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Deploying the Full Arsenal: Fighting Hunger with Biotechnology

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One of the most important issues in the debate over biotechnology today is its potential to combat hunger in the developing world. This question is especially relevant as biotechnology struggles to find acceptance while countries in Africa and elsewhere in the developing world face famine. This paper reviews modern efforts to fight hunger and the projected future of the problem. What does biotechnology have to offer in response to this situation and what are the major obstacles to its deployment? The paper then explores ways to overcome these obstacles, arguing that while traditional efforts should be continued, biotechnology's potential to make a safe, meaningful contribution to fighting hunger is too significant to be overlooked.

Introduction

Among the many hotly contested issues in the debate over biotechnology today is its potential to combat hunger in the developing world. This question is especially relevant as biotechnology struggles to find acceptance while countries in Africa and elsewhere in the developing world face famine. Proponents of biotechnology argue for the immense possibilities that it offers in the fight to end hunger, while opponents say that hunger can be combated successfully without dependence on what they consider dangerous genetically modified (GM) products. Anti-biotech activists often make the case that the inability to end hunger is due to failure in other areas. In a world awash with agricultural surpluses, they argue, we do not need biotechnology. Instead, we should redouble

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or refine our efforts to relieve distribution bottlenecks, open markets to exports from less developed countries (LDCs), increase investments in yield-enhancing hybridization techniques, boost foreign assistance budgets and medical aid programs, and focus on other areas where the record of success in combating hunger is characterized by less than satisfactory results or outright failure.

This paper reviews modern efforts to fight hunger and the projected future of the problem. It looks at what biotechnology has to offer and the debate surrounding it, and then explores ways to overcome the obstacles to realizing its potential to help wage a successful war on hunger. While traditional efforts should be continued, biotechnology's potential to make a safe, meaningful contribution to fighting hunger is too significant to be overlooked, and is in fact reason alone to embrace it.

Hunger Today in the Developing World

There are about 840 million undernourished people in the world today, about 30 percent of the world's population. Some 777 million of these people live in the developing world, and of these, 177 million are children under ten years of age.[1] Hunger is linked to poverty, and vice versa. Hunger and malnourishment impede productivity, thereby dooming people to poverty. The poor, meanwhile, cannot afford food. Hunger, therefore, often becomes a self-perpetuating cycle.

More than two billion people worldwide suffer from malnutrition,[2] meaning they live below the per capita daily caloric intake threshold of 2,350 calories that the UN Food and Agriculture Organization (FAO) defines as necessary for an adequate diet. This manifests itself in many ways. For example, almost two billion people in the developing world suffer from iron deficiency, 140 million people experience iodine deficiency, and 140 million children experience vitamin A deficiency. Today, fifty-four countries are estimated to fall below the 2,350 average minimum calorie level.[3]

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Hunger and malnutrition are particularly acute in sub-Saharan Africa. Three-fifths of Africa is unsuited to sustained yields in grain production and suffers from locust plagues and other

Hunger and Poverty in the Developing World

	Percentage of people undernourished, 1997–1999	Number of undernourished people (millions), 1997–1999	Percentage of underweight children under age 5, 1995–2000	Population living on less than $1 per day (%), 1999
Sub-Saharan Africa	34	194	31	47
South Asia	24	303	49	37
East Asia & the Pacific	10	194	19	14
Latin America & Caribbean	11	54	9	15
Middle East & North Africa	9	33	17	2
Countries in Transition	6	27	7	4
Developing Countries	18	777	29	23
The World	30	840	28	21

Sources: Bread for the World, UNDP.

scourges that restrain food production.[4] Regional food production has dropped 23 percent in the past twenty-five years.[5] Today, 46.7 percent of the population lives on less than $1 per day, and 194 million people go to bed hungry, including 31 million children under five years of age, one in three of whom suffer from mental retardation, blindness, and other illnesses brought on by malnutrition.[6] In 2002, drought, poor governance, and the ravages of HIV/AIDS meant that an estimated 14.4 million people in six southern African countries faced famine.

A Review of Modern-Day Efforts at Fighting Hunger

Despite the grim numbers, there has been significant success in the post-war era in combating hunger. The percentage of hungry people in the developing world has dropped by about one-half since 1970, from over 30 percent of 3 billion people in 1970 to 16 percent of 4.7 billion today.[7] The world's undernourished population has also dropped in absolute terms, from 959 million to 777 million. Major victories have been achieved in China (where the number of hungry people has fallen by 74 million since 1990), Indonesia, Vietnam, Peru, and Nigeria. Across the developing world, the almost 30,000 children who die daily from hunger today is down from the 40,000 in 1985.[8]

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This record of success is due to a variety of efforts carried out on many fronts. The most effective means of reducing hunger rates are general measures such as good governance, avoidance of war and political conflict, strong and stable economies, and social programs that protect the weakest in society. Specific efforts targeted at fighting hunger fall into five basic categories: technological advancements, foreign aid, expanded trade, financial investment, and multilateral cooperation.

