BigPictureSmallWorld and the Buckminster Fuller Institute in collaboration with Global Education Motivators present

DESIGN SCIENCE LAB

Strategies for Reaching the Millennium Development Goals

A Report on the work of the Summer 2005 Design Science Lab held at the United Nations and United Nations International School

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The Design Science Summer Lab 2005 was presented by
BigPictureSmallWorld Inc., Media, PA, www.BigPictureSmallWorld.com
and the Buckminister Fuller Institute, Brooklyn, NY, www.bfi.org
in collaboration with Global Educational Motivators, Philadelphia, PA, www.gem-ngo.org
The Lab was directed by Medard Gabel of BigPictureSmallWorld

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Design Science Lab Report designed by Mary Gabel, Gabel Graphics, Media, PA, www.gabelgraphics.com

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INTRODUCTION: Design Science Lab

Design Science is a methodology for recognizing, defining, and solving complex problems inspired by the work of Buckminster Fuller and other planners, scientists, and visionaries. It takes a whole systems, global, and anticipatory approach that fosters creative collaboration and synergy in the development of comprehensive solutions to societal problems.[1]

The Design Science Lab is a workshop where the tools of design science are used by groups to develop creative solutions to global and local problems and strategies for the implementation of those solutions.

The Design Science Lab 2005 was the prototype workshop of a program designed to take place each year from 2005 to 2015 that will focus on the development of strategies for achieving the UN Millennium Development Goals.[2] The 2005 lab focused primarily on the Millennium Development Goal #1—*by 2015 reduce by half the proportion of people in the world who are undernourished.*

The Design Science Lab 2005 took place in New York at the United Nations and the United Nations International School from June 24 to July 1. It was put on by BigPictureSmallWorld and the Buckminster Fuller Institute in collaboration with Global Education Motivators.[3] Medard Gabel was responsible for the structure and facilitation of the Lab.

The goals of the Lab included:

- Learning about the Millennium Development Goals, their usefulness to the world, and how we can use them to make the world a better place;
- Developing viable strategies for achieving one or more Millennium Development Goals;
- Learning how to apply a design science approach to global and local problems;
- Increasing our understanding of global dynamics, world resources, human trends and needs, and options for humanity's success;
- Increasing the public's understanding of these issues through disseminating the strategies as widely as possible;
- Serving as an incubator and growing force for developing and disseminating design science techniques for complex problem solving and development of viable solutions to the worlds problems;

Attending this workshop was a group of 25 college and high school students and professionals ranging in age from 14 to 42. The 2005 lab lasted for one very intense week, where the participants learned and applied the concepts and tools of design science to developing strategies to achieve the Millennium Development Goals (MDGs).

The two-day orientation segment of the program took place at UN headquarters in New York. Lab participants were briefed by UN staff from the World Food Program, FAO, UNDP, The Millennium Development Campaign, and others on the MDGs, their context, history, measurement, the progress made so far, and strategies in use for reaching them.

An introduction to design science was held at the offices of the Buckminster Fuller Institute and the Lab portion was conducted at the UN International School. A typical day saw Lab participants working ten to twelve hours. On the last day of the Lab, participants returned to the UN where they concluded the Lab with a presentation of their work to UN staff.

An overview of this work is what is presented in this report.

We thank you for your interest in the work of the Design Science Lab.

—Medard Gabel
President, BigPictureSmallWorld Inc.

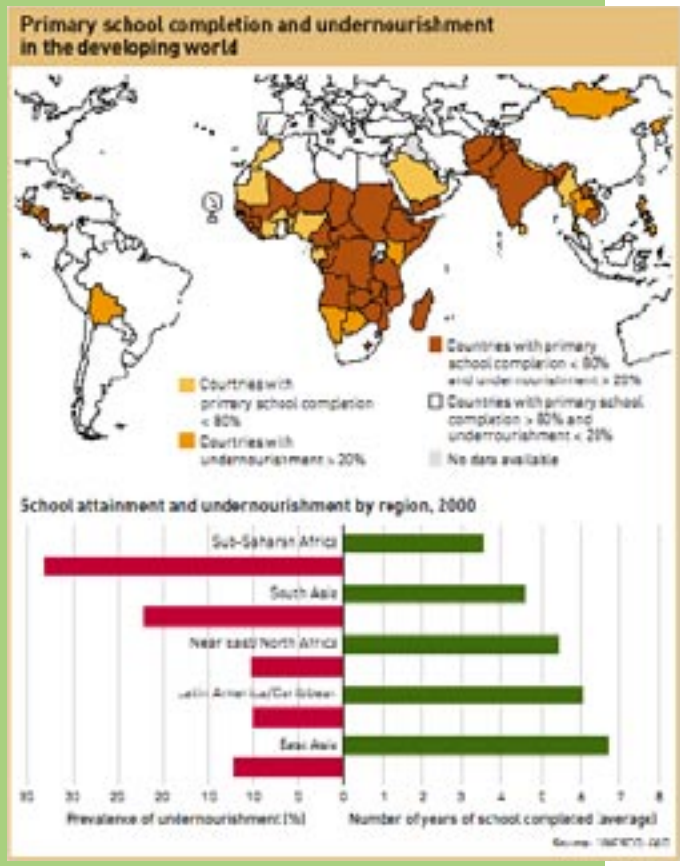
—Elizabeth Thompson
Executive Director, Buckminster Fuller Institute

Design Science Lab 2005 Work and Report

The work of the Design Science Lab 2005 was focused on demonstrating how, using present day technology, known resources, and limited financial wherewithal, hunger could be cut in half between now and 2015 (thereby achieving the MDG #1), *as well as eliminated entirely in another ten years by 2025*. The overall strategy developed by the participants of the Lab consisted of an eleven-part plan that when aggressively implemented shows great promise for a substantial reduction in the number of the over 800 million people currently suffering from hunger and malnutrition. Simultaneously it shows potential for improved health, productivity, and education; higher employment and incomes for those in most need; and a world that is safer, more secure, stable, and immeasurably richer as more and more people are able to participate in the creation of wealth.

Context/State of the World Food System

The work done by the Design Science Lab 2005 is embedded in a context of the global conditions surrounding the world's population and the global food system that supplies that population with its food. The following basic facts lay out this context:



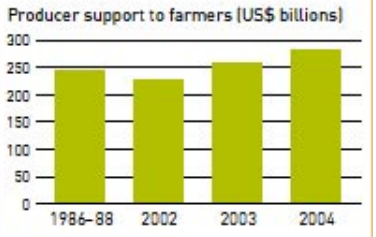
- World population in 2005: *6.4 billion.*
- About 50% of the world's total population—over 3 billion people—are living in urban areas.
- Number of well nourished people in the world: *5.548 billion people.*
- Number of hungry or malnourished people in 2005: *852 million.*
- Hunger and malnutrition are killing nearly six million children each year—a figure that roughly equals the entire pre-school population of a large country such as Japan.[4] Many of these children die from a handful of treatable infectious diseases including diarrhea, pneumonia, malaria and measles. They would survive if their bodies and immune systems had not been weakened by hunger and malnutrition.
- People living in rural areas constitute nearly 80% of the 852 million hungry people in the world, and over 50% of these are small, subsistence farmers.[5]
- Percent of hungry or malnourished people in 2005: *13%.*
- Percent of hungry or malnourished people in 1970: *24%.*
- 2.7 billion people were *added* to the world's population in this same 35-year period. This reduction, and the continuing yearly removal of 5 to 8 million additional people from the rolls of the malnourished, [6] is one of humanity's greater accomplishments.
- At the rate we are "improving" it will take 100 to 163 years to eradicate hunger from the world.
- Water resources play a critical role in the global food system. Not only is water essential for human survival, it is needed for producing crops.

Irrigated farmland, which accounts for less than 20% of global food production land, produces 40% of all food.[7] Irrigation increases yields of most crops by 100 to 400%.[8]

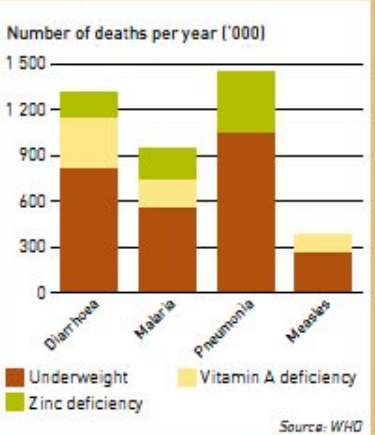
- There are over 1 billion people in the world without access to clean water and 1.6 billion without access to sanitation.[9]
- Fertilizer plays a key role in global food production. Without adequate fertilizer, total food production would not be enough to feed the world.
- Lack of education and undernourishment are linked.
- The global economic system and social/political arrangements play at least as big a role in the global distribution of food and hunger as does the weather. Subsidies given to wealthy country's farmers to encourage their production has serious and deleterious impacts on the farmers in the poorer parts of the world.
- Low-income food producers' lack of access to credit keeps these populations from moving up the economic ladder.
- Having a clear vision of how things should be is essential for getting there. Having specific and measurable goals for the global food system is critical for making those goals real.

