

Abolishing Hunger: Science to the Rescue

A Personal Résumé after 40 Years of Commitment

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Science, technology, and innovation are able to address the severe ecological challenges ahead and ensure that all people have that most basic of human rights, the right to food security. Today the condition of hunger in a world of plenty is monstrous and unconscionable and must be abolished. No single action is going to help us solve all the problems of world hunger. But several paths are open to us to achieve noticeable change within a few years. We need the political will to really put the abolition of hunger at the top of our agenda. Science is not going to flourish or bring about its desired results without sound national policies and effective local actions, from the global to the local level. We need good governance, in terms of transparency, participation, accountability, and information flows. The benefits from research should benefit those who produce most of the food where it is actually consumed by those who need it most.

1 Introduction: The New Abolitionists

Ensuring global food security is a major challenge, but it is not beyond the ken of human ingenuity and determination to succeed. We must, through sustainable and equitable systems of production and consumption, meet the needs of all the 6.7 billion inhabitants of the world today, and the additional 2–3 billion that we expect in the coming decades, recognizing the challenges posed by changing diets and continued production on environmental systems that are already stressed. We must do it using roughly the same amount of land and water.

Knowledge will be the key. Research and dissemination of current best practices will show how to close the yield gap, how to produce more for less, how to improve management and reduce waste along the entire supply chain, and how not to confuse the urgent necessity of humanitarian

aid with the fundamentally important developmental questions of transforming global agriculture and the food processing and distribution system. These are exciting prospects to finally abolish hunger in our lifetime.

In 2000, the leaders of the world met at the UN and adopted the “Millennium Development Goals”. The first of these was a promise to fight poverty and reduce the number of the hungry by half by 2015, to go down from 850 million to 425 million hungry souls on this planet. Shame on us all! By 2008, the figure had actually risen to 950 million and was estimated to have peaked at about one billion in 2009 before coming down to 925 million in 2010.

It is inconceivable that there should be close to *a billion people going hungry* in a world that can provide for that most basic of all human needs. In the 19th century, some people looked at the condition of slavery and said that it was monstrous and unconscionable. That it must be abolished. They were known as the abolitionists. They did not argue from economic self interest, but from moral outrage.

Today the condition of hunger in a world of plenty is equally monstrous and unconscionable and must be abolished. We must become the “*New Abolitionists*”. We must, with the same zeal and moral outrage, attack the complacency that would turn a blind eye to this silent massive killing of the innocents which claims some 40,000 hunger-related deaths every day. So what is the problem? What can science and technology do about it? And how can decision-makers make this happen?

2 Food Security for All

Food security is access to sufficient food by all people, at all times – in terms of quality, quantity, and diversity – for an active and healthy life without risk of loss of such access. Most societies have achieved this due to enormous advances in agricultural techniques, plant breeding, and engineering schemes for irrigation and drainage.

The Malthusian nightmare of famine checking population growth was systematically pushed back by Science, Technology, and Innovation. Global population grew, and many lagging so-

cities have achieved a modicum of security that would have been unthinkable half a century ago. India that could not feed 450 million in 1960 is now able to provide the caloric coverage for over a billion people with a surplus of 33 million tons largely on the same land and water.

So what went wrong? Let me put forward a few key statements about food security:

- The key to handling food security requires *increasing production* to increase the caloric coverage for both *food and feed* at rates that will match or exceed the quantity and quality requirements of a growing population whose diets are changing because of rising incomes. This increase must be fast enough for prices to drop (increasing accessibility of the available food to the world's poor) and must be achieved by increasing the productivity of the small-holder farmers in the less developed countries so as to raise their incomes even as prices drop.
- *Better management* will play an enormous role in this, from increasing the productivity of the farmers' fields to reducing the wastage in the entire supply chain, from post harvest losses in poor countries to the enormous amounts of food thrown away by consumers in the rich countries. Rapid deployment of the best practices, such as System of Rice Intensification (SRI), is badly needed.
- The desired productivity increases will also require all the available technology, including the use of *biotechnology* for food and feed products, an approach that every scientific body has deemed to be safe, even though it is being bitterly fought by the Organic Food Growers lobby and various (mainly European) international NGOs.
- *Climate change* has increased the vulnerability of the poor farmers in rain-fed areas and the populations who depend on them. Special attention must be given to the production of more drought resistant, saline resistant and less thirsty plants for the production of our basic staples that we rely on for both food and feed.
- *The qualitative aspects* of the food and feed and their production is important. Additional areas where research is needed and where

specialists must provide guidance are the decrease of *post-harvest losses*, increase of *storability* and *transportability* of food, and the increase of the *nutritional content* of the food through *bio-fortification* of the food crops.

