Opinion: To feed the world in 2050 will require a global revolution

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Achieving universal food security is a staggering challenge, especially in a world with an expanding population, accelerating consumption, and many signals of a deteriorating global environment (1). Some claim that population size and growth are irrelevant, and that the solution is a more equitable distribution of income, wealth, and available food. In this view, future food security is attainable, even if the global population grows to 10 billion or more over the course of this century. To others, biophysical constraints on how much food can be produced, combined with the size and growth of the human population, imply there soon may not be enough to go around, even with equitable distribution.

There is merit in both claims, but neither, alone, is adequate to identify the policies that have a chance of achieving the goal of food security. As we expand on below, large population size, high per capita consumption, and inequality of wealth or income can each (and especially in combination) impede attempts to achieve progressive and effective policies that will be needed to reverse the trend toward persistent maldistribution and environmental degradation. This grim diagnosis also points toward a solution, as we outline below.

Both demographic and environmental factors are crucial to this problem, according to a broad consensus of scientists (2). The basic task of supplying sufficient calories and nutrients is not being met now. Almost 800 million of today's 7.3 billion people are undernourished and perhaps half of the world's people—most but not all in poor and middle-income nations—lack access to one or more essential nutrients (3, 4). Even when adequate calories are available, diets are often far from ideal, increasing the burden of disease. Indeed, inadequate consumption of fruits, nuts, seeds, and vegetables makes a major contribution to ill health worldwide. In short, the current failure to feed humanity makes the prospects seem slim for making the projected 9.7 billion population food-secure and healthy in 2050, and perhaps billions more beyond that (5).

A combination of population size, high per capita consumption, and wealth inequality has stymied efforts to improve global food security, argue the authors. Image courtesy of Shutterstock/xuanhuongho.

Major Challenges

Humanity now faces severe biophysical constraints on achieving food security: (*i*) Increases in agricultural production are slowing because of climate disruption, and yields and nutritional quality of crops are being threatened by the loss of pollinators and growing atmospheric CO_2 concentrations. (*ii*) Fertile soil is being lost to both wind- and water-caused erosion, salinization, and nutrient depletion. (*iii*) Groundwater supplies for irrigation are increasingly limited as a consequence of overpumping and contamination of aquifers. (*iv*) Excessive applications of pesticides and fertilizers have contributed to dangerous levels of exposure to toxic substances. (*v*) Pollinators are declining rapidly as a result of climate disruption, poisons in the environment, and habitat destruction as a result of changing land-use practices.

Humans are likely to become increasingly dependent on marginal crop- and grazing lands, which are more vulnerable to all of the above risks. In addition, wild fish yields are decreasing because of overfishing and are threatened by ocean acidification resulting from CO_2 emissions (6).

With more people on the planet requiring more calories and demanding more animal protein, as well as commercial energy, each of these problems will likely grow worse. Magnifying the challenge, these threats are linked to each other, as well as to population and consumption rates, through a network of nonlinear relationships (7, 8). Attempts to deal with one problem sometimes exacerbate other problems.

For example, clearing forested land for food production can disrupt local and regional climates and hydrological regimes. Through such clearance, agriculture itself is one of the greatest destroyers of the biodiversity

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on which agricultural productivity depends. Clearing land for farming increases stress on other ecosystems and dependence on groundwater for irrigation. Climate disruption is likely the single greatest threat to future food supplies, yet some 30% of greenhouse gas emissions can be traced to the food production and distribution system. Food spoilage is more likely in areas with warmer and wetter climates, meaning such areas will require further increases in crop production to compensate. Crop failures may become more frequent in warming and less stable climates. Expanding cropland or using more intensive and mechanized agriculture and increasingly resorting to biofuels will impose food vs. energy land-use conflicts and likely require more fossil energy mobilization, thereby exacerbating global warming.