All charts on pages 8, 9 and 10 are from *The State of Food Insecurity in the World, Food and Agriculture Organization of the UN annual hunger report, November 2005.*

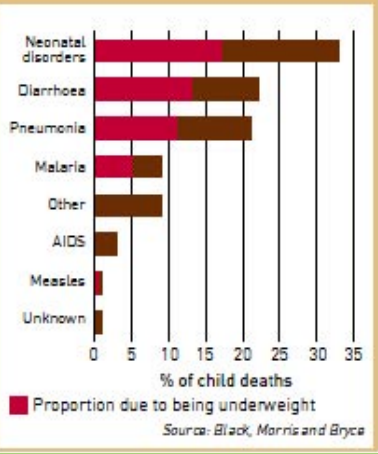
Farm subsidies in OECD* countries, 1986–2004



Child deaths from infectious diseases attributed to hunger and malnutrition



Global child deaths by cause



The Millennium Development Goals and links to reducing hunger

MDGs	Selected targets	Links to reducing hunger
1 Eradicate extreme poverty and hunger	• Halve, between 1990 and 2015, the proportion of people whose income is less than US$1 a day • Halve, between 1990 and 2015, the proportion of people who suffer from hunger	• Hunger perpetuates poverty by reducing productivity • Poverty prevents people from producing or acquiring the food they need
2 Achieve universal primary education	• Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling	• Hunger reduces school attendance and impairs learning capacity • Lack of education reduces earning capacity and increases the risk of hunger
3 Promote gender equality and empower women	• Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015	• Hunger reduces school attendance more for girls than for boys • Gender inequality perpetuates the cycle in which undernourished women give birth to low-birth weight children
4 Reduce child mortality	• Reduce by two-thirds, between 1990 and 2015, the under-five mortality rate	• More than half of all child deaths are caused directly or indirectly by hunger and malnutrition
5 Improve maternal health	• Reduce by three-quarters, between 1990 and 2015, the maternal mortality ratio	• Undernourishment and micronutrient deficiencies greatly increase the risk of maternal death
6 Combat HIV/AIDS, malaria and other diseases	• Have halted, by 2015, and begun to reverse the spread of HIV/AIDS • Have halted, by 2015, and begun to reverse the incidence of malaria and other major diseases	• Hunger spurs risky behaviour that accelerates the spread of HIV/AIDS • Undernourished children are more than twice as likely to die of malaria
7 Ensure environmental sustainability	• Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources • Halve the proportion of people without sustainable access to safe drinking water and basic sanitation	• Hunger leads to unsustainable use of resources • Restoring and improving ecosystem functions are key to reducing hunger among the rural poor
8 Develop a global partnership for development	• Develop further an open, rule-based, predictable, non-discriminatory trading and financial system • Address the special needs of the least developed countries • Deal comprehensively with the debt problems of developing countries	• Subsidies and tariffs in developed countries hamper hunger-reducing rural and agricultural development

Design Science Lab Preferred State

If the Millennium Development Goal #1 were reached in 2015 there would be approximately 400 million people in the world that were *still* undernourished.

The Design Science Lab's *Preferred State 2025* was developed from the values of the participants of the Lab, which dictated that 400 million people being hungry in 2015 (although a great improvement over 852 million being hungry in 2005) was not morally justifiable, economically desirable, or politically tenable. It was also a recognition that the global processes set in place in order to meet the MDG by 2015 would not just disappear in 2015 but would continue into the future and, if nurtured and expanded for an additional ten years, would result in the total elimination of hunger from the world.

This vision of how we wanted the world food situation to be in twenty years informed all the work of the Lab. It was not a prediction of what we thought the world would look like. Rather, it was a preference for what we wanted it to be. It was a statement of values as well as a definition of what a healthy global food system should look like.

The following are the major components of the Lab's preferred state vision:

By 2025:

- 100% of humanity is well nourished with safe, abundant, affordable food supplies.
- The production of food is done in environmentally regenerative ways.
- There is an ever increasing diversity of food choices and biological resources.
- There is an ever increasing resource efficient food system that is knowledge, rather than energy intensive.
- There is ever increasing local self-reliance in the production of food and a corresponding global interdependence of our local food system and supplies.
- National and local food systems are subsidy free and open market based.
- There are emergency backup systems and anticipatory crisis management systems in place.
- Local and global food systems are adaptable, flexible, and transparent.
- Local and global food systems are conflict free; food is never used as a weapon or bargaining chip.
- The global commons are managed for global well being, not national, local, or individual gain.

The strategies that follow this section were designed to achieve the MDG #1 by 2015 and the above preferred state by 2025.

STRATEGIES

for achieving the UN Millennium Development Goal #1 by 2015:

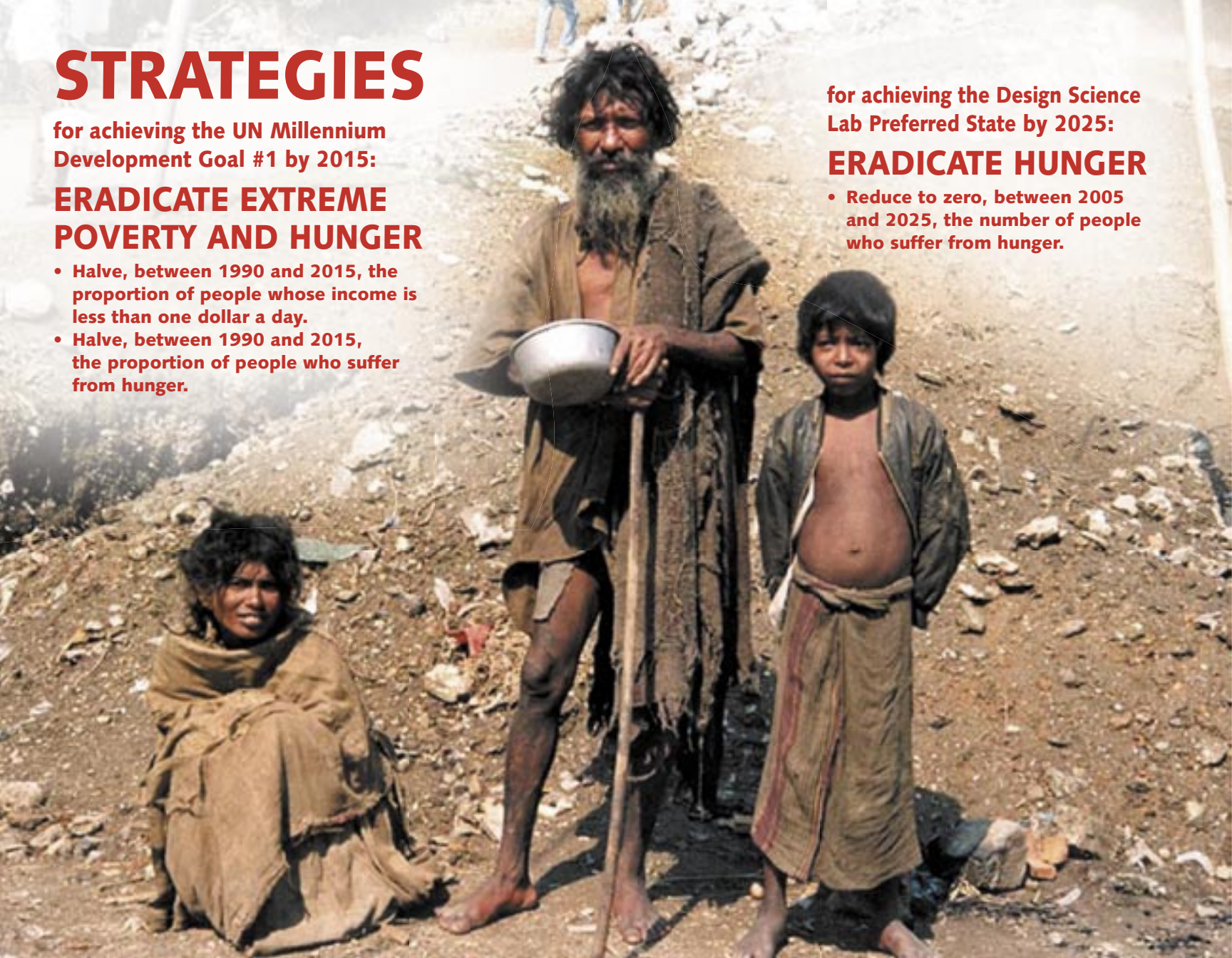
ERADICATE EXTREME POVERTY AND HUNGER

- **Halve, between 1990 and 2015, the proportion of people whose income is less than one dollar a day.**
- **Halve, between 1990 and 2015, the proportion of people who suffer from hunger.**

for achieving the Design Science Lab Preferred State by 2025:

ERADICATE HUNGER

- **Reduce to zero, between 2005 and 2025, the number of people who suffer from hunger.**



STRATEGIC AREA I: INCREASING FOOD PRODUCTION

1. The Giving Tree
2. Trash to Treasure
3. Sky Farms: Urban Food Production
4. Seven Generations: Regenerative Agriculture/Integrated Cropping Systems
5. Post Harvest Loss: Cool Pot and Grain Gain

1. THE GIVING TREE

Strategic summary: Increase food production, income, and employment in food short areas of the world by increasing fertilizer use through fast growing, nitrogen fixing trees. Simultaneously reduce atmospheric carbon thereby helping reduce global climate change. Finance through carbon abatement credits.

By Cara Collier, Leah Lowthorp, Chuck Michelson

Introduction

People living in rural areas constitute nearly 80% of the 852 million hungry people in the world, and over 50% of these are small, subsistence farmers.[10] Limiting factors for food access and production for these people include deforestation, centralized monoculture, poor soil quality, and restrictive factors for cultivation (i.e. fertilizer costs). *The Giving Tree Program* proposes a creative strategy in agroforestry centered on an amazing tree that gives and keeps on giving.

Leucaena: The Tree that Keeps on Giving

The leucaena tree (*leucaena leucocephala*) represents an enormous opportunity for doing more with less, and an amazing resource for reducing world hunger. It is highly adaptive, able to grow in both tropical and arid climates, and is highly drought-resistant. It is one of the fastest growing trees on the planet (10–12 ft/yr),[11] and is thus able to be harvested annually for its wood. It is a prodigious nitrogen fixer—more than 100 to 200 kg of nitrogen (or 500-1000 kg ammonium sulfate) per hectare is fixed annually[12]—delivering desperately needed nutrients directly into the soil without the need for costly and environmentally degrading chemical fertilizers. Its rapidly decomposing leaves are also a great source of green manure and cattle fodder.

The fertilizer response curve, which dictates that upwards of 50% more agricultural output is created when non-fertilized land becomes minimally fertilized, shows that natural fertilization through the leucaena tree would have an enormous impact in regions where fertilizer is currently un- or under-used. In addition, leucaena provides a renewable way to feed livestock. Its leaves have the nutritive value of alfalfa and are a great protein source for cattle. It can feed humans as well, through harvesting of its

L Leucaena (pronounced loo-say-na) grows 10 to 12 feet per year.

Leaves and seeds can be animal and human food and fodder.

beans, shoots, and seeds, which can be made into tempeh. It is a soil stabilizer and erosion controller, preventing vital nutrients in the soil from being washed away. It is an incredible source of raw materials, and can be used to make anything from paper, roofing felt and hardboard, to particleboard and rope. It is thus both a food and cash crop, sales of which can provide entry into local and global markets, as well as a sustainable source for organic fertilizer. It can also be used in symbiotic relationships with crops like cacao and coffee thereby providing additional crops for the economic development of the small farmer. And finally, critical to our funding strategy, due to its fast growth it sequesters carbon from the atmosphere at an unusually high rate, storing 50 lbs of carbon per year (forty trees will remove a ton of carbon from the atmosphere).