- *Biofuels* should not be allowed to compete for the same land and water that produces food for humans and feed for their livestock. *It is wrong to burn the food of the poor to drive the cars of the rich.* We need to look into a new generation of biofuels, either using cellulosic grasses in rain-fed marginal lands or produced from algae in the sea or other renewable energies (solar and wind) and not divert food and feed products for fuel production.
- Food security does not mean food self sufficiency for every country. We need a fair *international trading system* that allows access to food and provides some damping of sudden spikes in the prices of internationally traded food and feed crops.
- *Public education campaigns* about food security and eating habits of people is needed, and eminent professional groups should get involved. Like the global anti-smoking campaign, we need global pro healthy food habits. But we also need to campaign with the governments to maintain buffer stocks and make available enough food for humanitarian assistance that will inevitably continue to be needed in various hot spots around the world.

3 Science and New Technologies to the Rescue

No single action is going to help us solve all the problems of world hunger. But several paths are open to us to achieve noticeable change within a five year horizon. Many policy actions are already open to us, as explained above, and only require the will to pursue them. But there are a few more actions that need new technologies that are almost within our grasp, and which – with a small push – could lead to immediate results. I have grouped these under the heading of *land, water, plants, livestock, and aquatic resources*. Taken with the preceding policies, these actions will give us major benefits, showing how science, technology, and innovation, deployed

with good management that reduces waste and improves productivity all along the supply chain, can help to put us back on track to significantly reduce hunger in a few short years.

Land

Agriculture is the largest claimant of land from nature. Humans have slashed and burned millions of hectares, as they deforested for farmland. Sadly, through bad stewardship, much of our farmland is losing topsoil, and prime lands are being degraded. Pressure is mounting to further expand agricultural acreage, which means further loss of biodiversity due to loss of habitat. We must resist such pressure and try to protect the tropical rain forests in Latin America, Africa, and Asia. But let us also:

- rapidly deploy systematic efforts at collecting and classifying all types of plant species and use DNA fingerprinting for taxonomic classification. Add these to the global seed/gene banks and find ways to store and share these resources.
- Use satellite imagery to classify soils and monitor soil conditions (including moisture) and launch early warning campaigns where needed.
- For the longer term, launch more scientific work to understand the organic nature of soil fertility not just its chemical fertilizer needs.

Water

Water is life. Humans may need to consume a few liters of water per day for their survival and maybe another 50–100 liters for their well-being, but they consume on average about 2,700 liters per day for the food they consume. Approximately one liter per calorie, more for those whose diet is rich in animal proteins and especially red meat. At present it takes about 1,200 tons of water to produce a ton of wheat, and 2,000–5,000 tons of water to produce a ton of rice. Rainfall is likely to become more erratic in the tropical and subtropical zones where the vast majority of poor humanity lives. Floods alternating with droughts will devastate some of the poorest farmers that do not have the wherewithal to withstand a bad season. We absolutely must produce “more crop

per drop”. Partly this can be done with simple techniques such as land leveling and better management of irrigation and drainage; partly we need plants that are more suited to the times ahead (see below). Much can be done with existing knowledge and techniques, but there are four research areas that could help a lot:

