Stateless societies

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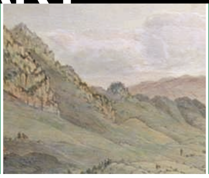

The iron in the mussel's grip

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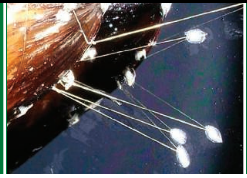

After the Maule quake

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# LETTERS

*edited by Jennifer Sills*

## Food Security: Population Controls

THE SPECIAL SECTION ON FOOD SECURITY (12 FEBRUARY, P. 797) PRESENTS VARIOUS TECHNOlogical fixes to address the problem of sustainably and equitably feeding the 9 billion humans now projected for 2050. However, population controls are not mentioned as a possible strategy. Suggestions for reducing demand are essentially limited to eating less meat and more insects, as well as establishing good governance and eliminating pervasive worldwide corruption. Why not make reduced world population a central part of the proposed mix of solutions for the future?

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**Editor's Note:** We received a number of thoughtful letters on this point. You can read them online at www.sciencemag.org/cgi/eletters/328/5975/169-b. **JENNIFER SILLS**

## Food Security: Green Revolution Drawbacks

AS DISCUSSED IN THE SPECIAL SECTION ON FOOD Security (12 February, p. 797), the process of increasing food production and improving its quality to sustain population growth without compromising environmental safety has been called a global green revolution. Science and technology are supposed to play a key role in this revolution by enhancing crop efficiency and food quality, as well as developing alternative protein sources (*1*). A successful green revolution, however, will likely maintain or exacerbate the current rates of population growth, eventually leading to resource exhaustion. Scientists should think critically about the green revolution option, just as they would about any other scientific endeavor. A green revolution is only needed if the current global economy and mode of development must be maintained.

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## Food Security: Beyond Technology

THE AUTHORS OF THE SPECIAL SECTION ON Food Security (12 February, p. 797) make a plausible case that feeding a hungry world requires "rethinking agriculture." Unfortunately, the advocacy on display here implies that technological solutions—any technological solutions—are not only necessary but sufficient. This would be a serious mistake.

Those of us engaged "on the ground" in Africa and elsewhere know very well that the binding constraint on a viable food system is not deficient technology but the institutional (policy) and organizational (bureaucratic) incoherencies—touched on in the Perspective by G. Ejeta ("African green revolution needn't be a mirage," p. 831)—that combine to pervert incentives, render necessary inputs unavailable, defeat the best efforts of dedicated extension agents, and generally encourage individual farmers to retreat into autarchy.

We have nothing against promising technology. We remain, however, incorrigible realists when it comes to the inevitable optimism that offers up the latest technical solution to complex policy and organizational settings and circumstances.

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## Food Security: Crop Species Diversity

THE SPECIAL SECTION ON FOOD SECURITY (12 February, p. 797) did not consider the value of crop species diversity. It is agronomically, ecologically, nutritionally, and economically risky and unsustainable to rely almost exclusively on a handful of major crops to provide food for the world's projected 9 billion people by 2050. Indeed, this approach may have been partially responsible for the failure of the green revolution in much of Africa.

Calls for improvement of major crops (described in M. Tester and P. Langridge's

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Review, "Breeding technologies to increase crop production in a changing world," p. 818), such as Africa's major staples (described in G. Ejeta's Perspective, "African green revolution needn't be a mirage," p. 831), should be extended to include locally important crops. Such crops generally are well adapted to local conditions, form the basis of local food systems, show remarkable resilience to environmental change, and frequently possess unique characteristics that are in demand on the global marketplace (*1*). Although the breeding infrastructure for such species is often severely underdeveloped and underfunded, breeding can be facilitated by linkages to closely related major crops (*2*). Strategies that aim to increase or sustain crop diversity in agricultural production systems have many benefits, including the maintenance of cultural practices and traditional knowledge, balanced nutrition, increased resilience to climate extremes, and exploitation of a broader array of environments for food production.