Strategy

The Giving Tree Program will be part of a non-profit organization[13] that cooperates with small farmers in developing countries to grow leucaena trees on their own land. The organization will claim carbon emission credits based on carbon sequestration through new tree growth. It will then sell the credits to heavy-polluting first-world corporations who are required to limit emissions as a result of the Kyoto Protocol.

The organization will primarily do three things:

- Employ local businesspeople to work directly with farmers;
- Provide training seminars for these businesspeople;
- Provide seeds.

An initial grant from an appropriate foundation or government agency is needed to fund the Giving Tree demonstration program on 1,000 farms throughout developing countries. Additional plantings will be made possible from revenues received through sales of carbon emission credits.

Based on current projections, the startup costs total $3,865,000, which includes $3,000,000 for an emission credit license, costs for seeds, staff, and land rental. The total cost of planting seeds is $100 per farm. The same farm will generate $300 per year in

Leucaena can grow under conditions of extreme drought.

carbon emission credits based on current carbon market prices. The Giving Tree Program will have substantial profits with which to fund further tree plantings.

This model has been tested. We are aware of one example in which the Japanese government funded a similar operation to plant leucaena trees in Columbia, with positive results.

Finally, two factors make this an ideal time in history for such a venture. Rising oil prices make oil-based fertilizers increasingly prohibitive. The passing of the Kyoto Protocol means the market price of carbon emission credits is likely to rise. Kyoto Protocol Article 2.1 advocates protecting and enhancing sinks and reservoirs of greenhouse gases *while* promoting sustainable forms of agriculture. The Giving Tree strategy does both.

Leucaena is an excellent source of firewood and lumber.

Conclusion

The Giving Tree strategy is an economically feasible way to directly target the Millennium Development Goal. It represents a locally and globally appealing case and comes with fringe benefits. Playing an integral part in creating a preferable global food system for the future, this venture emerges during an ideal time in history with a window of opportunity.

Leucaena leaves, which are 5% nitrogen, make an excellent animal fodder.

The Giving Tree Strategy Financial Summary

Total Investment: $3,865,000

Startup: $3,265,000

Seeds: $15 per farm x 1,000 farms = $15,000

Rental Capital: $50 per farm x 1,000 farms = $50,000

Training Program: $200,000

Emission Credit License: $3,000,000

Running: $600,000 per year

Salaries: $500,000

Training: $100,000 per year

Needed Resources:

Materials: Seeds, educational supplies, office, and supplies

Labor: Administrators, traveling educators, thousands of local reps/investors.

Output:

Measurable Positive Results: $300 per farm in carbon emission credits, minus $100 in total investment per farm = $200 profit per farm. 1,000 farms provide $200,000 profit per year. This will offset the cost of operating expenses after the first year. "Free" source of fertilizer, business opportunities, entry into local and global markets.

2. TRASH TO TREASURE

Strategic summary: Reduce urban organic waste and landfill mass; increase food production; reduce synthetic fertilizer use and costs by increasing organic fertilizer made by composting urban biodegradable waste; and increase job opportunities

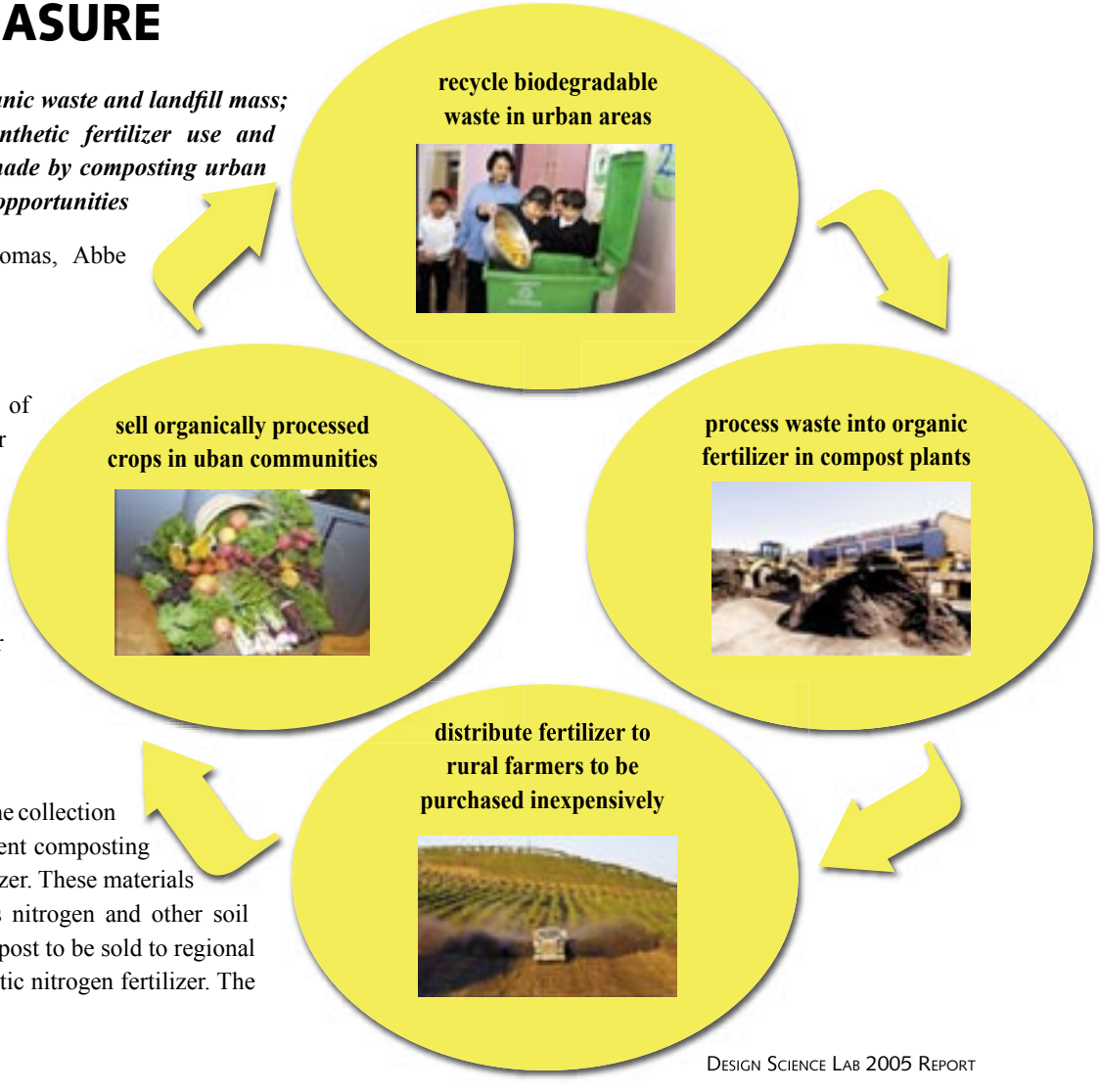
By Bamini Balaji, Natasha Cline-Thomas, Abbe Horswill, Zoë Richards

Introduction

Close to 530 million metric tons of organic wastes are generated each year in urban environments.[14] Given that total fertilizer consumption around the world is about 140 million metric tons,[15] urban organic waste could make a significant difference in increasing the amount of fertilizer available in the world.

Strategy

The *Trash to Treasure* strategy involves the collection of urban organic waste and the subsequent composting of this waste into valuable organic fertilizer. These materials are an excellent soil additive that adds nitrogen and other soil nutrients. This strategy calls for the compost to be sold to regional farms at less than half the cost of synthetic nitrogen fertilizer. The



Costs to Implement Trash to Treasure

In the Developed World

Expenses	
Ag-Bag Composting Machinery	$500,000
Regional Collection Bins	$50,000
8 Collection/Delivery Trucks	$480,000
Labor for 10 people (maintenance cost per year)	$300,000
Total Initial Cost	**$1,330,000**
Revenue	
50,000 tons of compost	**$5,000,000**
Net Gain First Year	**$2,340,000**

In Developing World Urban Environment

Expenses	
Ag-Bag Composting Machinery	$100,000
Regional Collection Bins	$50,000
8 Collection/Delivery Trucks	$48,000
Labor for 10 people (maintenance cost per year)	$30,000
Total Initial Cost	**$228,000**
Revenue	
50,000 tons of compost	**$2,500,000**
Net Gain First Year	**$2,272,000**

results will include increased food production, healthier soils, and less urban waste destined for rapidly filling landfills. Another impact of this program will be an increase in the number of jobs.

Various forms of this strategy are in place in different parts of the world. For example, in San Francisco, Sunset Scavenger Company,[16] has a successful program underway where urban organic waste is collected, composted, and sold to local farmers. In Japan, Toyonaka City Osaka Prefecture has set up a *Waste-to-Food Composting Program* that supplies fresh vegetables for school cafeterias. This waste-to-food composting program has been underway in since 2004. Local farmers, the municipal government, and a non-profit organization all work together. Under the program, food waste from school lunches are composted together with branches pruned from trees in parks and along streets. The resulting compost is used as fertilizer to grow vegetables, which then become ingredients for school meals.[17] A related program takes place in Sendai City in northern Japan. Here, people can exchange organic waste for fresh vegetables at morning markets. Under this system, when a consumer brings organic waste that has been dried and compressed by organic waste compactors to one of five vegetable markets in the city, each kilogram will be exchanged for 100 yen (about U.S. 91 cents) worth of fresh vegetables. The material collected at the markets is then used by farmers for growing more vegetables.[18]

The chart on page 18 illustrates the process:

- First, organic wastes are collected by schools, restaurants,

other institutions, as well as homes. For optimal success, a local government or private sector actor would establish a network of public deposit sites using color-coded dumpster bins.

- Second, biodegradable deposits at these sites would be collected and transported to the central composting center.
- Third, this waste is processed at compost centers. The biodegradable substance goes through a ninety-day composting process where temperature and oxygen levels are maintained.
- Fourth, the processed compost is sold to farmers who in turn sell food products produced with the aid of the compost back to city dwellers (which results in organic waste that starts the cycle again).

As illustrated in the chart on page 19, the costs for the implementation of this program in a developed world urban environment would be approximately $1.3 million, excluding land. The costs in a developing world urban environment would be substantially less.

Conclusion

The expected output from the composting plant (in tons) would be over 50,000 tons per year, generating revenue of over $5 million in a developed country where the compost could be sold at half the going rate for synthetic fertilizer. In the developing world, the compost product could replace high priced fertilizer imports at less than one-fourth of the cost and still show a net gain. At this level of production and sales, the plant and equipment in either setting would pay for themselves in less than six months of full operation and projected sales. In addition, these figures do not reflect the decreased cost to a city for dumping its waste in a landfill. Assuming a dumping fee of $20 per ton, a city would save about $1 million per year in reduced landfill costs.

