World Renewable Energy Congress, WREC 13, London, 4-8 August 2014

Biofuels and Food Security: Biting off more than we can chew?

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Abstract

This paper examines the demonization of biofuels in relation to food security and assess whether or not the negativity towards biofuels is justified. We first examine the concept of food security which has been a concern long before the emergence of biofuels. We show that creating food security is more than producing a 'sufficient' volume of food instead that it depends on complex, context dependent, social, economic, political and ecological factors in which growing biofuels. Indeed biofuels is only one of the influencing factors. We would suggest that too much focus on growing biofuels as the identified problem detracts from the underlying causes of food insecurity and hunger.

We do recognise that there are a number of real concerns about biofuels not only related to food security, for example, conditions of employment and displacement of rural people which can occur when biofuels crops are grown on large plantations. However, we would stress that this is nothing specifically linked to biofuels but more general issues related to economic develop. Biofuels can be a threat to food security through the LUCs when 'waste land' is used by outsiders for biofuel crops. Land that is not currently producing commercial crops is a source of food for the rural poor, particularly the landless. Growing biofuels by smallholders also provides income generating opportunities, so biofuels become part of the solution to food security provided the terms of incorporation into biofuel value chains are favourable particularly for women who are more likely to spend any income on food.

In order to avoid food-biofuel conflicts the Food and Agricultural Organization of the United Nations (FAO) as part of the Bioenergy and Food Security (BEFS) project has developed an assessment methodology when evaluating the potential for bioenergy development. The paper will present initial results from applying the Rapid Appraisal Tool in the context of Bolivia and Taiwan.

Introduction

World production of liquid biofuels has been growing steadily for the last 15 years, increasing from 16 billion litres in 2000 to more than 100 billion litres in 2011. Biofuels are an ideal alternative to liquid petroleum fuels since the fuel characteristics are similar so they can be used in existing engines with little modification as well as integrating into existing petroleum fuel distribution systems with minimum disruption. In 2011, biofuels provided around 3% of total road transport fuel globally (on an energy basis) and considerably higher shares are achieved in certain countries. Brazil, for instance, about 23% of its road transport fuel demand in 2009 was met with biofuels. In the United States, the share was 4% of road transport fuel and in the European Union (EU) around 3% in 2008 (International Energy Agency, 2011).

For governments biofuels offers an opportunity for diversification within the energy supply mix as well as improving energy security and reducing vulnerability to oil price shocks. There are other benefits such as providing a boost to rural areas by producing for new markets not only stimulating economic growth but also helping combat rural poverty. An estimated seventy-five per cent of the world's poor rely on agriculture for their living (FAO, 2008a). Growing biofuels to displace fossil fuels also allows governments to reach climate change commitments. However, whether biofuels actually reduce GHG emissions has been challenged (see for example, (Searchinger, 2009); (Lapola et al., 2010)). The values obtained depend on the feedstock, technology considered and boundary conditions assumed (UNEP, 2009). Other criticisms have included the environmental impacts, (such as water use and pollution) and social impacts (such as land rights conflicts) (Raswant et al., 2008) and the impacts on biodiversity. There have also been doubts expressed as to whether or not, with the current level of technology, that biofuels can be economically competitive with fossil fuels and other alternatives such as oil from tar sands (Doornbosch and Steenblik 2007). However, probably the most widely voiced concern in relation to biofuels is the *food versus fuel* issue. The concern is that first generation biofuels (ie those made from plants currently grown as food crops) compete with and displace food crops from high grade agricultural land which leads to reduced food availability and increases in food prices. An increase in food prices can have a dramatic effect on food access particularly for the poor (UN-Energy, 2007). An additional concern is related to the water demand of biofuels which could put the feedstock crops in competition with households, livestock and food crops for water supplies. It is this issue of biofuels and food availability which is the focus of this paper. We will first examine the concept of food security and how biofuels have become associated with threats to food security.

Food security

The concept of food security has been developed as means of measuring whether or not people are living with hunger. Food security is a complex concept incorporating more than availability and price. Discussions based on a simplistic understanding of what food security entails run the risk of a superficial analysis and drawing misleading conclusions.