Technological advancements

The Worldwatch Institute points out that while the output from fisheries and rangelands has increased five- and three-fold, respectively, since 1950, production in these two food systems has now hit a plateau. Future food growth must therefore come from the third system, croplands. Technological advances raised cropland productivity three-fold in the twentieth century, through irrigation, chemical fertilizers, hybridization, the development of short-strawed wheat and rice varieties, and, most recently, genetics. The Green Revolution, launched in the 1960s and 1970s, used these techniques to double and triple the yields of rice, wheat, and corn in Asia, saving hundreds of millions of lives. Largely because of these advances, world grain yield per hectare increased from 1.06 tons to 2.73 tons per hectare between 1950 and 1998, and world grain consumption per capita rose from 247 kg to 319 kg over the same period.[9] This increased food productivity has greatly contributed to the 50 percent drop in the percentage of undernourished people since 1970, and there is plenty of potential in LDCs for continued growth in yields through technological extension.

Foreign assistance

Overseas development assistance (ODA) was conceived after World War II as a means of helping LDCs to modernize and reduce hunger rates. In the early 1970s, the UN called on all Organisation for Economic Cooperation and Development (OECD) countries to dedicate at least 0.7 percent of their GDP to ODA; very few countries, however, have met that threshold. Total global ODA today stands at about $53 billion, down from $69 billion ten years ago,[10] reflecting the global trend in declining aid ratios in the post-Cold War era.[11] In particular, the U.S. contribution to total OECD aid fell from 60 percent in the mid-1960s to only 13 percent by the mid-1990s,[12] and non-governmental organizations (NGOs) now contribute more resources to aid in aggregate than the U.S. Agency for International Development (USAID). Official aid targeted specifically at expanding LDC agriculture is experiencing an alarming decline. In 2001, USAID's funding for agriculture dropped to 11 percent of total U.S. aid, while agriculture represented only 10 percent of World Bank lending, the lowest level ever.[13]

After fifty years of experience, many donor countries are unwilling to keep pumping development aid into LDCs because they see no correlation between aid and economic growth, and thus limited impact on reducing hunger. Experts blame the failure of aid on flawed policies and applications in the North and South, including an overemphasis on industrialization at the expense of agriculture-based development, corruption in recipient countries, and the influence of strategic and commercial self-interest on donor country aid allocation. With many LDCs experiencing aid dependency and skyrocketing debt, there is much debate over alternatives to traditional aid methods, such as pursuing growth through partnerships or identifying grassroots development approaches better suited to local needs.

Trade liberalization

In the 1980s, efforts to fight hunger shifted away from government action to a reliance on open markets, with mixed results. A World Bank study found that countries that increased their share of exports and imports to GDP and reduced their tariff levels (e.g., China, Malaysia, Mexico, India, Thailand, Chile, Argentina, and Hungary) saw average economic growth rates increase from 2.9 percent in the 1970s to 5.0 percent in the 1990s.[14] Hunger figures in these countries have seen some of the most dramatic declines anywhere. Those countries that decreased their share of trade to GDP and lowered their tariff rates the least (e.g., Burma, Pakistan, Honduras, and most sub-Saharan African countries) saw average economic growth rates drop from 3.3 percent in the 1970s to 1.4 percent in the 1990s. Hunger rates in these countries have remained some of the worst in the world.

However, embracing free trade is a necessary but insufficient element of national development strategies. Free trade is not an "easy" answer to the question of hunger either; its effectiveness depends on the underlying institutional and policy conditions in individual countries. To be successful, countries must support integration into the global economy with good governance measures such as putting the right institutions in place, reducing corruption, and improving infrastructure and public health systems.

Investment

Foreign direct investment (FDI) is another major tool to generate economic development and reduce hunger levels in LDCs. Industrialized countries in 2002 invested about $166 billion in LDCs through bonds, loans, and company ownership.[15] An Institute for International Economics study of 183 FDI projects carried out in thirty countries since the mid-1980s found the majority (55 to 75 percent) to have a positive impact on host country income levels. The study suggested that most of the negative effects could be addressed through reforming host country policies and laws.[16] Coupling these changes with new location incentives, rules of origin, and antidumping regulations in investing countries improves the chances for growth through FDI significantly.[17]

Microcredit is a particularly important tool in fighting hunger since it targets the rural poor, typically the poorest members of society. The Grameen Bank, which pioneered the concept in Bangladesh in 1976, has disbursed almost $3 billion in loans of less than $150 to individual entrepreneurs in LDCs. A typical borrower might be an impoverished mother who uses the funds to purchase a sewing machine, a cell phone, or even a cow—a small investment that enables her to produce a good or provide a service that meets a need in her community. One benchmark of the Bank's success is its impressive payback rate of over 90 percent. Today, Grameen Bank serves 2.35 million clients throughout Bangladesh, almost all women. The World Bank found that extreme poverty in these Bangladeshi villages where people had access to microcredit fell by 70 percent within five years. As of early

2002, there were about 30 million microcredit borrowers worldwide, 19 million of whom were once among the world's poorest people.[18]

Since well-structured FDI projects and microcredit can directly boost economic development in LDCs, they are some of the most successful tools for fighting hunger.