3. SKY FARMS: URBAN FOOD PRODUCTION

Strategic summary: Increase food production, freshness and quality of food, and employment in urban areas by growing crops in enclosed structures on rooftops.

By Daniel Eida, Jai Lakhanpal, Eric Rimpel, Allard Van Hoorn, Adrian Salinas Valdez

Introduction

About 50% of the world's total population, over 3 billion people, are living in urban areas. Over the next twenty years this percentage will rise to over 60% of the world living in urban environments. Most of these people are right now, and will be in the future, in developing regions of the world. Most of the urban poverty, and hence urban hunger, in the world is also in these developing regions. Un- or under-employment is also high. In addition, many of the recent arrivals to urban areas are former farmers who are escaping the poverty of the countryside brought about by increasing population, mechanization of farms, lack of land and other resources, and low commodity prices due to subsidized imports. These "agricultural specialists" have very valuable knowledge and experience that is, under usual urban conditions, at best severely discounted or, more likely, seen as worthless.

The need for additional supplies of fresh, affordable, high quality food as well as employment of both new urban emigrants and existing under- or unemployed urban residents is high. *Sky Farms* are a creative response to the opportunities of this situation.

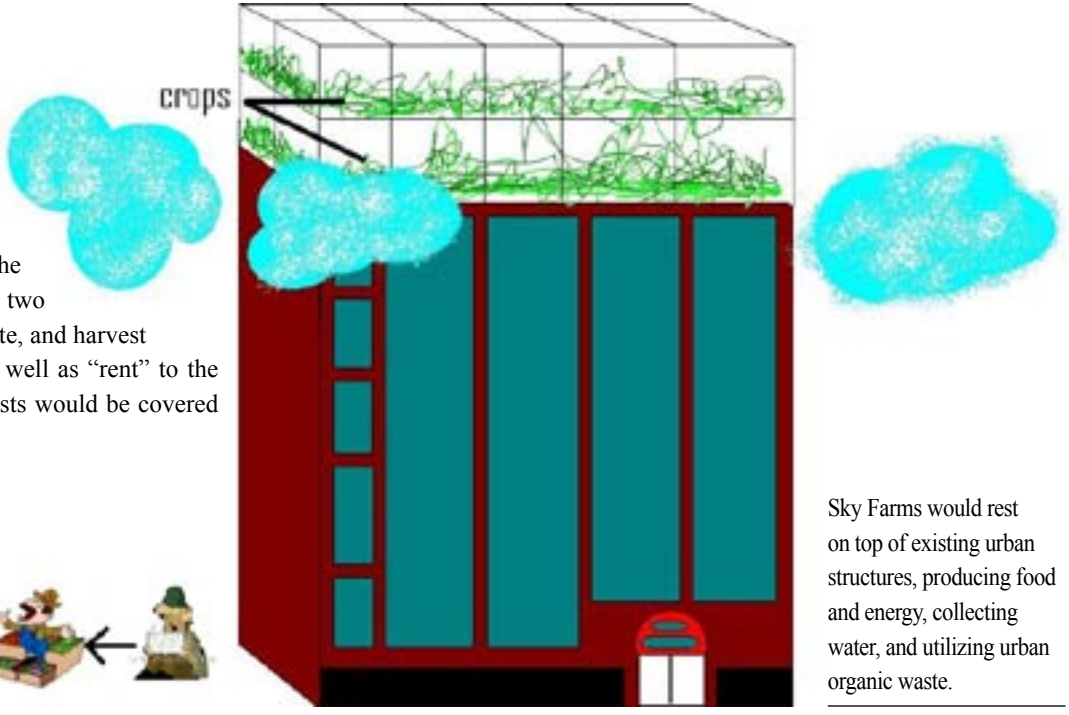
Strategy

Sky Farms is the name of an organization (which could be a non- or for-profit corporation) that would establish farms on city rooftops. The farms would be in lightweight enclosed structures that rest on the top of high-rise urban buildings. The Sky Farm structures are in a flexible variety of models or configurations, including multiple levels. These urban greenhouse farms would be attached to the top of existing buildings and begin growing food almost immediately. Rainwater will be collected from the structure to provide water for plants. Excess heat trapped by the structure will be pumped to heat or cool (via heat pumps) the building on which it is resting. Sky Farms would help transform buildings and cities into green buildings and green cities, being a valuable part of urban revitalization and economic growth—while supplying year-round sustainable supplies of fresh food to urban residents.

Costs

An average Sky Farm would be approximately 30,000 square feet and would cost $3.00 per square foot to build and install in a developing region of the world. It is expected that such a structure would be able to eventually supply fresh vegetables for 1,000 people if intensive farming techniques were used. The $90,000 building startup costs, coupled with maintenance, materials, and salaries would total approximately $150,000. This would come to $150 per person fed by the Sky Farm in the first year. Each

year the Sky Farm would produce additional food for urban residents thereby lowering this startup cost per fed person to negligible amounts over five years. The annual costs of running the Sky Farm would include salaries for the two to three urban farmers who plant, cultivate, and harvest the crops and maintain the structure, as well as "rent" to the building owners and residents. These costs would be covered by the sale of the food crops produced.



Sky Farms would rest on top of existing urban structures, producing food and energy, collecting water, and utilizing urban organic waste.

Implementation/Startup

Sky Farms would get off the ground in each city through a private sector initiative subsidized by government tax abatements, market guarantees, insurance, and regulation changes, where needed. Prospective buildings would be identified, inspected, and rooftop rights would be secured. These building could include apartment houses, factories and office buildings. A low-cost loan would be made available through the city government or local bank to fund startup costs. As the structure is being built, potential farmers would be identified and trained in urban rooftop food production and the maintenance of the Sky Farm.

Soil for growing the Sky Farm food will come from construction sites outside the city and will be supplemented by urban compost (see Trash to Treasure strategy, page 18).

Impacts

The impacts of Sky Farms include increased urban food production, fresher and healthier produce, shorter lines of distribution and the savings of fuel for transportation, increased awareness of citizens, corporations and cities of green issues, better-fed urban residents, increased employment and tax revenues, lower cooling and heating costs, and lower sewage costs through rainwater collection and reuse.

Sky Farms would rest on top of existing urban structures, producing food and energy, collecting water, and utilizing urban organic waste.

4. SEVEN GENERATIONS: REGENERATIVE AGRICULTURE/ INTEGRATED CROPPING SYSTEMS

Strategic summary: Increase food production, employment, and income through a knowledge-intensive agriculture that integrates multiple production techniques into one sustainable system. Simultaneously reduce expensive agriculture inputs such as fertilizer, pesticides, hormones, and antibiotics; improve water quality and availability; and slow or end desertification.

By Ilya Smirnoff and Eric Fedus

Introduction

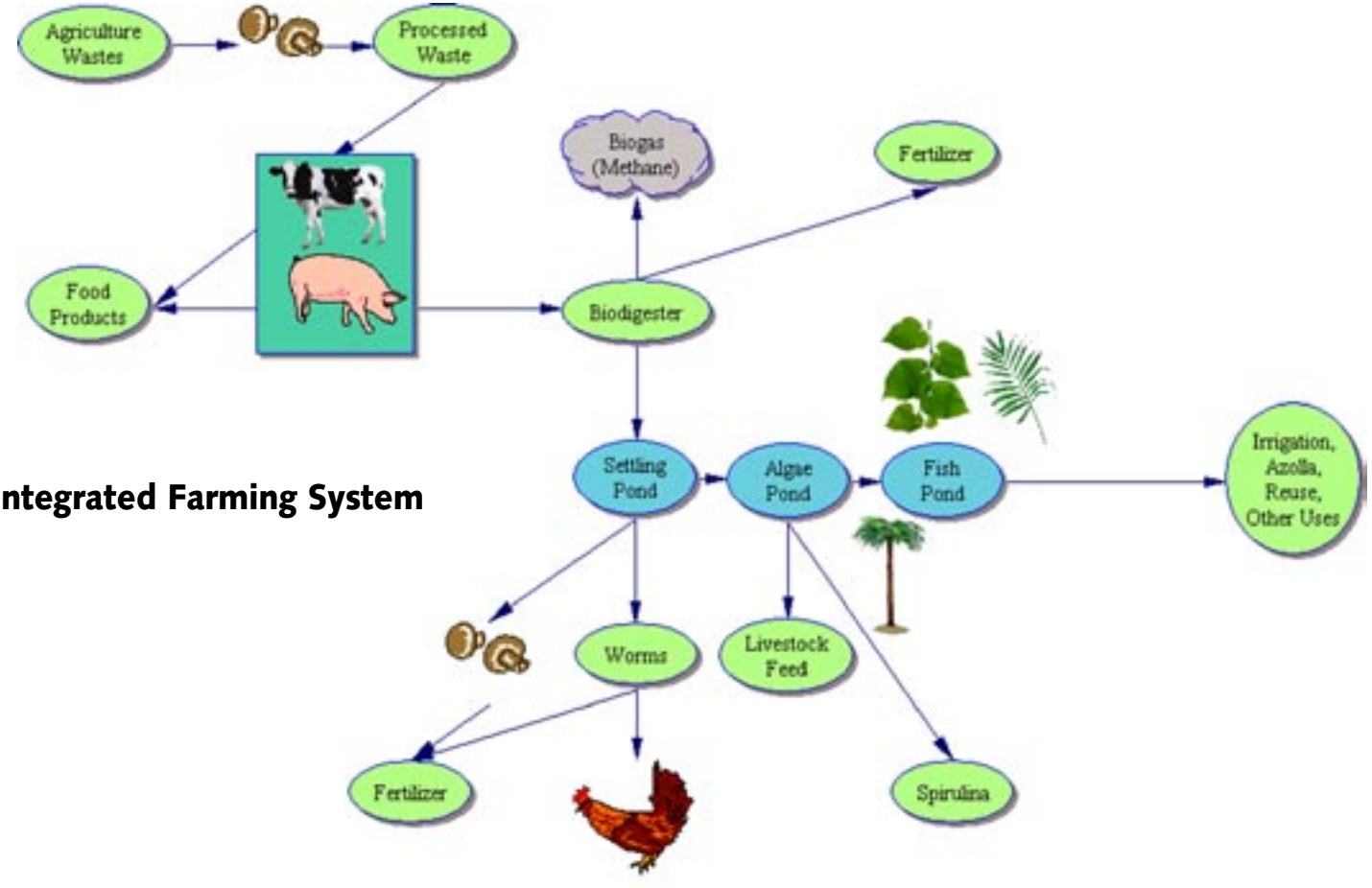
As indicated in *The Giving Tree* chapter, small farmers constitute nearly half of the hungry people in the world today. According to a recent 2005 report from the UN, there could be as many as 50 million additional refugees fleeing their home regions because of environmental breakdowns. Increasing food production, in environmentally sustainable or regenerative ways, is essential to helping the current situation and helping avert an even more disastrous situation in the future.