The 1996 World Food Summit Plan of Action states that food security exists when: 'all people, at all times, have physical and economic access to sufficient, safe and nutritious food for a healthy and active life' (FAO, 1996). Food insecurity can be considered the converse of food security and is generally understood as the limited access to sufficient quantities of nutritionally adequate and safe food. It is estimated that around half of all the people suffering from food insecurity are small-scale farmers (Cohen *et al*., 2008). Food insecurity and ill health are generally linked to poverty. Responses to addressing these interlinked conditions have been influenced by the work of the Nobel Prize winning economist, Amartya Sen. He identified three factors that influence access to food: ownership of production resources, available technology of production and level of income through the sale of goods or participating in the labour force (Sen, 2001). In other words, if people have sufficient land (in terms of quantity and quality) or income they can produce or buy the nutritional food they need and their food insecurity diminishes. Sen also points to another important factor in ensuring food security: who in the household controls the resources plays a crucial role. There is a large body of evidence to show that 'the greater the degree of control exercised by women over the family income, the greater the proportion of income spent on food' (Rahman Osmani, 2010).

However, it is not only women controlling financial assets that ensure food security. Food storage, preparation, in particular under hygienic conditions, and cooking play a role in ensuring palatable food. In addition, clean water and energy are important inputs for ensuring these conditions.

Nevertheless the number of chronically hungry people in 2007 had reached a total of 923 million (FAO, 2008a: 4), during a period in which 'the world has grown richer and produced more food than ever in the last decade' (FAO, 2008a: 4). The seriousness of this situation was underlined when food prices at the global aggregated level rose sharply in 2006, 2007 and 2008. 'By mid-2008 real food prices were 64 per cent above their 2002 levels' (FAO, 2008a: 9), despite the good harvests reported in 2008 (FAO, 2009). Although prices had fallen back somewhat by the end of 2008, they were still 17 per cent higher than two years earlier (FAO, 2009) but in 2009 they were lower than 2007[1]. The fluctuation in the price of food commodities on the world market is not unusual. However, what raised international concern was the simultaneous increase in so many commodities and the potential threat to poor people in reducing their capacity to buy food and in so doing increase world hunger. The link with the demand for biofuels was made when, during the first three months of 2008, the price of vegetable oils (which can be refined into biodiesel) rose 97 per cent over their price in the comparable period in 2007 (FAO, 2008ba).

It is worth pointing to two facts which underline Sen's contention that ensuring an end to hunger is primarily a distribution problem. As of 2010, FAO considered that there was enough food in the world to feed everyone with an adequate level of calories. As of 2008, WHO considered that more than 10% of the world's adult population was obese[2]. This is not a problem exclusively found in high-income countries; overweight and obesity are now on the rise in low- and middle-income countries.

Is it right to blame biofuels for undermining food security?

A number of factors have been identified as contributing to the price rises in early 2008. These factors include the rise in oil prices, the increase in food demand by emerging economies, increasing costs of agricultural production, the depreciation of the US dollar, financial markets speculation with commodities, hoarding along all parts of the production chain, as well as drought and poor crop harvests in some producing countries, such as Australia.

The price of oil, which peaked at US$145/barrel in July 2008, had impacts throughout the food supply chain. The cost of artificial fertilizers and transport were particularly affected. In the first two months of 2008 the price of some fertilizers tripled while freight transport costs doubled in the twelve months after February 2007.

In 2006, there was a decrease of 60Mt of cereal output linked to the weather in the main producing countries of North America, Europe and Australia (CFC, 2007). Such a level of reduction in cereal output would be expected to result in price increases. One of the traditional response mechanisms to stabilise prices is for governments to release part of their buffer stocks onto the market. However, trade liberalisation changed how governments and the private sector ensure food availability. Instead of paying to store cereals and grains they are now able buy as and when they need them on the world market (Trostle, 2008). This leaves international cereals markets vulnerable to relatively minor variations in availability which can trigger price rises (Wiggins et al, 2009). As a consequence there were insufficient stocks of food to respond to the situation that occurred in 2008.

[1] However, as in 2008, the FAO food price index has for the last four years been above 200 (http://www.fao.org/worldfoodsituation/foodpricesindex/en/). (accessed 31 July 2014).
[2] http://www.who.int/mediacentre/factsheets/fs311/en/ (accessed 31 July 2014).

Economic development and income growth in developing and emerging countries, as well as population growth and urbanization, have been gradually leading to a change in diets. There is increased demand for more meat and dairy products, which is intensifying the demand for feed grains. Approximately 30 per cent of world's grain supplies are reported to be used as animal feed (UN-Energy, 2007, p33).