Multilateral cooperation

From the World Bank, to the United Nations Development Programme (UNDP), FAO, World Food Programme, and the World Trade Organization (WTO), the world's nations have demonstrated their intent to work together to confront poverty, hunger, and other problems that threaten global peace and stability. Several NGOs aiming to eliminate hunger have also emerged, including Bread for the World, Food First, and the Partnership to Cut Hunger and Poverty in Africa. Numerous international conferences, most recently the World Food Summits in 1996 and 2002, have helped bring resources and attention to this continuing problem. All of this cooperation has had an inestimable effect, yet more is clearly required to eliminate hunger.

Future Projections of World Hunger

Hunger continues to be an immense foreign policy challenge, and will likely remain so for many years to come. At the 1996 FAO World Food Summit, 190 nations set a goal of reducing the number of hungry people in the world by half in twenty years. The follow-up Summit in June 2002 reviewed studies showing that the number of undernourished people is falling at an annual rate of about 6 million, well below the 22 million per year average required to meet the FAO's goal.[19] In certain countries, the hunger problem will remain especially acute. India will have one-third of the world's undernourished children. Sixteen million African farm workers (i.e., food providers) are expected to die from HIV/AIDS in the next twenty years, and hunger rates in some sub-Saharan African countries are actually expected to rise.[20]

Projected population growth rates threaten to overwhelm future efforts to feed the world. The FAO expects world population will expand to as many as 10-12 billion by 2050, with the vast majority of the increase occurring in the developing world.[21] Because of the expected population boom, the absolute numbers of people going hungry will increase, even though the percentage may continue to decline. Countries facing dramatic population increases include China, India, Pakistan, Nigeria, and Ethiopia.[22] Water scarcity is also emerging as an important constraint. Water tables fell on every continent in the 1990s, with particularly serious declines in North America, North Africa, the Middle East, India, and China.[23] Given modern agriculture's heavy reliance on irrigation, water scarcity will be a major obstacle to increasing crop yields.

There is widespread agreement that the world's demand for food will double by 2025. Some observers believe the world's farmers and food industries can, with appropriate changes to policies and resource allocation, meet this increased demand. But with cultivable grain area reaching a plateau, population exploding, and water scarcity constraining production, there is no doubt that feeding the world will be one of the most important challenges governments and policymakers face in the coming decades.

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Opponents of biotechnology argue that if foreign aid has failed to end hunger, then ODA budgets must be increased and refocused on grassroots development; if trade liberalization has not solved the problem, then more is required, or it must go hand in hand with better governance; where investment has come up short, then it must be replaced by better-structured investment projects; and if multilateral cooperation has failed, then these efforts must be redoubled. If governments around the world addressed distribution bottlenecks, corruption, bad domestic policies, and internal strife, etc. vigorously and creatively, then hunger would be a thing of the past.

All of this may be true. But can we afford to wait for such ideal results, which have yet to, and may never, be realized? If current methods have failed to feed six billion, we must use all available tools—deploy the full arsenal—if we are somehow to feed almost twice that number. Agricultural biotechnology is one of the most promising new weapons for successfully combating hunger, yet widespread controversy has created major obstacles to its deployment. What is the nature of this controversy and how can the obstacles be overcome?

Biotechnology Products on the Market and in the Pipeline

Modern biotechnology is essentially the introduction into organisms—often across species boundaries—of specific genes with the intention of fostering desirable new traits. It is superior to conventional cross-breeding in that it allows for a quicker, more precise, and more reliable transfer of traits, and draws on a wider variety of genetic material.

Since the introduction of GM crops in the mid-1990s, their share of planted acreage has steadily increased. As of 2001, the total area planted with GM crops was 52.6 million hectares (1.3 percent of total cropland area). More than 99 percent of this planting is in the United States, Canada, Australia, Argentina, and China, where more than five million farmers now grow GM crops.[24] In all, sixteen countries currently grow GM crops and fifty varieties of GM foods are on the market today in the United States and elsewhere. Most traits commercialized so far address herbicide tolerance (77 percent of planted GM crops) and insect and disease resistance (20 percent). These products include herbicide- and insect-resistant cotton (Bt cotton), insect-resistant corn (Bt corn), herbicide-resistant soybeans, and fungal-resistant wheat. GM potatoes, tomatoes, sugar beets, and apples are also being marketed.

The United States is by far the leader in GM production, growing 70 percent of all GM crops. Two-thirds of food products on U.S. shelves contain GM ingredients, and one-third of all corn, three-fourths of all soybeans, and 40 percent of cotton are now GM.[25] Herbicide-tolerant crops have reduced the need to plow, thus decreasing soil erosion (and resulting in less carbon dioxide escaping into the air). Pesticide use in the United States has decreased by 46 million pounds since the introduction of insect-resistant GM technology in 1995,[26] while corn and cotton yields have increased by 5-10 percent. Because of lower chemical and other input costs, U.S. farmers improved their bottom line by $1.4 billion in 2001 using GM corn, cotton, canola, and soybeans.[27]

Since today's biotechnology products serve largely to boost production in developed countries, they increase total supplies and lower world market prices. For the moment, therefore, biotechnology is not benefiting income levels or efforts to fight hunger in LDCs. Only once scientists and policymakers adapt biotechnology to enhance local production and target specific needs in LDCs, can it begin to have a real impact on hunger.