Strategy

Modern monoculture is "efficient" in the short term when environmental impacts are ignored. Integrating a number of food production techniques into one food production system that more closely mimics natural systems is more productive[19] in both the short and long term. Growing crops on farmland that is fertilized with the waste products of other biological processes that are part of the food production regime makes both ecological and economic sense. As the illustration on page 24 points out, waste products from meat and milk production can produce both fertilizer and energy that is used in other parts of the food production system.

Producing fish, animal meat and milk, traditional crops, algae, worms, chickens, and the so-called waste products of all these in an integrated system, where the inputs of one food production system are the outputs of another system, is simultaneously resource efficient, highly productive, economical, and environmentally regenerative. Such integrated food production systems are sustainable over the long term ("seven generations") under tight resource limitations.

Regenerative agricultural methods include nutrient cycling, diverse production regimes, zero or minimum tillage (farming with little or no plowing), companion planting, diversified farms that raise both crops and livestock, composts, mulches, biological pest control, and soil and nutrient conservation, as well as water-conserving, small-scale drip irrigation, and post-harvest loss reduction. All these add together in ways that increase the health and productivity of agricultural lands and communities, and build



Integrated Farming System

economic wealth for the local area and world.

Widespread institution of these methods coupled with the increased availability of fertilizer would help guarantee both local abundance and future productivity.[20] In addition to increasing local food production and self-reliance, such an approach would decrease soil erosion and dependence on foreign imports of food and petrochemical products. Furthermore, using locally available organic fertilizers and regenerative agriculture techniques would enhance crop resistance to drought and pests.[21]

The basic farm tools required to tap into local nitrogen fertilizer sources, expand irrigation, bring crops to market, and reduce the loss of crops due to insects and rodents can be manufactured domestically by any developing country, adding to its industrial production and providing employment.[22] In addition, the incomes of farmers would rise with their higher productivity, even as their newly enriched croplands become more resistant to soil erosion and salinization.

Global Extension Service for Regenerative Agricultural Systems

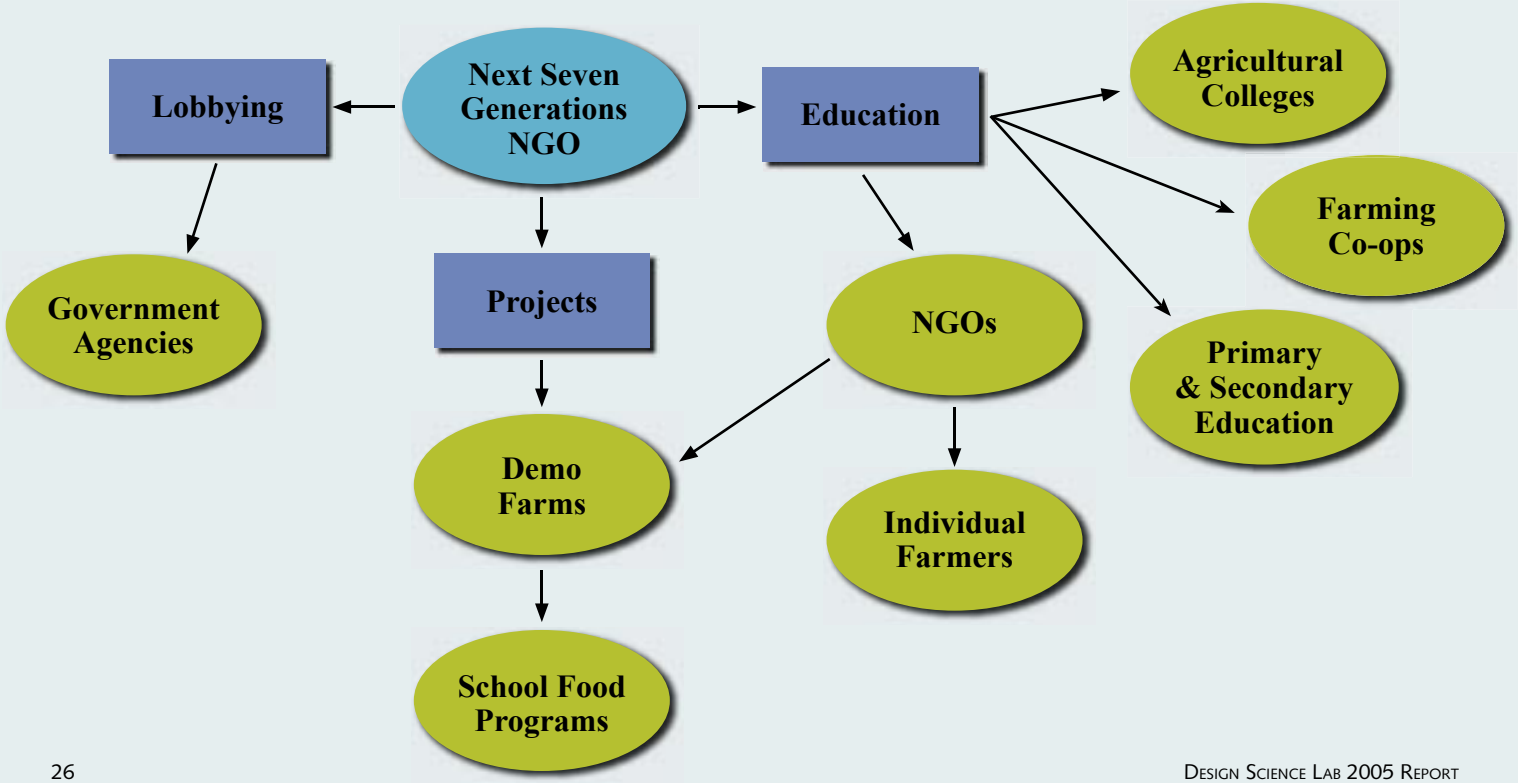
To scale this food production system to the level where it has a significant impact on the food-short areas of the world will take a serious, persistent, locally implemented and globally facilitated development effort. It will involve an aggressive program for teaching and demonstrating regenerative farming methods to traditional small-scale farmers, coupled with financial incentives and economic safety nets that strongly encourage the switch-over. A global extension service for regenerative agricultural systems would be instituted to make the transition as smooth, risk-free, and fast as possible. Modeled after the highly successful U.S. Agriculture Extension Service, it would assume responsibility for teaching regenerative farming techniques to food-short areas of the world—demonstrating fertilizer, irrigation, animal and cropping systems that build up the ecological underpinnings of our food supplies.

Key functions of this service would include providing on-farm extension workers on an order of magnitude greater than the world presently has, along with demonstration farms, education materials, transportation vehicles, communication equipment, tools and support facilities, and the financial incentives to encourage farmers to learn the new agriculture methods."[23]

NEW WAVE AGRICULTURE

"The Peacemaker taught us about the Seven Generations. He said, when you sit in council for the welfare of the people, you must not think of yourself or of your family, not even of your generation. He said make your decisions on behalf of the seven generations coming, so that they may enjoy what you have today."

—Oren Lyons, (Seneca) Faithkeeper, Onondaga Nation



5. POST HARVEST LOSS: COOL POT AND GRAIN GAIN

Strategic summary: Increase food availability by reducing post harvest loss.

By Jeremy Bang and Arthur Steiner

Introduction

Addressing hunger throughout the world has taken on many forms, the tail end of which has as much to do with saving what is produced as it does with producing more. Current figures regarding post-harvest losses from all over the world range from 10% to 80% crop losses, depending on what you measure and the area in which the food is produced. The two specific areas where the most loss occurs are highly perishable foods (i.e. fruits and vegetables), and less perishable but highly important grains.

Fruits and vegetables in arid regions can have almost total post-harvest losses. Considering that most of these losses come from subsistence farmers, the effects are directly on the hungry population of the world. Whereas grain losses are mainly the misfortunes of those living below the poverty line, it become clear that curbing post-harvest losses directly impacts the success of the first millennium development goal.

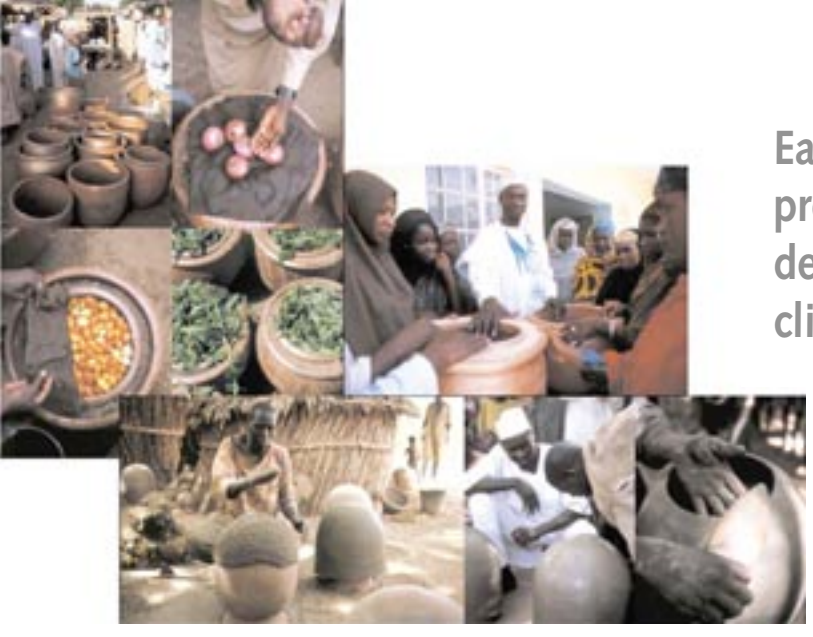
There are many strategies and techniques for reducing post harvest loss. Two of the most effective and affordable are the following:

The 'pot-in-pot' storage is a cheap electricity-free cooling system. The other is an efficient storage system for grains designed and distributed by a company called GrainPro.

