helped Mr Palaniswamy in India to set up a sweet-sorghum-based ethanol production centre, Rusni Distilleries Pty Ltd. Chinese industry has successfully experimented with sweet sorghum, and Bapamin Enterprises in the Philippines are pioneering by-product utilisation. Demonstrations conducted

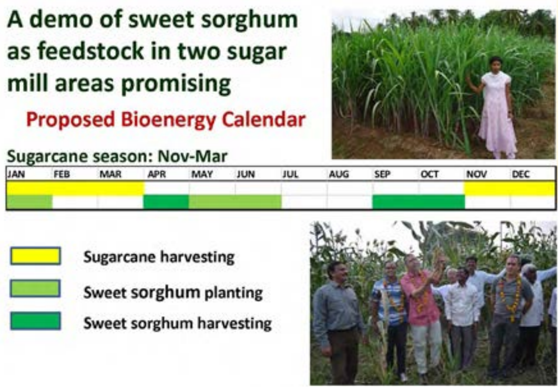

Figure 6. In India a practical approach has been developed, integrating sweet sorghum and sugarcane cropping.

by ICRISAT in partnership with sugarmills in southern India suggest that sweet sorghum may be grown in rotation with sugarcane crops (Figure 6). These collaborations are developing the science and technology needed to produce both feedstock and biofuel products from sweet sorghum, and promote its potential.

Summary

In summary, ICRISAT, in pursuing various forms of biofuel production, takes the view that food security is paramount. We need to balance food security and energy security to mitigate food price volatility. We know that biofuel development offers both opportunities and risks, which we must take advantage of and manage well. We believe sweet sorghum is an emerging and competitive feedstock for bioethanol production that does not compromise food security and feed security. We believe that the right policy environment and support, with significant investments in research for development, are critical in biofuel development. And in pursuit of energy security that does not compromise food security it is essential to ensure the participation and engagement of smallholder farmers, including women and youth.

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William Dollente Dar PhD was the Director General of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), from 2000 to December 2014. ICRISAT is a non-profit, non-political and pro-poor institute and a member of the CGIAR Consortium. Dr Dar was Chair of the Committee on Science and Technology of the United Nations Convention to Combat Desertification from 2007 to 2009. He was also a Member of the UN Millennium Task Force on Hunger. Prior to joining ICRISAT he served as Presidential Adviser for Rural Development, and Secretary of Agriculture in the Philippines (equivalent to Minister of Agriculture). Before this, he was Executive Director of the Philippine Council for Agriculture, Forestry, and Natural Resources Research and Development and Director of the Bureau of Agricultural Research of the Philippine Department of Agriculture. Dr Dar served on the governing boards of the Australian Centre for International Agricultural Research and the CGIAR International Maize and Wheat Improvement Center as well as of ICRISAT. He was Chair of the Asia–Pacific Association of Agricultural Research Institutions and the Coarse Grains, Pulses Research and Training Center based in Indonesia. Dr Dar received a PhD in Horticulture from the University of the Philippines Los Baños and an MS (Agronomy) and BS in Agricultural Education from Benguet State University (BSU) in La Trinidad, Benguet, Philippines. He taught at BSU for 11 years, becoming a Professor and the Vice President for Research and Extension.