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Currently available GM products could be leveraged on a case-by-case basis to enhance some crop yields in LDCs. But the coming "second generation" of GM crops and foods is of even greater relevance and may provide significant benefits for poor farmers. "Golden rice"—rice genetically modified to contain high levels of Vitamin A—should be commercialized in Asia by 2006 and is expected to make a significant contribution to fighting Vitamin A deficiency, a major cause of blindness and death. The company that developed golden rice, Syngenta Corp., has offered it royalty-free to the world's poorest farmers. Unfortunately, concerns over biotechnology have led some Asian rice growers to postpone plans to plant golden rice. If fully adopted, golden rice could have a major impact on malnutrition in Asia, as rice is already a staple, and rice dependence is expected to double by 2025.[28] Other products five to ten years down the pipeline include crops designed to tolerate cold, drought, and salt, and plants that can flourish in acidic soil.

Some LDCs are experimenting to produce foods that will help target their specific hunger problems. The Philippines is developing GM rice that resists bacterial blithe,[29] while India is developing GM groundnuts that survive Indian peanut clump virus, as well as GM pigeon peas, chickpeas, and sorghum.[30] China—a country with 33 million acres of saline soil—has experimented with salt-resistant tomatoes, soybeans, and rice.[31] Kenya is developing virus- and drought-resistant sweet potatoes, and in South Africa, Bt cotton has already helped poor farmers reap financial gains due to higher yields.[32]

In the realm of pharmaceutical biotechnology, private sector researchers are developing about 400 plant-based drugs that promise significant benefits for fighting health problems and combating hunger. These include allergy-free soybeans, cancer-fighting tomatoes and tomatoes with vaccines for Hepatitis B and diarrhea, bananas with vaccines against diarrhea and cholera, spinach with rabies vaccine, a corn that treats cystic fibrosis, and potatoes, pearl millet, corn, cassava, and other vegetables with enhanced nutritional value. These products are also expected to become available in five to ten years and, because of their cost benefits as domestically-grown medical alternatives, they could have a significant impact on health care in LDCs.

The Debate over Biotechnology

Despite its demonstrated benefits and immense potential, biotechnology has met strong resistance in many countries and from many quarters. Concerns center around its perceived threats to human health and the environment, the role of the corporations involved in its production, and ethical and moral considerations connected with its creation. Myths and misinformation fuel many of these concerns. The following discussion attempts to respond to these concerns, and assess the origins and ramifications of anti-biotechnology resistance.

Dangers to health

Concerns over the health effects of biotechnology are widespread. One of the most common is that genetic material introduced into new foods could cause unexpected allergic reactions in consumers. Yet, regulatory authorities worldwide pay strict attention to allergenicity when assessing the safety of foods produced using biotechnology. Since GM foods first hit the market in 1996, there have been no known cases of allergy, illness, or death from consuming GM products. In the mid-1990s, regulatory action forestalled the introduction of genes from Brazil nuts into other foodstuffs on the possibility they would cause allergic reactions. In 2000, a number of corn products were pulled from shelves when they were found to contain GM StarLink corn intended only for cattle feed, producing much controversy but no apparent ill effects in terms of human health.[33]

The fact is that more safety tests have been conducted on GM foods than on any food products in history. The U.S. Food and Drug Administration, Environmental Protection Agency, and Department of Agriculture have approved every GM food available on the U.S. market today, and a broad, international consensus has emerged on the safety of GM crops for human consumption and the environment. This consensus includes the OECD, World Food Programme, World Health Organization, Third World Academy of

Science, American Medical Association, American Dietetic Association, Swiss Association for Research and Nutrition, American Society of Toxicology, six national science academies, and nineteen Nobel Prize-winning scientists.[34] At the 2002 World Food Summit, the FAO came out in support of biotechnology products as being as safe for human consumption as their traditional counterparts.[35] Even the European Commission recently declared that "the use of more precise technology and greater scrutiny probably make GM foods even safer than conventional plants and foods."[36]

Nevertheless, since the potential for human health risks exists, continued regulatory scrutiny will be necessary to ensure that only those products suitable for human consumption enter the market.

Environmental damage

Greenpeace, Friends of the Earth, and other NGOs have warned about the possible emergence of environmentally hazardous "superweeds," new plants that draw unexpectedly on traits introduced through biotechnology. This is essentially a matter of gene flow, a phenomenon common in agricultural production, and one which scientists have experience at containing. Some critics worry about the possible side effects of GM crops on other species, such as the monarch butterfly; however, any negative impact on such species remains, for now, theoretical. What we do know is that examination of environmental impacts is taking place in every country that produces or consumes biotechnology, as well as through several of the international bodies mentioned above, significantly enhancing the risk control process. As with the question of risks to human health, the scrutiny of environmental impacts should, and in all likelihood will, remain intense.

The risks of biotechnology for both human health and the environment are being exaggerated. On the other hand, the proven and potential environmental benefits of biotechnology must be recognized, particularly the reduced reliance on dangerous chemicals that it makes possible. In Australia, for example, the use of Bt cotton has cut the country's pesticide use in half.[37] In South America, biotechnology has the potential to help preserve rainforests by increasing yields on existing farmland, lessening the need to clear more land by felling trees.