- We know hardly anything about groundwater. New technologies can now *map groundwater reservoirs by satellite imagery*. It is imperative that an international mapping of locations and extent of water aquifers must be undertaken. New analysis of groundwater potential is badly needed, as it is likely that as much as 10 percent of the world’s grain is grown by water withdrawals that exceed the recharge rate of the underground reservoirs on which they draw.
- The effects of climate change are likely to be problematic. But global models are of little help to guide local action. Thus it is necessary to develop *regional modeling for local action*. Scientists agree on the need for these models, to complement the global models and to assist in the design of proper water strategies at the regional and local scales, where projects are ultimately designed.
- We need to recycle and reuse water, especially for peri-urban agriculture that produces high value fruits and vegetables. New technologies to *bring down the cost of recycling* must be moved from lab to market rapidly. Decision-makers can encourage accelerated private sector development programs by promises of buy-back at given prices.
- Finally: *Desalination of sea water*, not in quantities capable of supporting current agriculture, but supporting urban domestic and industrial use, as well as hydroponics and peri-urban agriculture is possible and important.

Plants

Climate change is predicted to reduce yields unless we engineer plants specifically for the upcoming challenges. Whether food or fodder, we will need major transformation of existing plants to be more resistant to heat, salinity, and drought and to adapt them to shorter growing seasons.

We must use all the tools at our disposal, including biotechnology. Improved nutritional qualities such as vitamin-A rice and other forms of bio-fortification must be pursued. Also off-the-beaten-track approaches should be pursued. Thus the mangrove's biochemical pathway that allows it to live on sea water has been identified. Can it be inserted into other plants? This is a worthy research project that needs acceleration!

Furthermore, reduction of post harvest losses is a major way of increasing the finally available food and feed. Thus storability, transportability, and value added processing should be pursued. Again much can be achieved by using the best of science on those crops that interest the poor, for the conditions that prevail there.

Too much focus has gone to the study of individual crops, and the promotion of large monoculture facilities. There are costs in that, both environmental and social. A massive push should be pursued for plants that thrive in the tropics and subtropical areas and the arid and semi-arid zones. We need to focus on the farming systems that are suited to the complex ecological systems of the small-holder farmers in the poor countries.

This kind of research should be treated as international public goods, supported with public funding and the results made freely available to the poor. Such an investment will reduce the need for humanitarian assistance later on.

Livestock

Animals are an integral part of the farming systems of the poor. They provide milk, and frequently traction and manure as well. Milk is nutritionally important for the poor family, and the Indian experience has shown that you can organize small-scale producers into a truly national program. India overtook the USA as the world's largest milk producer. We need science to pay attention to their diseases and to the development of appropriate vaccines as well as to provide a better understanding of their interaction with the environment, from methane releases into the atmosphere to their provision of organic fertilizer.

Furthermore, given the importance of farm animals, and the rising demand for meat products in the world due to changing diets, especially in

China, and the pressure that is going to be put on the production of feed, competing with the direct consumption of grain by humans, a better understanding of livestock issues is badly needed.

Aquatic Resources

In almost every aspect of food production, we are farmers, except in aquatic resources, where we are still hunters-gatherers. In America in the 19th century, hunters almost wiped out the buffaloes from the Great Plains. Today we have overfished all the marine fisheries in the world, as we focused our efforts on developing ever more efficient and destructive hunting techniques. We now deploy huge factory ships that can stay at sea for months at a time.

We need to invest in the nascent technologies of fish farming. There is some effort at promoting Tilapia (freshwater), sometimes called the aquatic chicken. In addition, integrating some aquaculture in the standard cropping techniques of the small-holder farmers has proven to be ecologically and economically viable. The private sector has invested in some high-value products such as salmon and shrimp. But all aquatic resource farming is still in its infancy compared to other fields. A massive international program is called for.

Marine organisms reproduce very quickly and in very large numbers, but the scientific farming of marine resources is almost non-existent. Proper farming systems can be devised that will be able to provide cheap and healthy proteins for a growing population. About half the global population lives within a short distance of the sea. Given the billions that have gone into subsidizing commercial fishing fleets, it is inconceivable that no priority has been given to this kind of highly promising research. Decision-makers must address that need today.

4 Contextual Issues

4.1 The Context of Science: Globally

First: Science has already done much for humanity. Nobody could imagine, neither Malthus at his time, nor at the beginning of the last century, a world with over 6.5 billion people which

is largely covering its needs in production, although still a billion *people go hungry because of bad policies and bad distribution*.