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## Food Security: GM Crops Threaten Biodiversity

THE SPECIAL SECTION ON FOOD SECURITY (12 February, p. 797) appeared to strongly and uncritically support the application and development of genetically modified (GM) technologies and the reliance on agrochemicals. There was little appreciation of the conflicts that are likely to arise. Increased access to expensive nonrenewable inputs, along with increased public acceptance and trust of GM crops, could threaten biodiversity (*1*, *2*) and overall sustainability of agriculture. The articles should have acknowledged the success of non-GM alternatives, such as observed increases in yields resulting from low-input ecological practices on rainfed farms (*3*).

In their Review for the section ("Food security: The challenge of feeding 9 billion people," p. 812), H. C. J. Godfray *et al.* wrote, "we must avoid the temptation to further sac-

### CORRECTIONS AND CLARIFICATIONS

**Perspectives:** "A test for geoengineering?" by A. Robock *et al.* (29 January, p. 530). In the third paragraph, the sentence "Some authors have argued that the effects of polar testing could be confined to the Arctic (*4*)" should read, "Some authors, in simulations designed to control Arctic climate, have confined radiative forcing to the Arctic (*4*)." In the fourth paragraph, the phrase "Even if insertion does indeed have to end up as planetwide" should read "Even if insertion does indeed have to end up affecting a large part of the planet…."

**Association Affairs:** "Reflections on: Our planet and its life, origins, and futures" by J. J. McCarthy (18 December 2009, p. 1646). In the second sentence of the Fig. 10 caption, the allowed emissions should have been referred to as gray, not blue.

**Reports:** "Imaging the interaction of the heliosphere with the interstellar medium from Saturn with Cassini" by S. M. Krimigis *et al.* (13 November 2009, p. 971). Because of a conversion error, on p. 973, first column, line 15, the expression ($B^2/2\mu_0$ = 0.25 pPa), and in Fig. 4 the label at lower right $P_B$ ~ 0.25 pPa are both inconsistent with the value commonly assumed for the interstellar magnetic field (ISMF) of 0.25 nT (brought to the authors' attention by J. F. Cooper). The value of 0.25 nT for the ISMF corresponds to a pressure of 0.025 pPa. For the hot plasma pressure that was estimated (0.31 pPa) from the measurements to be balanced by the external ISMF, the external field would need to be ~0.9 nT.

rifice Earth's already hugely depleted biodiversity for easy gains in food production." By being held hostage to the agro-industrial "machine," we succumb to that temptation.

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## Food Security: Rigorous Regulation Required

WE AGREE WITH N. V. FEDOROFF *ET AL.* THAT the U.S. regulatory framework for agricultural biotechnology needs serious reexamination ("Radically rethinking agriculture for the 21st century," Perspectives, special section on Food Security, 12 February, p. 833). However, we disagree with their suggestion that regulators should relax oversight to facilitate biotechnology products' entry into the market. The existing framework is already too weak. For example, under current food laws, the Food and Drug Administration (FDA) does not require data, review it, and then use it to conclude that biotech plant foods are safe (*1*). Instead, the agency reviews studies submitted by product developers and issues letters that simply restate the developers' conclusions about the safety of their products [e.g., (*2*)]. Understanding that this cozy approach would be unacceptable for biotech food animals, FDA regulates them under stronger, but inappropriate, authority as drugs (*3*).

The authors are wrong to assert that genetically modified (GM) crops are safe because we've consumed them "without incident" for 15 years. First, no agency collects data to evaluate adverse incidents, and because GM foods aren't labeled, consumers experiencing problems would not know to report them as such. Second, the relative safety of the insect- and herbicide-resistant crops that dominate today says little about the safety of more complex traits the industry has promised for the future.