Corporate control

Monsanto and other leading food science companies led the charge to develop agricultural biotechnology. Both these companies and their critics now recognize the error of introducing biotechnology to the public in ways that benefited corporate bottom lines more than they addressed consumer needs. This did not help the acceptance of a controversial technology. Company requirements that farmers re-purchase new GM seeds yearly, instead of allowing for replanting in the time-honored tradition, have also raised concerns over corporate control, as have plans to insert genes that would prevent such replanting (the so-called "terminator genes"). In addition, some companies are engaging in a mad rush to patent plant gene strains around the world, enraging LDC farmers who developed these strains over generations and who consider them "public goods."

Clearly, corporate behavior has contributed to the resistance these products have encountered, and companies are now trying to repair their image. Syngenta's offer to provide golden rice royalty-free to LDCs is one example, as is Monsanto's decision to make its sequence of the rice genome freely available (LDC research facilities should eventually benefit from this access). Biotechnology's proponents expect the pending "second generation" of GM products, with its potential for more direct benefits to farmers in LDCs and consumers everywhere, to improve the technology's acceptance.

Biotechnology is also seen as a production tool that, because of economies of scale and purchase costs, benefits only corporate and other large-scale producers. However, evidence is beginning to show that it can deliver benefits to smaller farm operations as well. For example, a study on the adoption of Bt cotton in South Africa concluded that "both large-scale and small-scale farmers enjoy financial benefits due to higher yields and despite higher seed costs."[38]

Ethical objections

Some opponents object to biotechnology on moral or ethical grounds, saying that human beings should not interfere with the "natural order" by modifying genes or crossing species boundaries. However, humanity has always made use of science in order to improve living conditions. Traditional plant and animal improvement processes such as cross-breeding and hybridization are obvious examples, and genetic engineering is essentially a refinement of such methods.[39]

Reflecting these various concerns, resistance to biotechnology is at a high level today, particularly in Europe. Fueled by pressure from the environmental lobby and other NGO sources, as well as genuine consumer preferences for conventional foodstuffs, Europeans have opposed the introduction of GM products into their food system. Although the European Union does not officially ban foods with GM ingredients, a de facto ban on approvals of GM products has existed in the EU since 1998.

There are recent signs, however, of a shift to a more accommodating European position. The European Commission in 2002 cited eighty-one separate studies supporting the view that GM foods on the market are as safe to eat as their traditional counterparts.[40] Spain, France, and Portugal are currently growing GM crops, and Spain has reported benefits from Bt corn that include environmental improvements, higher yields, better quality, and increased income.[41] In addition, dozens of European companies are developing products like GM beans, grapes, wheat, and bananas—but for now they are intended only for sale in LDCs or the United States, not in Europe.[42] Finally, the new European Food Safety Authority is expected to lift the de facto ban in the EU.

Other industrialized countries have been slow to accept biotechnology as well. Switzerland and New Zealand remain biotech-free today, the latter taking a long look before approving any GM products for market entry. This is also the approach in some Asian countries. The resistance of some industrialized countries to biotechnology has even begun to dampen U.S. farmers' enthusiasm for planting GM crops and stifle the development of new products by biotechnology companies.

However, it is EU resistance to biotechnology that is the major obstacle to poor countries' development and use of biotechnology. Africa needs biotechnology more than any other region, yet the EU's position has made some African countries reluctant to take up this technology. Last year, Zambian President Levy Patrick Mwanawasa refused 17,000

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tons of U.S. grain intended to forestall the famine facing 2.9 million Zambians out of fear the country would lose its export markets in Europe. Four other African countries facing similar food shortages—Mozambique, Malawi, Zimbabwe, and Lesotho—accepted GM corn, but only if the grain was first milled into flour (to prevent it from affecting the region's exports). European resistance could also affect Africa's livestock exports if they become GM-fed.

In some cases, concerns about the risks associated with biotechnology are preventing the establishment of national regulatory regimes that could facilitate the commercial importation or development of biotechnology in LDCs. In others, they are leading to the establishment of regimes that interfere with the technology's development and importation. China, for instance, recently reversed course on biotechnology and imposed restrictions on domestic varieties of GM rice, soybeans, vegetables, and tobacco, while requiring stringent safety tests and labeling for GM imports. Critics consider these constraints protectionist measures designed to shield China's huge domestic farming sector from further pain while it restructures to meet its WTO commitments.[43]

Pressure from NGOs also contributes to LDC resistance to biotechnology. The environmental lobby has targeted LDCs in a $175 million campaign to convince them to reject biotechnology.[44] Greenpeace warned the Philippine government that there would be "millions of dead bodies and disease" if it accepted GM foods.[45] The Sierra Club has called for a moratorium on all planting of GM crops,[46] while the Earth Liberation Front has caused $40 million of damage to GM farms and laboratories around the world.[47] Former Greenpeace co-founder Patrick Moore and others have questioned the honesty of the environmental lobby's arguments on biotechnology, denouncing them as scare tactics designed to raise funds in order to stay solvent.