Second: There is the issue of *war and peace*. A map of areas of malnutrition and hunger is close to a map of failed states and conflicts. Food security requires peace as much as it requires food, infrastructure and other needs. Therefore, we will need continued *humanitarian assistance*. Food must be available for humanitarian needs for those caught in wars or civil strife or ecological disasters. But humanitarian assistance, though essential, is not a solution to the food security problem, which requires a comprehensive approach to ensure food security for all the 6.7 billion people in the human family today and for the 9 billion that we expect to become in a few decades. A comprehensive approach involves production and sustainability, prices and access, subsidies and policies, science and practice.

Third: We also recognize that *climate change* is increasing vulnerability, especially of small-holder farmers. Everywhere, from floods in Pakistan to droughts in Russia, the changing climate and its accentuated cycles is indeed problematic.

Fourth: We need *political will*. We need the political will to really put the abolition of hunger at the top of our agenda. Political will is drawn from public opinion that is shaped by intellectuals, scientists, the media, communities, and national leaders. National leaders should not only follow what is fashionable in the public, but they should shape it in order to generate the actions needed to abolish hunger and thereby become the “New Abolitionists”.

Finally: We must operate at *multiple scales*: Global, regional, national, and local. The issues are different and the actions required are different, but they fit in nested hierarchies that are all required, and that ultimately complement each other. The whole is more than the sum of the parts.

Given all the above, we need *global policies* to address the increases in food prices that reduce the access of the poor and therefore make the problem more difficult, and so does the variability of prices. Thus action on *stabilization of food prices* and increased access are important. Beyond recognizing the volatility of rice, wheat, and maize prices and the need for better func-

tioning markets with some means of improved stabilization of food prices, we must ensure, even in periods of shortage – when countries that normally export start to block exports, as we saw in 2008 globally and as we saw again in 2010 in Russia – that we still have available *stocks* for humanitarian aid and agencies like the World Food Program have resources to meet that side of the equation.

The issues of *fair trade and the triangulation of markets* are important. That means that we can buy in regional markets from places that have surplus to the places that are in shortfall, thereby helping the poor farmers who have a surplus and costing the rich countries only the funds, as opposed to using these funds for buying in the international markets from major grain exporters to ship directly to the poor areas in shortage.

Subsidies (agricultural subsidies, biofuel subsidies, petroleum subsidies), given by the rich to the rich, are really parts of what distorts the global scene and need to be addressed. We need fair trade and we need above and beyond that, a *global grand challenges approach to agricultural research as a global public good*. The benefits from research should not benefit only the stockholders of rich corporations, but those who need and use it, those who produce most of the food where it is actually consumed by those who need it most.

But in that knowledge we possess, as in the markets that we want to see operate effectively, broad participation is essential. We need to *fight monopolies and oligopolies* that have been created by a few large multinationals, whether in pharmaceuticals or in seeds. We need to change the regulatory frameworks. We need to encourage local industries to produce generics and local seeds.

And on that question of food availability, we must also help reduce post-harvest losses in the poor countries. But do people know how much of the food in the rich countries in the north is just thrown away? Packaged food that is date stamped and expired goes unused and is destroyed. Enormous amounts of cooked food are just thrown away. In food production and consumption, we have – like in many other aspects of today’s world – enormous waste. We must not only *reduce waste* but also share what we know.

Also, at the global level, we need to deliver our promises of *increased aid*, and not just deliver the aggregate amounts that were promised on the G8 summit 2009 in L'Aquila, but we need to focus on the smallholder farmers in the developing countries and meet their needs. They need all the help they can get. We need to support research and also to recognize sub-sovereign credit whether to local communities or community-based organizations or NGOs, but not just the state.

But more than money is involved. We must also share what we know. In promoting that sharing of knowledge, we must adopt *evidence-based regulation* and seek domestic-based production and adopt a precautionary principle that recognizes potential risk but sees the risk as part of the process, for no step is risk-free. And the proper basis for evaluating a new technology is not to assume that the alternative is zero risk, the alternative is the continuation of past policies and technologies. A new policy or program must be compared to other policies that exist. And as we promote our national regulatory policies, we must ensure that the interests of the poor, the youth, the women, and the marginalized are served, not those of international private corporations. We must think of how to empower people to choose technologies that suit them best.

