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PolicyPennings by Daryll E. Ray & Harwood D. Schaffer

Modeling world food production needs in 2050

The challenge of feeding an additional 2 billion people by 2050 has generated considerable discussion since 2009 when the United Nations Food and Agricultural Organization (FAO) suggested that we would need to increase agricultural production by 70 percent over the 2005-2007 period level to feed 9 billion in 2050.

Others have used the figure of 100 percent. Since then everybody and their brother has used the need to increase agricultural production to pitch their own product. But before we get all excited, we need to ask ourselves, "What's behind those numbers?"

And that is exactly what Timothy Wise of the Global Development and Environmental Institute at Tufts University did in his paper, "Can We Feed the World in 2050?" (http://tinyurl.com/nc3y7yb). The various numbers that we see with regard to the size of the increase in agricultural production needed to feed the 2050 population are all the result of various computer simulation models.

Wise begins the paper with a quote from Michael Reilly and Dirk Willenbockel: "Model outputs should not be misinterpreted as forecasts with well-defined confidence intervals. Rather they are meant to provide quantified insights about the complex interactions in a highly interdependent system and the potential general size order of effects, which cannot be obtained by qualitative and theoretical reasoning alone."

Wise begins his paper by reviewing various models that have been developed to examine the question of what it will take to feed the world's population in 2050, beginning with the 2009 FAO projection that agricultural production would have to increase by 70 percent. Depending upon the base period used for analysis along with assumptions about population growth, the rate of GDP growth, changes in the consumption of commodities, the rate of increase in agricultural yields, the rate of biofuels expansion, climate change, and a host of other issues, the estimates of the needed increase in agricultural production to feed the world in 2050 vary widely.

While modelers understand the sensitivity of the results of their models to the assumptions that they make about these factors, the general public does not. They are likely to take the results that they read about in a news article as a prediction and base the policies they might support based on those results. As different people read about different models they are likely to come to different policy conclusions.

As we look at the list of assumptions, the policies that would bring about change in some of these variables are complex and not clearly understood. These would include assumptions about population growth and the rate of growth of GDP.

For other items the policy changes that can be applied to bring about the desired results—what are desired results may vary from individual to individual—are much clearer. Some of these drivers of change are agricultural productivity, biofuel expansion, climate change, land use, and water use.

By using a technique called scenario modeling, researchers can identify the impact of changes in a model's results as the result of changes in a single driver of change, holding all other variables constant. In scenario modeling the emphasis is not on the absolute numbers for 2050—the models are still affected by assumptions in variables like population growth and the rate of change in GDP—but rather the change in the final results. These models thus allow policy makers, agricultural producers and the general public to design policies that will bring about the desired results.

With regard to agricultural productivity, Wise writes, "As we have seen, modeling of agricultural production to 2050 is extremely sensitive to assumptions about agricultural productivity growth. Over a 40-year time horizon (2010-2050) each 0.1% change in the assumed rate produces a 4% change in total output. If uncertainty were assumed to be within a range of plus-or-minus 0.25%, the resulting production levels come with a range of plus-or-minus 11%. Higher assumptions…therefore assume a great deal more available food in 2050. More pessimistic assumptions…can generate panic about food availability into the future."

Knowing this, it becomes clear that investment in agricultural productivity is important if we are to be able to feed the world in 2050. What is not clear, and thus is the subject of political debate, is the type of change. Should the emphasis be put on increasing the productivity of smallholders who are the most vulnerable to hunger or should it be put on enabling farmers everywhere to use the latest equipment and seed technologies?

It is important to note that the models do not include dealing with the low-hanging fruit like bring about a reduction in harvest and post-harvest loss. Investment in this area could dramatically affect the availability of food in 2050 reducing the level of new production needed between now and 2050. It is also important to understand that most of the models do not deal with fruit and vegetable production.

Biofuels expansion is also an issue that needs to be examined. Different models assume biofuels expansion until a given date—2019 or 2030—and then no further expansion. Some of this is based on

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the emergence of second-generation biofuels that use cellulosic and waste materials. But one model "shows that even moderate additional biofuel demand over 2008 levels raises prices 7%, increases those at risk of hunger by 21 million people, and requires a 21% increase in cultivated land, even with early and gradual deployment of second generation biofuels. If advanced biofuels are not available until 2030…prices increase 11%, hunger risks rise to 42 million, and there is a 29% increase in cultivated land. In other words, delays in the deployment of advanced biofuels have serious implications."

Climate change is much more difficult to model than either changes in agricultural productivity or biofuels expansion because it is an emerging science and all of the consequences are not known. This makes the level of production that can be achieved highly uncertain, "Fuss, Havlik et al (2011) use the Global Biosphere Management Model (GLOBIOM) to assess the impacts on food security of yield uncertainty from climate change.

"If meeting minimum food needs is defined as a constraint of the model, and if yields are difficult to predict given the levels of uncertainty, what levels of production are required to ensure food security? They conclude that high levels of uncertainty about yields increase the need for decision-makers to plan levels of **overproduction** (emphasis added).

"They find this is feasible but potentially costly. They find that the key to success is the reduction of trade barriers to allow agricultural products to flow from surplus to deficit regions, and they find the most useful adaptation is the expansion of irrigation, which can help stabilize yields and expand production. They acknowledge that water use under climate change is inadequately accounted for in their model, so that adaptation strategy itself comes with significant uncertainties.

"Finally, they note the value of increasing global storage capacity for basic grains, as this reduces vulnerability to the kinds of short-term yield variations expected with climate change. This is one of the few mentions we found in the literature of the potential importance of food reserves in contributing to global food security in 2050 scenarios."

Wise goes on to look at scenario modeling of the use of key natural resources like land and water and again the results of changes in these variables have clearly defined consequences that have policy implications.

What is important in Wise's review of the various models that deal with answering the question of whether or not we can feed the world in 2050 is the need for the public to be aware that the numbers they read in the headlines are not written in stone, but are subject to many of the policies that we have adopted in the past as well as those we adopt today and in the future. In all likelihood, the solution will not come from one area, but will have to come from policy changes in a wide number of areas, some of which—like the rate of change in GDP and population—are extremely complex.

Complex or not, we will not be able to shirk from the task before us.

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