Finally, some individual anti-GM activists play a prominent role internationally. India's Vandana Shiva opposes all forms of high-tech agriculture, which she says will destroy the land and "traditional farming." The ecologist-activist has opposed golden rice, attempted to block U.S. food donations to Indian cyclone victims that contained GM ingredients, and argued in favor of organic production as the "wave of the future."[48] Partly as a result of Shiva's activism, India—a country with significant hunger challenges—has banned the domestic marketing of all GM food crops for supposed human health and rural employment reasons.[49]

Overcoming Obstacles to the Use of Biotechnology

Enough opposition to biotechnology could stall or defeat breakthroughs in important areas. Opposition could also result in GM products, once developed, going unused, left, as the saying goes, to "wither on the vine." Indeed, many approved GM foods are going unplanted in industrialized countries for fear of attracting NGO-inspired demonstrations or violence. For LDCs, the story is the same. Out of fifty-four African countries, only South Africa and Kenya have plans for developing GM products, and these plans are small scale and limited. The restricted availability and adoption of biotechnology in LDCs is due to several factors, including:

- Fear of lost export sales to Europe and elsewhere
- Intellectual property rights constraints
- Health and environmental concerns
- Inadequate scientific and research capacity in LDCs
- Absence of government regulatory mechanisms to oversee testing and regulation
- A general inability to assess biotechnology's potential and risks

These obstacles must be overcome before LDCs can take full advantage of biotechnology in addressing their nutrition needs. Let us review each in turn.

When coupled with appropriate domestic policies, trade liberalization can be one of the most important engines for growth in LDCs. Two-thirds of the developing world labor force is employed in agriculture. In Africa, rural small-holder farms provide over 80 percent of agricultural exports.[50] It follows, therefore, that developing the export potential of LDC agriculture can generate significant growth and combat hunger. However, European export subsidies deny LDC producers their due market share, and EU opposition to GM products creates negative incentives for LDCs to invest in production-enhancing biotechnology and the supporting regulatory mechanisms, with disastrous consequences for economic growth and hunger levels in LDCs.

Many believe that if today's large food surpluses could find their way overseas, we could adequately feed the world. But, while channeling those surpluses to LDCs would feed people today, it would also undercut local agricultural sectors. Such a strategy would, in fact, have a dampening effect on efforts to raise local agricultural production, which is one of the best long-term solutions to hunger. Biotechnology can deliver these much needed production increases, and help people help themselves to break out of the poverty-hunger cycle. Although only four LDCs worldwide currently grow GM products, the initial results for productivity are positive (e.g., South Africa).

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One way to resolve the biotechnology standoff is to establish a global system for setting safety standards that rely on scientific evaluation and risk assessment procedures. Such a system could include a labeling regime that facilitates the acceptance of uniform, science-based standards and common regulatory procedures. The ongoing negotiations in the WTO Doha Round are not the appropriate avenue for addressing this issue. Instead, efforts must be made to establish such a global system through alternative fora like the Codex Alimentarius Commission, which sets international food standards and guidelines. In the meantime, the concept of "substantial equivalence," in which GM products are tested to determine whether they are substantially different from their traditional counterparts, is already employed in many countries and can help smooth the way for approval in new countries. Mutual recognition agreements, in which countries agree to recognize each other's approval processes, can also help facilitate trade in GM products today.

Second, the international community needs to develop a shared vision of the role of GM crops that gets beyond current intellectual property rights issues such as the corporate patenting of gene strains. Consideration should be given to creating an international commission, perhaps under UN auspices, that could promote a broad public consultation that balances the corporate need to pursue profits with local needs in the battle against hunger.

As for the risks to human health and the environment, strengthened regulatory scrutiny and transparency will be essential to achieving broader public acceptance of GM products in Europe, LDCs, and elsewhere. A case-by-case assessment of risks will be required, with due attention paid to the effects on human health and the environment in each country concerned. As David

Victor and Ford Runge have noted, "A failure in regulating biotechnology anywhere will harm the industry everywhere."[51]

Although private sector investment in biotechnology rose by $100 billion in the 1990s, greater governmental investment in research will be necessary to disperse the benefits of biotechnology more widely. In particular, increased U.S. government support for foreign agricultural research offers the best potential to raise income and lower hunger levels directly in the developing world. Yet governments in the developing world must invest more as well. In 1995, for every $100 of agricultural GDP, developed countries invested $2.70 in public research and development, while LDCs invested only $0.62.[52] Public-private partnerships can help bridge this investment gap. A promising example is the case of South Africa, where the government is cooperating with industry on a $30 million research project to develop drought-resistant crops by 2003.[53]

LDCs are not currently in a position to invest substantially in the science of biotechnology, nor are they capable of creating the necessary regulatory institutions to govern its adoption and application. They must therefore work with developed countries not only to build their scientific capacity, but also to exchange information that will enhance their ability to construct and enforce regulations and institutions that will facilitate biotechnology's adoption in their own countries.

Last, any assessment of biotechnology's potential and risks in LDCs must take into account the specific and varied needs, conditions, and circumstances of these countries if hunger is to be eliminated there. This means that governments, businesses, and scientists operating in places such as New Delhi, Beijing, Capetown, and São Paolo should have a hand in their development. At the very least, it is essential for LDCs to stay abreast of the latest developments in biotechnology in order to make informed decisions.