The US dollar is the currency used to trade many crops internationally and the relatively weak dollar against many currencies in the first decade of the 21st century[8] has in many cases lessened the impact of price increases but it has also increased the demand for grain imports from the US (FAO, 2008a, p75; Heady and Fan, 2008). On the other hand, the relatively high Brazilian exchange rate in 2008 slowed the expansion of soy (Searchinger, 2009).

Food exporting countries have contributed to price rises on international markets by placing bans on exports to protect their own consumers (e.g. Egypt, Vietnam, Cambodia and Indonesia banned rice exports). At the same time, importing countries, afraid that prices would escalate even further began to buy extra stocks. This brought a similar reaction along the chain down to the level of consumers who, probably driven by incorrect media reports of food shortages, took to panic buying (Paarlberg, 2010).

In 2006, there were also new entrants into the world agricultural commodity markets in the form of hedge funds, index funds and sovereign wealth funds looking to diversify their portfolios. With so many contributing factors affecting the prices of commodities it is difficult to attribute the exact influence of these actors, indeed economists and financial analysts seem unable to agree on whether or not these new actors had any influence (see Baffes and Haniotis, 2010) for a summary of the arguments). However, it has been suggested that the way such funds trade and manage their portfolios contributed to short-term price volatility of some commodities by influencing the decisions of farmers, traders and processors of agricultural commodities. (FAO, 2008a; Trostle, 2008). Also the sheer size of the funds[9] from this new source relative to the size of commodities markets might have helped push up food prices (Baffes and Haniotis, 2010).

However, to what extent has the increased production of biofuels played a role? There is general agreement among international development agencies that the increasing demand for feedstock for the production of biofuels has played an important role in the rise in food prices (World Bank, 2008 and IMF, 2008 quoted in Evans, 2009, p14). However there is less agreement about the extent of the contribution (Pfuderer et al, 2010). This can be explained by the fact that agencies are using different models and scenarios with different assumptions and which factors are included, hence they get different answers. Indeed, one economist for the Asian Development Bank considered that it was "near impossible" to quantify contributions based on models (Timmer, 2008 quoted in Pfuderer et al, 2010, p38). There is a consensus that the increasing demand for feedstocks in the US and the EU for biofuels production had a direct impact on the rise of maize and oilseeds prices, and indirectly on wheat and soybean prices by means of induced land-use changes to produce biofuels feedstock instead of food. Mitchell in a paper for the World Bank attributes a share of 70-75 per cent to biofuels in the increase of food commodities prices (Mitchell, 2008). The IMF calculates a share of 60-70 per cent in the rise in maize prices and 40 per cent with respect to soybeans prices (Lipsky, 2008 and Collins, 2008 quoted in Mitchell, 2008, p4; and Heady and Fan, 2008, p8). A study for the International Food Policy Research Institute (IFPRI) (Rosegrant et al, 2008 quoted in Mitchell, 2008, p4; Leturque and Wiggins, 2009, p1) estimates that between 2000 and 2007 increased biofuel demand accounted for 39, 21 and 22 per cent of the increase in the real prices of maize, rice and wheat respectively. In another study by the IFPRI different factors considered as possible drivers of rise in commodity prices were analysed. This study concluded that increased production of biofuels and increased oil prices offer the most convincing explanations for increasing prices across different commodities, and biofuels production providing the strongest explanation for the rise in maize prices (Heady and Fan, 2008). The divergence in conclusions between all of these studies demonstrates the difficulties in establishing the extent of influence of biofuels (or any other factor) on food prices. Indeed, the FAO considers that it is not possible to quantify accurately the contribution of biofuels demand to increases in commodity prices.

Between 1980 and 2002, there was a steady increase in demand for wheat and commodities known as coarse grains (maize, barley, sorghum, rye and oats), some of this demand was for fuel ethanol (7 per cent of increase) but the vast majority was for feed use (44 per cent), and food and other non-feed use (49 per cent excluding US ethanol) (Trostle, 2008). What appears to have been the significant impact on global grain prices was that between 2002 and 2007, an additional 53 million metric tons of US maize were used to produce ethanol which accounted for 30 per cent of the global growth in wheat and feed grains use (Trostle, 2008). However, it can be argued that biofuels demand was not the leading driver since maize prices would have risen more sharply than wheat or rice (neither of which are used extensively as biofuel feedstocks), while in fact maize prices rose less sharply than the other two grains (Paarlberg, 2010).