Pot-in-Pot

The 'pot-in-pot' system is just as it sounds: one clay pot with a smaller pot inside of it has a wet sand barrier in-between the two pots. Perishable food is placed in the inner pot and as the heat of the day evaporates water out of the sand barrier the food inside is kept at up to fourteen degrees cooler than the outside temperature, extending food life dramatically. For example, spinach in parts of Africa rots in one day, in the 'pot-in-pot' system, it can last twelve days.

The earthenware-cooling device costs about $.50 to produce. The 'pot-in-pot' system also creates local employment opportunities, especially in countries where unemployment rates and agricultural unemployment rates are very high. A factory that could produce these 'pot-in-pot' systems could employ people in local villages with a yearly operating cost estimated at $14,000, and first-year profits estimated at $7,000. The initial investment could come



Earthenware cooling system to preserve perishable foods in developing countries with arid climates.

from governments, non-profit development organizations, or private enterprise. This strategy is capable of creating employment, increasing the amount of available food, increasing productivity, and still making a profit for the investors. It is an extremely attractive low-level solution to curbing hunger in sub-Saharan Africa and elsewhere.

GrainSafe

The grain storage system has similar results with improving grain storage. This has many implications for the profitability of the crop because it removes a bottleneck to people's food needs, and lessens the need to get rid of rotting crops.

The grain storage system is simple yet effective: it consists of a large bag and a protective cylinder. The flexible white bag is impermeable to water, water vapor, and air. This allows the grain to be stored and protected from one of the major elements that causes grain rot: moisture. The cylinder is made of polypropylene and further protects the grain from pests and other natural elements. The purchaser of this system would have to construct a platform that can be made from local resources such as wood, mud bricks, or bamboo. For further protection, this storage bin has a spout at the bottom allowing the farmer to dispense the desired amount of grain without exposing all of the stored grain to moisture and air. This storage method is simple enough so that the small-scale farmer would not have to acquire any expensive complex machinery but efficient enough to reduce post harvest losses to 1%.

The cost and expenses of this system are significantly lower compared with the benefits of reducing post-harvest losses, but in some cases financial help of a microfinance program may be necessary for the purchase. ProGrain has distributors in Bangladesh, China, Ethiopia, Ghana, India, Indonesia, Latin America, Turkey, Uganda, and other countries, making these storage bins accessible in many key areas needing improved grain storage.

Above: assembly
Right top: loading grain
Right middle: sealed bag
Right bottom: extracting grain
Far Right: the finished GrainSafe

STRATEGIC AREA 2: WATER MANAGEMENT

6. Waterment: Clean Water Access

7. Drops for Crops

6. WATERMENT:[24] CLEAN WATER ACCESS

Strategic summary: Increase accessibility to clean water and efficient use of water in irrigation through government efforts.

By William Sheehan

Introduction

There are over 1 billion people in the world without access to clean water and 1.6 billion without access to sanitation.[25]

Strategy

Waterment refers to a government agency that would establish laws, codes, and regulations for water use by industry, agriculture, and households. It would guarantee access to clean, safe, and abundant supplies of water to every citizen. Its primary focus would be on water conservation—making sure that water is not being wasted in any part of the water system—and providing clean safe water to families.

The later is accomplished through mass production and distribution of the Kisii Water Filter[26]. This relatively low-cost, easy to maintain, efficient filter costs about $10 in small production runs. When mass-produced, the costs could be lowered to less than half this amount. The filter removes virtually all the harmful bacteria that cause cholera, dysentery, and other water-borne diseases. It can provide 100 to 700 liters of clean water per week. If every house in the world that currently does not have access to clean water were to receive one, the incidence of water caused diseases would be nearly eliminated, saving the world economy hundreds of billions of dollars in health care costs and lost productivity—to say nothing of the 2 million lives lost annually due to this cause. The mass production and distribution of the Kisii Water Filter would also provide employment for thousands of people.

Another component of the Waterment Strategy is the construction and maintenance of local wells in town centers in arid areas where water is scarce. The Kisii water filter and town wells would go a long way to eliminate the lack of access to clean water throughout the world. In addition, if these two strategies were undertaken by a government authority, such as the "Waterment" agency proposed here, the delivery of water could also be a public service that could employ thousands of additional people.

The Kisii Filter

7. DROPS FOR CROPS

Strategic summary: Increase food production through increased use of water-efficient irrigation.

By John Yuan

Introduction

Not only is water essential for human survival, it is needed for producing crops. Irrigated farmland, which accounts for less than 20% of global food production land, produces 40% of all food.[27] Irrigation increases yields of most crops by 100% to 400%.[28]

Rainwater Harvesting

There are a number of innovative ways of "harvesting" water in arid regions of the world. One set of technologies revolve around rainwater catchments. The goal here is to capture and store rain water when and where it is abundant, often times in super-abundant quantities, for use in the dry season. The Kuis method of rainwater harvesting is from western India. It involves the digging of a crater, at the bottom of which is a tiny opening leading into a hole were the water is stored and kept from evaporating. Heavy rainfall gathers in the craters where it then flows into the water holding hole. Once the holes are built, they will last for years and years. Water stored in thee holes can be channeled into wells and irrigation systems for use in water short seasons.

Fog Harvesting

Another techniques for gathering water in arid regions is what is called "fog harvesting." This technique is good for arid climates where access to water is seriously limited. It involves the use of a net that lets humid early morning air pass through. As the air goes through the netting, its moisture collects and drips into the gutter at

the bottom of the net. From here, the water flows into a collection basin where it is stored until needed.

Drip Irrigation

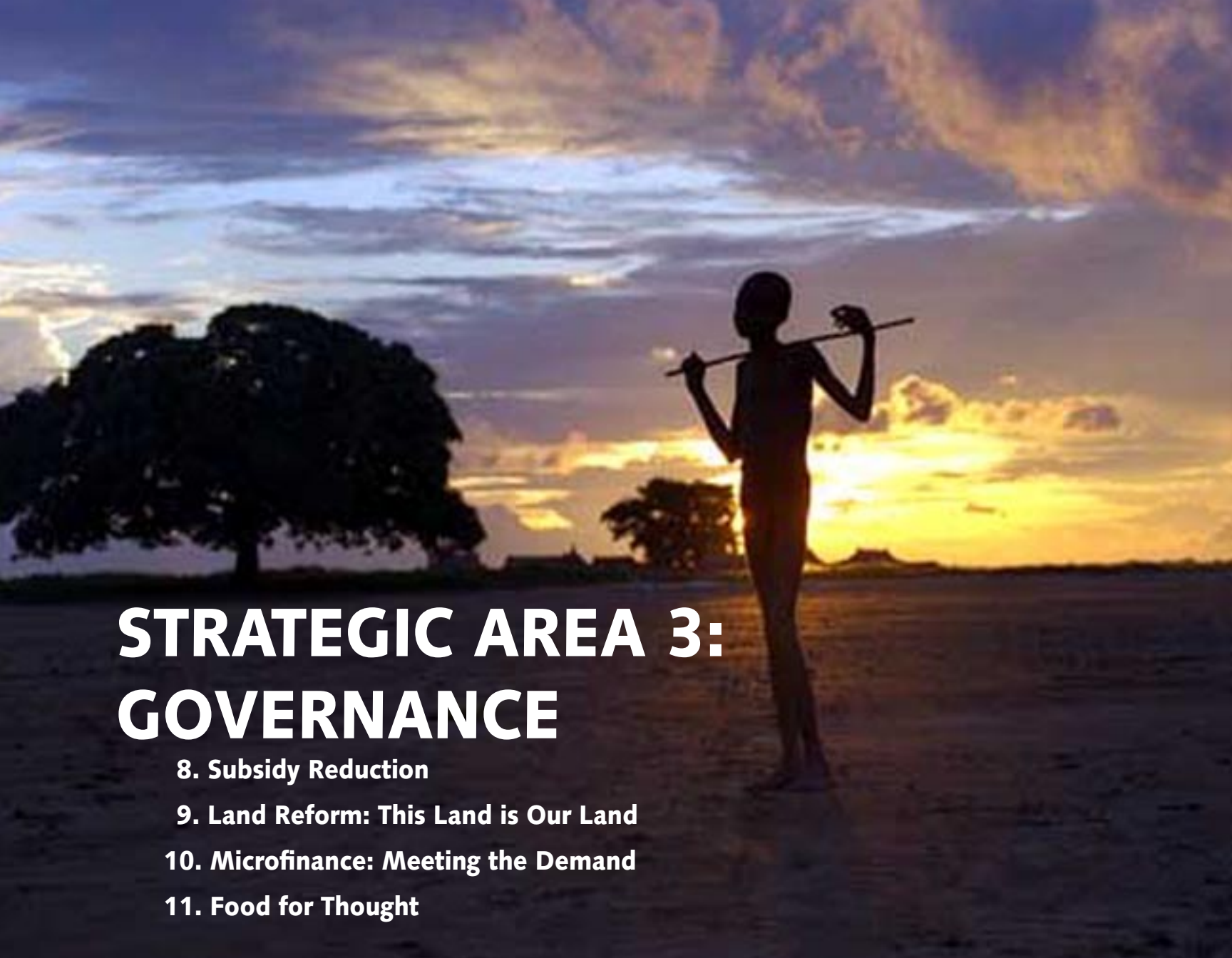
Another technique for meeting the water needs of water-short areas is through the conservation of this scarce resource. The largest user of water is irrigation. In most parts of the world, including wealthy areas such as the U.S., irrigation water uses 50% or more of all fresh water. Using the least efficient irrigation technique, that of open field flooding, wastes 70 to 90% of the water.

Drip irrigation is a method of irrigation particularly suitable to arid climates where water is scarce. It is also suitable to any climate where there is an interest in conserving water. Precise water application is possible and runoff is eliminated, thereby reducing erosion and loss of soil nutrients. Drip irrigation is also helpful in other ways—it allows precise application of nutrients to depleted soils.

The primary disadvantage of drip irrigation is that it is more expensive in the short term. In the U.S. it costs between $500 and $1,000 per acre, depending on the technology used. In the developing world, there are low-cost drip irrigation techniques that utilize bamboo or inexpensive plastic tubing. Using these materials, illustrated below and at right, the cost for drip irrigation is an order of magnitude lower. Water savings and increased crop production will pay for the apparatus in less than one season.

The "curled" micro-tube dripper: simple, low cost, if it clogs, one can simply blow through it to clean out the clog.

The bucket kit for low cost drip irrigation in the test laboratory of IDE India near New Delhi. A simple product with a long trial-and-error phase to make it suited to the needs of poor horticulturists.