4.2 The Context of Science: Locally

Science is not going to flourish or bring about its desired results without sound national policies and effective local actions. Good science is not going to help poor farmers in bad national contexts. We need *good governance*, in terms of transparency, participation, accountability, and information flows – and not just for governments, but for public and private corporations, for NGOs, for the civil society. This is equally applicable to all levels. We need to think of how to actually help national products meet international standards; how ethical standards, concerns of human rights, and other considerations – that are now rightly shared across the planet – also inform local policies.

We need *strong intermediary organizations* that can mediate between positions at the state and the global level, and at the local level. Knowledge and technologies available at the

global or national level need to be brought to the farmers' fields. The yield gap observed between what is achievable on research stations and what the average farmers produce is a manifestation of the inadequacy of the weak intermediary organizations in many countries.

In all we do we should not forget the environment, not just in terms of better integration of soil, water, and nutrition in our agronomic systems management, but more generally, we need to adopt an agro-ecological approach to recognize the benefits of biodiversity, and create publicly and internationally supported gene banks so that food security will never be captured by a few.

We need to exchange more knowledge about success stories and best practices. A most important area to focus onto are the gains that are available through *better management*. Successful examples such as System of Rice Intensification recognize farmers as partners. There must be more human contact, less paper.

We also need to focus on *health and nutrition*: It is not just about the aggregate amount of calories, or the aggregate tons of cereals that are available. Hunger is something that requires attention to health and nutrition. The primary vector for effective action is women's health, because from the 6th month of pregnancy to the 18th month of age of the baby is the critical period for the formation of the child's brain. The best way to reduce maternal and infant mortality, to reduce low birth weight babies and to guarantee effective breast-feeding is a healthy mother. And a healthy mother will also ensure healthy children.

Women not only play an important role in health, they are also the custodians and transmitters and shapers of the values of society. They are also farmers and frequently the custodians of its best practices at the local level. *Empowering women* in terms of legal status, access to education, credit, market facilities, political voice, and other dimensions is essential.

5 Conclusions

Science, backed by good policies, has been able to eke out of the green plants a system of food production that is more or less supporting six to seven billion persons on the planet. It is not

beyond the ken of scientists to ensure that the bounty of that production system is translated into food for the most needy and the most vulnerable of the human family.

Science, technology, and innovation have been responsible for all the advances that have benefited humanity. It is time that we turn that ingenuity and creativity to address the severe ecological challenges ahead, and to ensure that all people have that most basic of human rights, the right to food security. The science is largely there and many of the technologies are on the verge of becoming deployable. All of that is indeed within reach in a very short time. It is possible to transform how we produce and distribute the bounty of this earth. It is possible to use our resources in a sustainable fashion. It is possible to abolish hunger in our lifetime.

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Development Assistance and Investment in Agriculture: Promises and Facts

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Growing development challenges have renewed attention to the critical role that agriculture plays in the broad development process. The impact of agriculture extends beyond economic growth and poverty reduction to include improving health and nutrition and building resilience to climate change and conflict. While global and national promises have been made to advance agricultural development and food security, important gaps in implementation remain. To sustainably reduce poverty and improve food security, investments in agriculture – both foreign development assistance and national public expenditures – must be scaled up and adapted to exploit these new opportunities and to build resilience to future development challenges. To this end, the role of new actors, including emerging economies and the private sector, must be fully harnessed. The efficiency of public agricultural spending by national governments must also be improved.

1 Introduction

The role of agriculture in promoting overall development has been established as important for economic growth and poverty reduction (Diao et al. 2007), and investment in agriculture is one of the most effective instruments for achieving these goals (Fan et al. 2009a and Fan et al. 2009b). Yet, agriculture has suffered from many years of policy neglect. Increasing global development challenges, including high and volatile food prices, persistently high levels of malnutrition, biofuel expansion, and climate change have renewed attention to the role of agriculture. Moreover, the role of agriculture is increasingly seen in a broader context, particularly as it relates to improving the nutrition and health of poor people, providing new economic opportunities, and building resilience to conflict, land and environmental degradation, and climate change risks.