Biotechnology's Role in Combating Hunger

The need to increase future food production is clear. Over 840 million people go hungry today, and hundreds of millions are expected to go hungry in the decades to come. With cultivable grain area plateauing, feeding tomorrow's global community will require making a choice: either we harvest remaining forests and plant crops on available marginal lands, or we find ways of boosting the yields of existing croplands in both developed and developing countries in ways that circumvent impending water shortages. These demands and constraints highlight biotechnology's potential.

World leaders agree on the production-enhancing benefits of biotechnology. FAO Director-General Jacques Diouf has said that since global food production must increase by 60 percent in coming decades, it makes sense to take advantage of the productivity benefits that biotechnology offers.[54] To get around the current stalemate, Sakiko Fukuda-Parr, Director of UNDP, has called for the development of a "third way," one that involves strengthened measures to address the risks associated with biotechnology, accompanied by a focus on harnessing its potential to tackle the pressing need to improve the productivity of poor farmers.[55]

There is no time to waste. Half of the world's poorest people live in uncertain climates, dependent on staple crops such as cassava and sorghum for survival.[56] Africa in particular requires advances in food technology—and fast. Most Africans farm small plots of less than four acres, cultivating crops such as corn, sweet potatoes, cassava, and millet. Few have the capital to invest in agricultural improvements, and their harvests are vulnerable to the ravages of plant and animal diseases, pests, soil toxicity, floods, and droughts.[57] These are some of the very problems that bio-engineers are tackling in today's laboratories.

However, biotechnology should not be considered a panacea, but rather a complement to traditional agricultural methods. Farmers in Africa and other LDCs could benefit from the application, where feasible, of existing herbicide-tolerant, disease-resistant, and insect-resistant crops (managing pest infestations in poor rural areas for example is a major problem), and particularly the promising new drought-, cold-, and saline-tolerant crops under development (one-fourth of the Earth's landmass is saline soil). From drought-resistant sweet potatoes in Africa to salt-resistant crops in China to golden rice in Indonesia and Bangladesh, biotechnology must be used to target specific problems in specific locations.

Deploying the Full Arsenal

The question of accepting or banning products made using modern biotechnology is an important issue that cuts across social, economic, and political boundaries. The battle lines in the debate are being drawn, and opponents of biotechnology are out in force.

Fortunately, GM products have been well received in many countries. Recent polls show that 71 percent of U.S. consumers are willing to embrace products with GM ingredients.[58] And a poll of 600 consumers in Thailand, China, and the Philippines suggests that most Asians do not mind buying or eating GM products either.[59] The battle for public acceptance must be fought principally in Europe and increasingly in Africa and other developing countries that are concerned about their trade relations.

Developing countries need many things: improvements in infrastructure, credit for small farmers, development that targets women, stable societies and economic policies, anti-corruption policies, medical assistance, technology transfers, and greater and better aid, trade, investment, and cooperation from developed countries. Eradicating hunger will require fighting on all of these fronts simultaneously.

Agricultural biotechnology is an essential tool with immense potential to help developing countries improve crop yields and productivity, safely provide a broader array of more nutritious foods at lower costs, reduce harvest losses, and create higher and more stable rural incomes. And it can do this while also using less land and less water in production, improving pest control methods, reducing dependence on chemical fertilizers, and providing other environmental benefits. With such a powerful array of proven and potential benefits, biotechnology, if deployed, could lead to an agricultural revolution more dramatic than the Green Revolution, and potentially make the difference in waging a successful war on hunger.

Notes

1 Bread for the World, *Hunger Basics*, <http://www.bread.org/hungerbasics/index.html> (11 December 2002).

2 John Mason, "Hunger Reduction Slows to Dismal Level," *Financial Times*, 16 October 2002.

3 Bread for the World, *Hunger Basics*.

4 Anthony J. Covington, "What's So Terribly Wrong with GM Food?" *Asia Intelligence Wire*, 18 September 2002.

5 Bread for the World, *Hunger 2001: Foreign Aid to End Hunger* (Silver Spring, MD: Bread for the Word Institute, 2002).

6 Sebastian Mallaby, "Phoney Fears Fan Famine in Africa," *East African Standard,* 16 September 2002.

7 FAO, *The State of Food and Agriculture 2000* (Rome: FAO, 2000), 306.

8 RESULTS, *Global Action*, Worksheet, October 2002.

9 Lester R. Brown, "Feeding Nine Billion," in *State of the World 1999* (New York: W.W. Norton & Company, 1999), 115–132.

[10] Worldwatch Institute, *State of the World: More Connected, Less Stable,* Press Release, January 2002, <http://www.worldwatch.org/alerts/020110.html> (11 December 2002).

[11] Anders Närman, "Reconstructing Development Assistance and Co-operation," in David Simon and Anders Närman, eds., *Development as Theory and Practice* (Harlow, England: Addison Wesley Longman, 1999), 171.

[12] Ibid., 159.

[13] Bread for the World, *Hunger 2002: A Future with Hope* (Silver Spring, MD: Bread for the World Institute, 2002), 83.

[14] David Dollar, "Globalization, Inequality and Poverty Since 1980," World Bank, September, 2001.

[15] Institute of International Finance, as quoted in "A Helping Hand," *The Globalist,* 27 November 2001. <www.theglobalist.com>

[16] Theodore H. Moran, *Foreign Direct Investment and Development: The New Policy Agenda for Developing Countries and Economies in Transition* (Washington, DC: Institute for International Economics, 1998), 24–25.