STRATEGIC AREA 3: GOVERNANCE

8. Subsidy Reduction
9. Land Reform: This Land is Our Land
10. Microfinance: Meeting the Demand
11. Food for Thought

8. SUBSIDY REDUCTION

Strategic summary: Increase food production, employment and wealth in developing regions through reducing subsidies to developed countries' farmers. Make developed countries' food systems stronger by removing subsidies.

By Sidharth Shah

Introduction

International trade has enormous potential for reducing global poverty. For example, a 1% increase in the developing countries' share of world exports would lift 128 million people out of poverty.[29] The current global trading system discriminates against developing countries and hinders poor country participation in the global economy. Two of the biggest problems are agricultural subsidies in rich countries and lack of access by poor countries to international markets.

Agricultural subsidies are government payments or financial benefits (e.g. tax breaks) to farmers. Subsidies reduce the marginal cost of producing a crop for a farmer. Farmers therefore produce more crops and sell them at a lower price than without the subsidy. The lower price means that crops imported from poor states at the world market price cannot compete with the cheaper subsidized products in developed countries. Subsidized farmers produce more than the economically efficient quantity. They also often sell the surplus crop at cheap rates to other countries, a practice known as dumping. This means local farmers are able to sell fewer crops. Agricultural subsidies in wealthy states therefore have an adverse effect on the livelihood of farmers in developing countries as well as on the economy of these countries and, because the subsidies can put local farmers out of business, on the long term viability of local food systems.

The Extent of Agricultural Subsidies

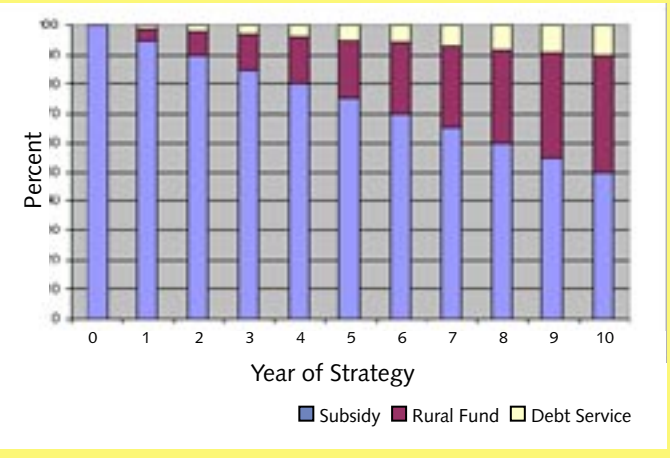
Some brief statistics on farm subsidies:

- In 2003, the U.S. subsidized agriculture by almost $40 billion[30]; major subsidies went to cotton: $3.9 billion in 2002[31]
- European Common Agricultural Policy (CAP) provided $138 billion subsidies in 2003[32]; $9.7 billion EU sugar subsidies annually[33]
- U.S. exports cotton at 65% below production cost; EU exports sugar at 44% below normal market value[34]
- Approximate negative effect of U.S cotton subsidies in 2001–2002 on the GDP of selected African cotton producers[35]:
  - Burkina Faso—$145 million
  - Mali—$179 million
  - Benin—$108 million

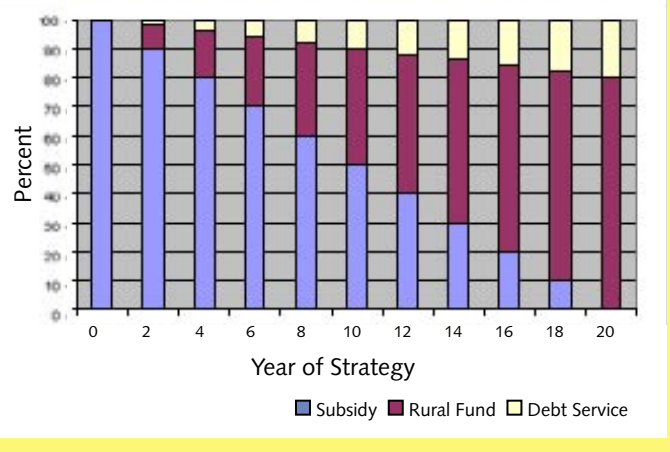
Goal

Halve the $40 billion American and $138 billion EU farm subsidies by 2015. Special emphasis should be placed on American cotton subsidies and EU sugar subsidies as these have the largest adverse effect on farmers in poor countries.

Decreasing Subsidies Over 10 years



Decreasing Subsidies Over 20 years



Strategy

The strategy requires a gradual diversion of money that is currently used for subsidies towards other forms of investment in rural communities in developed countries. Some money could also be used towards payments on national debt. Eighty percent would go back to farming communities and 20% would go towards debt payments.

Each year, less money is allocated as an agricultural subsidy and more towards investment in farm communities or debt payments. The objective is to demonstrate to farmers in developed countries that despite cutting subsidies, their government is committed to supporting rural communities. It should be explicitly advertised that money is not being taken away from citizens; rather, rural communities are being given the opportunity to reallocate funds towards other local needs. This will weaken the appeal of pro-subsidy groups as well as reducing public hostility towards freer trade in agriculture. Additionally, this program should alleviate some of the political "damage" that politicians are afraid of enduring if they cut subsidies, thereby encouraging more legislative decisiveness in reducing farm welfare.

The central government will lead this program, but local administrative authorities, including farmers' councils, should be able to choose how to spend the redirected money allotted to a particular district. However, the central government should impose basic controls on how the money is spent to ensure that it is not used to directly or indirectly subsidize farming operations. For example, acceptable uses for the money could be to buy computers for local schools or to improve roads.

With the domestic political situation under control, the U.S and the EU should use the institutional framework of the WTO to multilaterally and simultaneously roll back subsidies. This would

entail closing the various loopholes that allow for significant exemptions to anti-subsidy laws, such as the de minimis clause in the 1994 Agreement on Agriculture.[36]

Costs

Initial	Zero, as current government spending is simply being redirected
Running	A negligible sum that will be used to administer rural funds for redirected money
Sources	A combination of central and local governments

Results

The halving of subsidies will mean that poor countries can sell their agricultural products on the world market at a fairer price. This will increase their GDP and the income of their farmers. This, in turn, will facilitate a long-term reduction in hunger, as more people will have the financial resources to buy food. The strategy will reduce the debt of the U.S and the EU. The reduction in subsidies will also force farms in developed countries to be more efficient in the crops they plant (they can only plant those in which they have a comparative advantage). A major non-tangible benefit is that farmers in developing countries will develop a sense of income security as their crops will have clear access to foreign markets.

9. LAND REFORM: THIS LAND IS OUR LAND

Strategic summary: Increase food production and economic well being by increasing access to land ownership in developing countries.

By Kristina Mader

Introduction

It is vital for the rural and urban poor to own land in order to help them confront the challenges of the 21st century. Not only do property rights and access to land provide economic and social support for the rural and urban poor, but efficient and equitable laws are a key factor in allowing a country's citizens to experience a sense of security. This, in turn, helps increase production and standards of living.

A surprising number of people informally occupy land that technically or legally does not belong to them. This lack of land ownership undermines access to credit and other economic services. Having ownership of the land your family lives and works on is vital for economic security as well as social vitality.

Strategy: Land Policy Reform

Existing government land policies need to be transformed in many developing parts of the world. To facilitate this change, a new NGO, called the Our Land organization, would be funded at a scale that would enable it to undertake the changing of government land policy and to enforce existing policies so as to implement more equitable access to land.

This Land Policy Reform plan will take place over the next 10 years. The Our Land NGO would be funded from grants and partnerships with other organizations, as well as corporations. The Our Land organization would coordinate with governments at national and local levels to develop equitable, transparent, efficient, and culturally sensitive policies relating to land tenure. The success of these policies will be measured by the number of registration and ownership claims to land, as well as the increase in land value, which is a result of titling land.

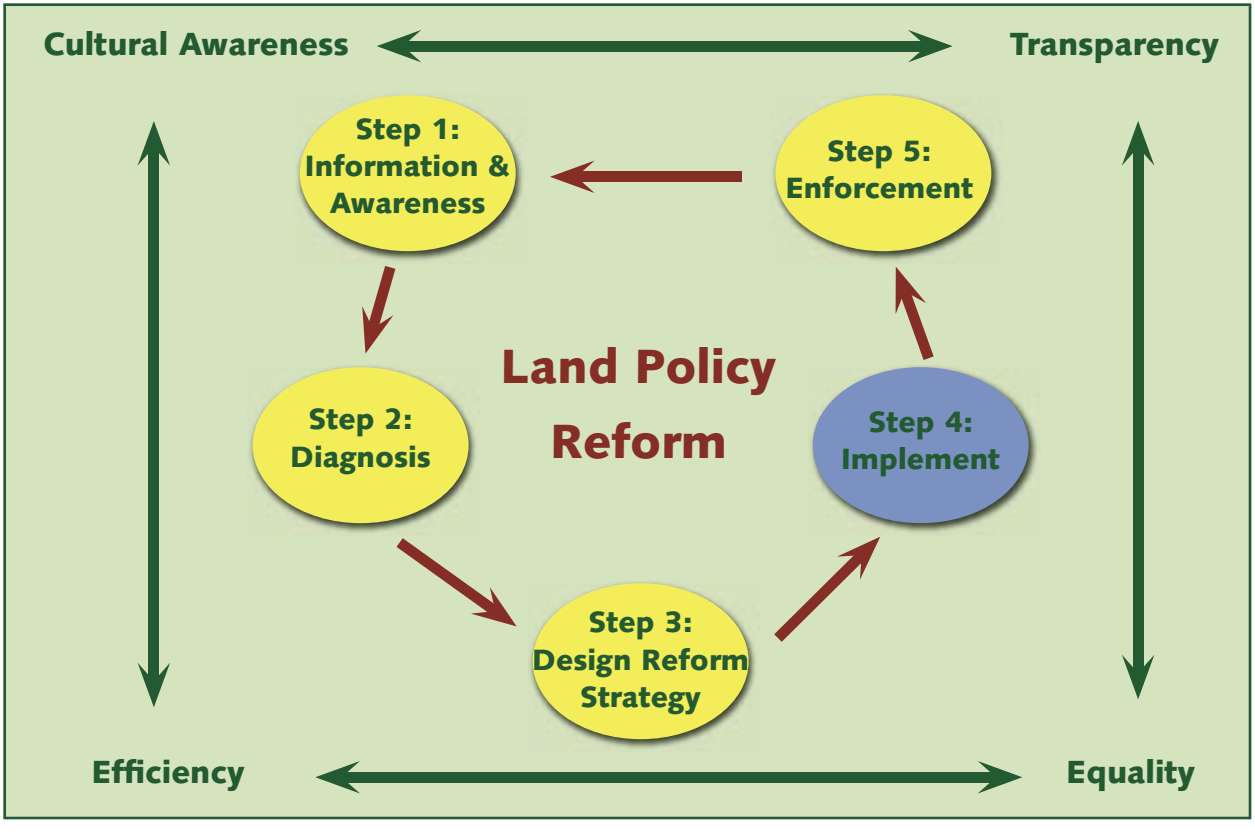
The following is an explanation of the chart on page 34. All the steps are overlapping.