There has been a long-term trend of a slow increase in food prices. FAO considers that a significant demand for biofuels, together with high oil prices which contributes to the increasing cost of food production, will be a factor contributing to high food prices becoming a permanent reality. This forecast is based on the assumption that the demand for first-generation biofuel feedstock is likely to continue growing rapidly due to high oil prices and governmental policies supporting substitution for liquid transport fuels. The IEA estimates the share of the world's arable land devoted to growing biomass for liquid

biofuels could increase from 1 per cent in 2004 to between 2.5 and 3.8 per cent in 2030 (FAO, 2008b, p21). The estimates are based on the assumption that liquid biofuels will be produced using conventional crops, that is, first-generation feedstocks. Therefore based on this analysis, it is the first-generation biofuel feedstocks derived from edible crops which are likely to pose the greatest threat to food security when they compete for prime agricultural land. However, if investment in R&D to bring second- and third-generation technologies to maturity continues, then these options potentially reduce the competition with food crops. Alternatively, the floor could drop out of the biofuels market if hydrogen or electric vehicles become the promoted options for transport fuels resulting in a waste of investment by Southern economies, unless biofuel developers target domestic as well as export markets.

How can biofuels be part of the solution to support food security?

The question is: can biofuel programmes be designed so that they do not undermine food security? There are clearly examples in the literature which show that this is possible and in some cases have actually enhanced food security. (See for example (ICRISAT, 2007):p17; (FAO, 2008b): p81)); (Practical Action Consulting, 2009); (Haralambous et al., 2009); (Karlsson and Banda, 2009); (Narayanaswamy et al., 2009). However, there is little comparative crop yield data provided in the literature to substantiate the claims.

Given that most rural households are net purchasers of food, their capacity to do so can be enhanced when biofuels become a new source of household income. Therefore increased household income can enables access to more and better food. Household food production can potentially increase if smallholders benefit from increased extension support for improving output. There are a range of different models reported in the literature that promote either small-scale production for self-consumption or integration of smallholders into large- and medium-scale production systems. These schemes seem to rely generally on non-edible oil seeds, with the notable exception of sweet sorghum for ethanol production in grain sorghum growing areas. Sweet sorghum has the potential to promote food security through producing grains for household consumption, income from selling the juice for fermentation, and the residues for feeding cattle (ICRISAT, 2007).

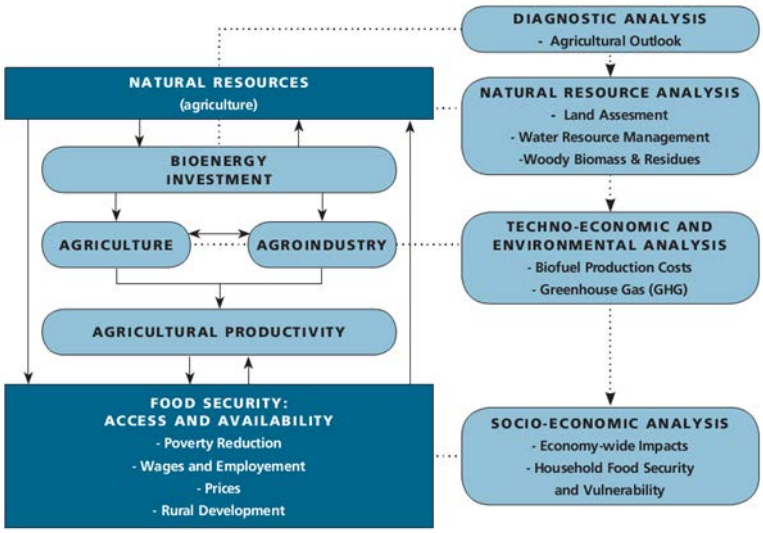
The institutional arrangements seem to be the key to ensuring food security. NGOs, CBOs and development institutions have been acting as catalysts in the configuration of partnership between small-scale farmers, large processors and producers of biofuels, governmental agencies and funding institutions. Such organisations are able to mediate to ensure the fairness of and compliance with agreements. They also provide training, agricultural inputs and funding, assets which the rural poor generally do not have access to. Food security may be also enhanced by the promotion of intercropping food crops with energy crops benefit from agricultural inputs supplied for the latter, and soil fertility is promoted by the use of organic fertilizers that are by-products of the oil extraction process, such as seed-cake in the case of jatropha (Practical Action Consulting, 2009) or by intercropping with leguminous crops (Vaidyanathan, 2009). The success of neem and karanj seedcake as a bio-pesticide has also been reported (Vaidyanathan, 2009). If the by-products can replace artificial fertilizers and pesticides and either enhance or at least do not reduce yields, then this can potentially decrease household expenditure on chemicals, freeing cash which could be used for buying food. Farmers cooperatives in southern Brazil with food security as one of the aims of growing biofuel promote a model of intercropping, using both tree and food crops, in which each producer is only allowed to plant 2 ha of biofuel crops (Wilkinson and Herrera, 2008) quoted in (McMichael, 2010): p620).