As the planet warms, the wintertime "pest control" effect will decrease and reproductive rates of pests will rise, leading to increased pesticide use and toxification. Open spaces adjacent to farmland often support crop pollinators, the natural predators of pests, reduce wind-caused erosion, and recharge aquifers. Protecting these spaces becomes more difficult when land prices go up because of population growth. When yields decline, farmers often can only maintain their profits by expanding their acreage, unless they have the funds and opportunity to invest in new crops or technologies. Regulating pesticides, herbicides, antibiotics, and fertilizer use requires cooperation between farmers, corporations, civil society, and governments. All of this will become more difficult in a world torn by conflict over resource constraints, health hazards, and the needs of a growing population.

False Dichotomy

Portraying the opposing viewpoints as "insufficient food" versus "inequitably distributed food" may seem like a caricature, but in fact, discussions on sustainability often polarize into these two camps. As with many other dichotomies, this one impedes the sort of critical analysis required in order for humanity to achieve sustainable food security. It is as intellectually unjustified and counterproductive to focus on the "sufficiency-distribution" dichotomy as it is on that between those who seek to base land-use decisions on a monetary valuation of healthy ecosystems and those who think they should be based on the intrinsic value of nature (9).

Equity issues make adequately feeding everyone extremely difficult, but biophysical constraints limit our ability to feed more than a certain number of people, even under the most equitable of distributional arrangements. Most importantly, our biophysical and social dilemmas are tightly linked. From villages to nations, egalitarian systems of governance and resource distribution do not flourish when communities lack basic resources. Great inequalities in wealth or income can affect governance systems so that the nutritional needs of the poor are not properly met. Well-financed resistance to programs to feed the poor in the United States demonstrates how sound governance can be distorted by wealth. When population growth outpaces the availability of education, healthcare, and other basic services, and environmental degradation threatens livelihoods, people have less time to seek social justice because they must spend more time focused on survival. Those who champion increased equality as a means of achieving global food security must team up with those who urge both curbing overconsumption and a transition to a reduced population. Otherwise, the new political and economic institutions desperately needed to redirect humanity toward sustainable food security and away from the fiction of perpetual growth will not evolve.

First Steps Toward Solutions

Numerous policies could be implemented today to start that transition. At the top of our list are a set of seemingly unconnected reforms: (*i*) Carefully evaluate and reduce excessive use of pesticides, fertilizers, antibiotics, and growth hormones in plant and animal agriculture. (*ii*) Price water appropriately, regulate groundwater use, and encourage development of much more efficient water-handling systems as pioneered (for example) by Israel. (*iii*) Greatly expand research that can lead to more ecologically sound cropping systems, with more emphasis on long-term sustainability as opposed to immediate yield. (*iv*) Institute a carbon tax and expedite the transition to greater energy efficiency and reliance on cost-effective renewable energy. (*v*) Generally revise tax codes to limit individual income and inhibit consumption by the wealthy, and to provide more purchasing power for the poor to increase their capacity to acquire food. (*vi*) Allocate more funding and reduce barriers to promote the health, education, and human rights of women around the world, including unobstructed access to modern methods of family planning. (*vii*) Set aside vast natural areas, including old-growth forest, on land and at sea to protect biodiversity and ecosystem services. (*viii*) Transition to a new economic system in which internalizing externalities is a central rather than a side issue.

Whether such a set of reforms can be instituted, given the influence wielded by those who profit from the status quo, and the indifference of far greater numbers, remains a huge question; we find it hard to be optimistic. Many have claimed that technological fixes alone will solve the food security problem, but the record does not give us great hope (5). A call for dramatic global changes that do not rely on new technologies resonated worldwide in response to Pope Francis' encyclical on the environment (10). We hope that its perspective can be expanded to embrace the implications of having too many people on the planet, and that its basic thrust will be adopted as a response to the challenge now facing humanity.

In sum, attempts to frame the issue of food security as either "the solution lies in more equitable distribution of food" or "there are too many people and not enough planet," miss an essential factor that links these two viewpoints: achieving the forms of governance needed to more equitably distribute resources becomes ever more difficult on a more crowded and degraded planet. Meeting the challenge of food security demands a revolutionary change in human society, necessarily one as far-reaching as a combination of the agricultural revolution, now 10 millennia in the past, with the industrial revolution and the multiple transitions to more democratic governance that started three centuries ago. We urge policy makers around the world to move this issue to the top of the political agenda. Anything less is a recipe for disaster (ref. 11 and references therein).

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