Food, Feed and Fuel: Assessing the Impact of Competing Demand on Food Production & the Environment

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Rationale

In the past few years global prices of food commodities have increased, often accompanied by episodes of sharp increases in the cost of staples. While the short-term spikes were more immediately caused by supply shortfalls resulting from weather anomalies in different regions, there are several longer-term underlying trends for concern. First, global rates of growth in yields of staples are barely keeping up population growth. Second, food insecurity has been exacerbated by government mandates for biofuel production, and the coupling of agriculture & energy sectors has contributed to the rise in food prices. Additionally, biofuels have begun to compete for land with agriculture uses and ecosystem protection. Large-scale land clearing and the overuse of fertilizers cause a range of problems from biodiversity loss, to freshwater depletion and water pollution. On decadal timescales, emerging problems such as climate change (to which agriculture is also contributor) pose a serious threat to food productivity. These pressures come at a time when increasing meat consumption in rapidly industrialized countries is creating additional demand for feed grain. This article will provide a systematic review of these competing pressures on food production and the environment, particularly in Asia. We will also pay special attention to the consequences of first and second generation biofuel use on grain production, its knock on effect on food prices and greenhouse gas emissions.

Annotated Outline

1. Competing Pressures

This paper examines the competing pressure on food production resulting from recent shifts in demand. In particular we will review the impact of demand for grain as animal feed, and as a feedstock for transport fuels on food production and affordability. We will also provide a synthesis of the environmental consequences of the resulting increases in demand for grain.

2. Overall Picture

1. **Land use**: Globally croplands (12%) and pastures (26%) occupy 38% of land. Growth in global cropland has slowed (~3% from 1985-2005 years) including in Asia (~2.7%). There is little place to grow except in ecologically sensitive tropics.
2. **Yields**: Global crop yields of common crops increased by 47% and for all 174 crops tracked by FAO the increase was 28%. Though allowing for increase in harvested land (land left fallow, with multi-cropping and do on) the increase was only 20%.
3. **Prices**: Global Price Index for food crops fairly stable till 2005; the past few years have shown a dramatic trend with sharp increases.
4. **Other trends**: Global population increased by 33% - Asia by ~ 25%; Urbanization & loss of prime crop land;

3. Food, Feed and the Environment

- Globally per capita consumption of meat has increased by ~35% over the past 25 years (though sea food has increased).
- Per capita consumption in industrialized regions has slowed somewhat; there are dramatic increases in consumption particularly in China (by 250% over the past 25 years) and Brazil. Less so in India

- The impact of meat consumption in specific regions on feed grains will be quantified. Resulting increases in consumption of grain, along with related impact on land use (and resulting ecological consequences) will be assessed.

4. Biofuels: Consequences of Coupling Energy and Agricultural Markets for Food Security

The past decade has seen the entrenchment of policies promoting biofuel production and use in countries around the world – including several industrialized countries (U.S., Europe, Brazil). These policies resulted in the coupling of energy and food markets, and so have led to a dramatic impact on global food prices and food security in developing countries. This coupling raises several questions: have food markets begun to follow volatile energy market in terms of price and availability? How have changes in agricultural commodity prices benefitted food producing nations and farmers? Have they raised farm incomes in poor countries? What has been the effect on countries that are consumers of food? This section will provide a synthesis of findings in the recent literature on these and related questions.

5. Biofuels: Consequences for Land Use, Carbon Emissions and other Environmental Impacts

1. Biofuels do have a positive net energy balance despite some initial concerns (i.e., they provide more energy than is needed to produce them). However, corn ethanol only yields 25% more energy than is invested in its production, while soybean biodiesel has a net-energy gain > 90%.
2. In terms of greenhouse gas (GHG) emissions, Hill et al. (2006) estimated that production of corn ethanol would result in a net release of 88% of GHG emissions compared to energetically equivalent amount of gasoline. For soy biodiesel, the equivalent value would only be 59% compared to diesel fuel. There are, however, two caveats to this:
    a. The above estimate of GHG emissions assumes that biofuels are produced from existing crops. If biofuel production results, however, in the clearing of natural vegetation, the initial carbon release will create a carbon debt, i.e., the annual carbon savings from using biofuels to offset fossil fuels will be smaller than the initial carbon release from clearing and therefore only paid back after many years of biofuel production (Fargione *et al.*, 2008; Gibbs *et al.*, 2008). Gibbs et al. (2008) estimated that clearing of tropical rainforests for biofuel production would result in a carbon debt lasting decades to centuries, while using degraded or already cultivated land will result in immediate savings.
    b. If biofuel production only replaced existing cultivated lands, there is, instead, a different issue. If the associated loss of crop production is not accompanied by reduced demand, crop production may simply shift elsewhere.
    c. An initial analysis of "indirect land use change" (ILUC) for the US by Searchinger et al. (Searchinger *et al.*, 2008) suggested that corn-based ethanol grown on US croplands would generate a carbon debt for 167 years. This result is, however, controversial, and seemingly model dependent. Recent studies have lower estimates of the impact of ILUC (e.g. Hertel *et al.* 2010; Kim and Dale, 2011). The ILUC effect may, however, be very difficult to quantify, with one of the largest uncertainties being how crop yields change in the future (Sheehan, 2009).
3. Other environmental consequences of biofuel production are similar to those of agriculture in general, and include the excessive application of nitrogen and phosphorus fertilizers, pesticide application, the depletion and pollution of freshwater, etc. Hill et al. (2006) also found that biodiesel was preferable to ethanol in terms of nitrogen, phosphorus, and pesticide pollution.

6. Second Generation Biofuels

The second generations of biofuels are expected to use inedible feedstock designed to increase fuel production per acre. Second generation biofuels can be made from variety of feedstock including lingo-cellulosic biomass crops (such as switchgrass), woody crops and agricultural residue. The agronomy of these crops, the technical aspects of production, and consequences for land use competition with conventional agriculture (and first generation biofuels) will be discussed. Special attention will be paid to oilseeds (such as *Jatropha* and *Pongamia*) that have

been promoted as capable to growing in marginal lands in developing countries with little need for water and fertilizers.

7. And so on…