Schemes that recognise and respect traditional land holding systems are less likely to damage food security. There are examples in the literature where companies have made efforts to respect local land holding systems and to integrate smallholders into production chains as outgrowers (see for example (Cotula et al., 2008); (ICRISAT, 2007)). However, it is too early to assess the impact such schemes have on household food security.

The literature does provide some evidence to show that it is possible to produce biofuels, even on a large-scale without jeopardizing rural poor's food security. Important components in ensuring food security include safeguarding land rights and stimulating partnerships between small farmers and private companies/investors. The involvement of NGOs, CBOs and development institutions has been instrumental in promoting better land management practices and for assisting the rural poor in obtaining fairer treatment from biofuel developers.

The BEFS Approach in supporting decision makers to do the right thing

Governments are left with difficult choices in relation to biofuels and food security. The problems which led to the interest in biofuels are still there as are the threats to food security. Food prices remain historically high. However, our knowledge about using first generation crops for biofuels has also improved and people are more aware of the pluses and minuses which raises the question about whether or not it is possible to produce biofuels in a sustainable way and particularly doesn't threaten food security. Nevertheless it is difficult to generalise about the net impacts for a country, specific groups or households: biofuels and their impacts are context specific varying with the type of crop, method of production and processing as well as the overall management of the chain (FAO, 2010). Biofuel development decisions are complex because the sector cuts across different disciplines covered by a range of Ministries - notably energy, agriculture, environment, industry, and trade. Hence bioenergy policy needs to be embedded in a broader context of relevant strategies



and policies (UNEP, 2008).

In this context FAO has developed a tool to help governments decide whether or not biofuels are a policy choice that are sustainable and do not threaten food security: The Bioenergy and Food Security Approach (BEFS Approach). BEFS *supports countries in the design and implementation of sustainable bioenergy policies and strategies, by ensuring that bioenergy development fosters both food and energy security, and that it contributes to agricultural and rural development in a climate-smart way* (FAO, 2010). The BEFS Approach includes two sets of methodologies and tools to conduct a sustainable bioenergy assessment based on the BEFS Analytical Framework:

(i) a preliminary indication of the sustainable bioenergy potential of a country (BEFS Rapid Appraisal)
(ii) a detailed analysis providing more accurate results to inform policy making (BEFS Detailed Analysis)

The BEFS Approach can support both policy formulation and revision, based on the country context and its policy priorities. The Analytical Framework generates information to help decision makers in three key ways:

- Reduces the time governments spend in their various roles as decision maker and resource allocator when considering the direction of bioenergy development
- Assists governments in identifying teams of experts that have the correct abilities and skills to carry out the required analysis
- Identifies training needs.

The central focus of the BEFS AF is to examine how bioenergy development can be implemented without hindering, and potentially enhancing, food security. For this, BEFS AF considers the balance between the natural resource base and food security. Figure 1 shows the AF with the tool box used to carry out the analysis at different points in the framework. The AF assumes that bioenergy interventions affect food security by competing for the same natural resources used for food production (land and water) and so potentially have an impact on agricultural productivity that could affect food security outcomes. The framework considers that poverty reduction, employment, food prices and rural development also play a role in food security. The tool box is not exhaustive and users are encouraged to adopt and use other existing tools.

The BEFS AF starts with the definition of the Country Context. This is followed by an analysis for the whole biofuel supply chain, namely Natural Resources, Techno-economic Analysis and Socio-economic Analysis. The Natural Resource analysis includes a Biomass Potential Assessment. The Techno-economic and Socio-economic analyses address technology requirements, production costs, smallholder inclusion, job creation and investment requirements (FAO, 2014).

The BEFS Rapid Appraisal consists of a set of easily applicable methodologies and user-friendly tools which allow countries to get an initial indication of their sustainable bioenergy potential and of the associated opportunities, risks and trade-offs (BEFS Project, 2014). The BEFS RA covers the whole biofuel supply chain from feedstock production to the processing plant gate. In the case of electricity generation, distribution is addressed as well.