[17] Ibid., 163–168.

[18] RESULTS, "Microcredit," <http://www.results.org/website/article.asp?id=244> (21 December 2002).

[19] Jacques Diouf, Press Release, United Nations FAO, 21 January 1999.

[20] Bread for the World, *Hunger 2002*, 71–91.

[21] FAO, *The State of Food and Agriculture 2000*, Rome 2000.

[22] The UN expects China's population to grow from 1.3 billion today to 1.6 billion by 2050; India's from 1 billion to 1.6 billion; Pakistan's from 148 million to 357 million; Nigeria's from 122 million to 339 million; and Ethiopia's from 62 million to 213 million. Iran, Indonesia, Sudan, Egypt, and Bangladesh will also likely have trouble feeding their growing populations in coming decades.

[23] Brown, 120.

[24] Joel I. Cohen and Robert Paarlberg, "Explaining Restricted Approval and Availability of GM Crops in Developing Countries," *AgBiotechNet* 4 (October 2002).

[25] "Why Africans Are Starving," *Wall Street Journal*, 17 September 2002.

[26] Judy Aita, "Developing Countries Should Adopt Biotech, UN Panelists Urge," U.S. Department of State International Information Programs, 24 September 2002.

[27] Rachel Melcer, "Altered Crops Have Farmers Walking a Tightrope of Acceptance," *St. Louis Post-Dispatch,* 25 September 2002.

[28] Reuters, "Asian Farmers Seen Sowing 'Super Rice' in 2-3 Years," 19 September 2002.

[29] Carmelo Q. Francisco, "Philrice to Commercialize Genetically Modified Rice," *Business World*, 16 September 2002.

[30] "GM Peanut a Field Trial Stage," *Hindu Business Line,* 14 September 2002.

[31] "China Cultivates Salt-Resistant Cloned Tomatoes, Rice, Soya, Poplars," *Asia Intelligence Wire,* 15 September 2002.

[32] Johann Kirsten and Marnus Gouse, "Bt Cotton in South Africa: Adoption and Impact on Farm Incomes Amongst Small- and Large-Scale Farmers," *ISB News Report*, October 2002.

[33] *New Scientist*, "Much Ado About Nothing," 18 May 2002.

[34] Marc Morano, "Green Activist Accused of Promoting Famine Wins Time Magazine Honor," *CNSNews.com*, 17 September 2002, <www.cnsnews.com/ForeignBureaus/Archive/200209/FOR20020917a.html> (12 December 2002).

[35] "Irrational Fears of Frankenfood," *Las Vegas Review-Journal*, 16 September 2002.
[36] Francisco, "Philrice to Commercialize Genetically Modified Rice."
[37] Denis Dutton, "Fear-Mongering Greens Doom Children to Death," *New Zealand Herald*, 28 September 2002.
[38] Johann Kirsten and Marnus Gouse, "Bt Cotton in South Africa: Adoption and Impact on Farm Incomes Amongst Small- and Large-Scale Farmers."
[39] International Policy Council on Agriculture, Food and Trade, *Plant Biotechnology and Global Food Production: Trade Implications*, Position Paper No. 7 (Washington, DC, October, 1998).
[40] James Morris, "Biotech Food Can Save Millions of African Lives," *International Herald Tribune*, 19 September 2002.
[41] "The Farm Level Impact of Using Bt Maize in Spain," Brookes West Consultancy, 27 September 2002 <http://www.europabio.org/pages/ne_gbgmcrops.asp> (21 December 2002).
[42] Brandon Mitchener, "Politics Hamstring Europe's FDA," *Wall Street Journal*, 17 September 2002.
[43] Joseph Kahn, "The Science and Politics of Super Rice," *New York Times*, 22 October 2002.
[44] "Why Africans Are Starving," *Wall Street Journal*.
[45] Murray Lyons, September 19, 2002.
[46] "Why Africans Are Starving," *Wall Street Journal*.
[47] Michael Rodemeyer, "Ratcheting Down the Debate Over Biotechnology," *Newark Star-Ledger*, 24 June 2001.
[48] Norman Borlaug estimates that organic production could feed only about 4 billion out of today's 6.1 billion people.
[49] Morano, "Green Activist Accused of Promoting Famine Wins Time Magazine Honor."
[50] Partnership to Cut Hunger and Poverty in Africa, <http://www.africanhunger.org/Intro.htm> (12 December 2002).
[51] David G. Victor and C. Ford Runge, "Farming the Genetic Frontier," *Foreign Affairs* 81, no. 3 (May/June 2002).
[52] Sakiko Fukuda-Parr, "Making New Technologies Work for Human Development," United Nations Development Programme, 6 September 2002.
[53] Ibid.
[54] Jacques Diouf, Press Release, FAO, 21 January 1999.
[55] Sakiko Fukuda-Parr,"Making New Technologies Work for Human Development."
[56] Ibid.
[57] Bread for the World, *Hunger 2002,* 81.
[58] Institute of Food Technologies, "Survey: Consumers Support Food Biotechnology," 30 September 2002.
[59] Jason Leow, "Asians Are Game to Try GM Foods," *Straits Times* (Singapore), 22 September 2002.