There are some benefits associated with GM crops, but the authors oversell their virtues. Insect-resistant crops have reduced insecticide use, but this is offset by the surge in herbicide use due to resistant weeds (*4*). GM corn and soy yields have indeed risen, but the increase is largely due to the success of classical breeding and other practices, not GM traits (*5*). Finally, further increases in no-till farming would have environmental payoffs, but recent research has called into question the extent of its carbon sequestration benefits (*6*–*8*).

We applaud the authors' recommendation to radically rethink the U.S. agriculture system, but it might be simpler than they suggest. Cover-cropping and four-crop rotations for commodity crops, for example, would enable farmers to reduce pesticide use and nitrogen fertilizer pollution [e.g., (*9*, *10*)] without ever encountering a federal regulator. Policymakers should prioritize increased research support to optimize such methods and provide incentives for farmers to adopt them.

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## Food Security: Focus on Agriculture

THE REVIEW BY H. C. J. GODFRAY *ET AL.* (12 February, p. 812) and the rest of the special section on Food Security call for a multifaceted approach to future global food security. We would like to emphasize three agricultural issues that were lacking.

First, it is important to analyze yield as the result of genotype, environment, and management interactions. This type of analysis permits a nuanced understanding of the factor(s) that lie behind regional differences in yield gaps, especially between developed- and developing-country agriculture. These insights can then be used to apply more targeted research as needed.

Second, we must pursue the fastest route to improved yield. We have 30 to 40 years, and it can take 10 to 15 years to develop a food crop variety that can be cultivated extensively in farmers' fields. We have little time to experiment with totally new crop plants and need to work with currently available genetic material. Poor farmers in Africa will benefit sooner by having access to plentiful and inexpensive nitrogen and phosphorus fertilizer than by waiting for possible N-fixing cereal crops.

Third, there needs to be a focus on scenario-building exercises for agriculture—the kind used in the development of the Millennium Ecosystem Assessment and the IPCC reports. Major drivers such as regional or global agricultural markets should be analyzed against low or high impacts of environmental change (including climate) on agriculture. Such scenario analyses recognize that agriculture is more than just food production; this is a crucial perspective, given that 45% of the global population depends on agriculture for their livelihoods.

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## Food Security: Fossil Fuels

THE SPECIAL SECTION ON FOOD SECURITY (12 February, p. 797) omitted two points. First, addressing the unmet need for voluntary, cost-effective family planning (*1*) deserves mention as a means for improving global food security in the coming decades. Second, any discussion of food security should address the dangerously heavy dependence of global agriculture on fossil fuels. Although several authors stressed the need for sustainability in agricultural systems, none even alluded to the virtual certainty that the peak of global oil production will occur before 2050. The rise in food prices in 2008 and the attendant civil unrest derived in part from the extreme rise in the costs of oil and of fertilizer. The potential for similar disruption in the future—possibly as soon as the global economy recovers—deserves serious consideration.

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## Food Security: Perception Failures

THE SPECIAL SECTION ON FOOD SECURITY (12 February, p. 797) examines several obstacles to achieving global food security. One obstacle the section did not address is perception failure.

Perception failure poses an imminent danger to the advancement of science. Consumer resistance to genetically modified (GM) products affects trade relations and reduces private research and development on plant biotechnology (*1*). A case in point is the recent rejection of GM eggplant in India, detailed in the News of the Week story by P. Bagla in the same issue ("After acrimonious debate, India rejects GM eggplant," p. 767). GM technology is not new to India; *Bacillus thuringiensis* (Bt) cotton was first commercialized in India in 2002. Since then, about 5 million farmers have adopted the technology (*2*). Thus, negative experiences with GM crops cannot explain the rejection of Bt eggplant. Nor can regulation—India's highest biotechnology regulatory body, The Genetic Engineering Approval Committee, approved the Bt eggplant, deeming the technology safe (recounted in Bagla's News story). The major obstacle stemmed not from inadequate technology or strict regulations, but from the public's perception of the technology. Bridging the gap between science and society needs to be a high priority in order to put all currently available science to efficient use in addressing global food security concerns.

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