The BEFS RA guides the country in the first level of assessment of all bioenergy options of interest based on the potential feedstock production for bioenergy, techno-economic viability and socio-economic implications. It considers all bioenergy options including solid, liquid and gaseous biofuels and covers the following energy end uses: heating and cooking, rural electrification and transport (FAO, 2014).

This first level of assessment will guide the country in excluding some options while focusing a more detailed analysis on the more environmental, technical and socio-economically viable solutions (BEFS Project, 2014). There are three core modules in the assessment:

(i) Country Status

This module covers key environmental and socio-economic indicators, the identification of main food staples and cash crops, along with energy production and demand (household level, transport sector and industry).

(ii) Natural Resources

A Biomass Potential Assessment is performed where feedstock options are selected and the availability of the selected

feedstock for bioenergy is assessed. The output is an initial indication of quantities of feedstock available from (a) Crop residues; (b) Livestock residues; and (c) Forestry and wood residues.

(iii) Energy End-use Options

The bioenergy end use options of interest are selected and analyzed on technology aspects, economic profitability and financial viability, GHG implications and smallholder inclusion for each option considered.

Initial results from Bolivia and Taiwan

The BEFS AF has been developed using data from three countries: Peru, Thailand and Tanzania. The Twente Centre for Studies in Technology and Sustainable Development (University of Twente) has been testing, with the support of the BEFS Project, the Rapid Appraisal in two countries: Bolivia and Taiwan. Both countries are in food deficit and import petroleum products. They both need a stimulus to their agricultural sector and biofuels provides a possible policy choice.

Our experience so far has been positive. The RA tools have not been difficult to use. To date we have completed the first step which is to run the country status tool and obtain information on the key food staples, the key agriculture export crops, basic information about energy use, and household energy access in rural areas and current use of fossil fuels and biofuels for transport in the country. The AF assumes the availability of the data required by the tool. For Taiwan, its international status has sometimes made this difficult: whether or not it is aggregated with PR China varies with the agency collecting the data.

The tool has also highlighted some important policy decisions. For Bolivia, we had initially chosen only Transport as our end-use option – since this is the main user of imported petroleum products. However, the analysis has indicated that heating and cooking and rural electrification also need to be taken into account.

Four staple crops have to be selected to assess their biofuels potential. The sugarcane yield in Bolivia is approximately a third of that of neighbouring Peru and it is obvious that this needs to be improved. However, data to show how long that would take is not so easy to find. The tool only assesses the ethanol yield from the sugars and not from the cellulose component of the cane. For Taiwan there are interesting policy choices to be made about which crops to grow for biofuels. Coconut plantations are disappearing for economic reasons which using coconut oil as biodiesel feedstock might alter and make the crop economic. Despite this potential the government appearing not to consider the oil as an option but prefers sunflower oil. This is despite the additional advantages of perennial crops over annual crops: higher biodiversity than and better soil conservation potential. For bioethanol, sweet potatoes are a possible crop and are grown in Taiwan but these are not a choice in the tool. Sorghum is also grown in Taiwan but sweet sorghum with a higher ethanol yield per hectare is also not an option in the tool.

Conclusions

Biofuels are promoted as solution for fuel security, high oil prices, climate change, rural development and securing new markets for farmers. They are a technological fix for what are complex social, economic, political and ecological problems which can't be reduced to the level of "Tweets". Biofuels have been blamed for the increase in the sharp food prices in 2008. There is no denying that such a level of increase as occurred in 2008 is problematic for the poor who struggle to feed themselves adequately. However it is too simplistic to correlate an increase in biofuel production and a coincident increase in vegetable oil prices and come to the conclusion that 'biofuels cause world hunger'. The food price rise in 2008 was caused by many more factors than an increase in biofuel production; a number of factors occurred simultaneously to create a 'perfect storm'. Expert view has a consensus that it is impossible to say which the most significant factor was.

This is not to deny that growing biofuels is not problematic – there are potentially serious environmental problems and there already exist acute social issues related to rural people being disposed of their land (sometimes violently, sometimes illegally). On the other hand, biofuels do offer opportunities to help rural people and they can be grown without environmental damage and threatening food security. FAO has introduced an assessment tool which can help decision makers with an answer to the question about whether or not to grow biofuels. However, this tool is not a magic bullet which provides all the answers – it is a useful starting point in determining which crops can be grown where and for which end-use. It does not deal with many of the socio-political issues of power relations in which poor people are often the losers in determining land ownership rights.

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