Step 1: Awareness and Information

This step is mostly informational. It includes making an economical case to governments that illustrates the benefits of land reform to everyone in their society. It would include how the plan should be implemented, its costs, and how it will benefit both the poorest people in the country as well as the entire society. This aspect of the program has four key issues: cultural awareness, efficiency, equality, and transparency.

Step 2: Diagnosis

This step analyzes data and discovers the problems and inequalities in the current land system in each country. Included in this step is collection of data on current ownership of land, both legally owned and extra-legally "owned," as well as accurate border maps. Environmental and geographic issues are identified, as well as any


Cultural Awareness
Transparency
Step 1: Information & Awareness
Step 5: Enforcement
Land Policy Reform
Step 2: Diagnosis
Step 4: Implement
Step 3: Design Reform Strategy
Efficiency
Equality

economic, cultural, and religious impacts on the system.

It is important to look at the historical reasons for the current land reform system but not to get bogged down in blaming people. Recognizing that there are historical inequalities and attempting to fix them in the present is key to being able to diagnose the country's problems using a transparent process and to target them efficiently.

Step 3: Design Land Reform Strategy

Step 3 is to be completed within two years of starting the diagnosis process. The reforms created in this step shouldn't necessarily completely overhaul current policies, but should reform problem areas, paying special attention to equality in distributive, inheritance, and ownership rights. Traditionally underrepresented groups, such as women, indigenous people, and the poor should be included equally. A process to collect and update land data, such as borders, ownership, etc. should be designed. This benefits the country as a whole, but also specifically this strategy, because it creates a base of information to use for enforcement. It is vital that this plan not be corrupted and care should be taken to maintain transparency through public access.

The process created to gain ownership must be cheap and fast, therefore encouraging the acquisition of rights. Local access should be emphasized for many reasons. Jobs created within the new sector will benefit the local economy. In addition, if the data is easily accessible to all, there will be a higher level of participation in rural areas which are key to the success of the program.

It is also important to remember to account for extra-legal land. Care must be taken so as not to punish current owners of illegal property, thereby discouraging legal registration. In this step, the strategy should also take into consideration any environmental, transportation, technological, educational, and communication reforms that need to be made so as to make this plan conducive to the country's overall development.

Step 4: Implementation

This step is carried out by specific countries' governments with the help of the Our Land NGO plus other civil society organizations that worked with the government from step one. This step will work only if effort is made by the country's citizens and lawmakers to create or reform land laws.

In implementing the reforms, rural organizations and governments must be included. This will require better communication and transportation between organizations and regions. Most importantly, the implementation process must be culturally sensitive to each country's unique religious, ethnic, and cultural makeup.

Step 5: Enforcement

In the final step, followup of the progress of the reforms is ongoing. It signals the end of one stage of reform and the beginning of the next. Local agencies and organizations need to be made part of a mechanism that will allow reports of misuse or illegal acts regarding the new land policies. Whether the existing judicial infrastructure is used, or a new system is created, it is important that the process be transparent so as to allow the reforms to be their most effective.

Cost

The cost for this strategy varies widely from country to country, depending on how it is organized and the amount of reform necessary. The amount that current landowners are compensated will be the largest expense. This could be funded from the general budget or from a special tax on the revenues produced by the new owners of the land. If this strategy is integrated into the legislative agendas of each country, then the cost will be minimal, but the benefit to the government and its citizens from having millions of additional legal landowners will be immeasurable.

Conclusion

Through the hard work and dedication of those within each country, land ownership and use laws can be reformed. Ownership of land has proven to be an effective way to increase the economic well being of impoverished citizens in many areas around the world and will contribute to reaching the UN Millennium Development Goal of halving poverty by 2015.

10. MICROFINANCE: MEETING THE DEMAND

Strategic summary: Increase availability of credit to new entrepreneurs; meeting the need for microfinance. Making small-scale loans available by greatly expanding resources of existing microfinance institutions.

By Meredith Aach

Introduction

The demand for microfinance has not been met due to the non-profit sector's lack of resources to finance it. Currently, it is estimated that 95% of the people who could use microfinance are not able to take advantage of this engine of economic development. Money allocated from the donor community to microfinance institutions around the world cannot fund enough loans to make a difference at the scale needed to radically improve the economic well being of the poorest segments of the global economy.

To meet this demand, the microfinancial system needs to be supported by for-profit institutions. The combination of investment from the for-profit community would be directed towards providing funds to offer credit and savings options to the economically active poor. The rest of the money given to these institutions by the donor community would be directed towards the extremely poor in terms of services (training and education).

One critique of microfinance claims that microfinance does not meet the credit needs of the poorest of the poor. This is because the extremely poor cannot take out a loan. It is generally believed that if these people were given a loan without any training or education, the loan might be spent on consumption. With more resources from the for-profit community to meet the demand for credit of the economically active poor, more funds could be made available for pre-loan services to those who cannot take out a loan.

Microfinance has proven to be one of the more efficient tools in the "toolbox" of development. It allows individuals and families in poverty to access financial services such as credit, savings, and insurance, which they would not have been able to do in a regular commercial bank because they generally lack collateral. With the met demand for microfinance being only about 5%, more innovative ways must be implemented to meet the demand for microfinance.

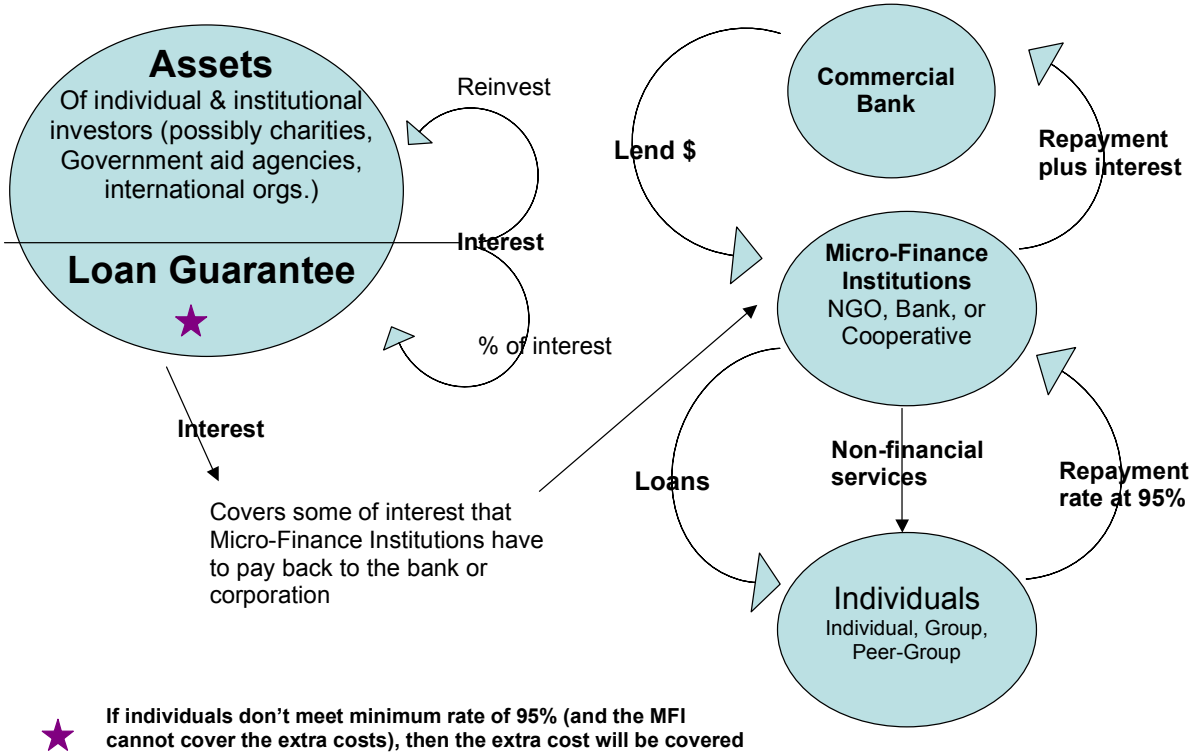
Goal

Expand microfinancal resources by at least an order of magnitude and encourage investment into existing microfinance institutions in order to meet the global demand for microfinance.

Strategy

Because the great demand for microfinance has not been met, microfinancial institutions need more resources to offer loans, services, and improve their present infrastructure. In order to do this, these institutions need to become sustainable institutions that can meet their costs (without support from NGOs, governments,

The Microfinance Expansion Program



or other donor agencies) through the efficiency of their financial transactions.

Many for-profit institutions feel the return is not high enough to loan out to so-called "high-risk" clients because they are poor. In fact, they have higher repayment rates than most clients in developed countries, especially in times of crisis. To increase incentives for microfinance, the strategy calls for:

- Increased transparency for all government and corporate transactions.
- Standardized financial reporting across all industries.
- Reduced transaction costs. Transaction costs of providing credit to the poor can be high due to the fact that there are many loans and they are small. Certain innovations, like a personal digital assistant (PDA) that is shared among microfinancial workers, can decrease these costs.
- Global information exchange for the microfinance industry.
- Reliable information marketplace to facilitate exchange of quality data. This will enable corporations to feel confident that they are getting true costs of transactions and repayment rates so they can decide whether their investments are profitable.
- Increased percent of financial expertsise in the microfinance institutions. A large percentage of workers who work personally with clients is necessary because these workers increase social impact.
- Increased incentives for the commercial lending institutions to invest in microfinance (see chart). If commercial banks were guaranteed money if repayments rate were not up to "par," there would be little to no down-side for these institutions to invest. Even though commercial banks are focused on increasing shareholder value and returns on investment, improving their social image and the value of their brand will serve to help the company in the long-run.

Much of the current money for microfinance institutions comes from donor agencies, NGOs, and governments. If commercial banks and for-profit institutions invested money in microfinance institutions (which is becoming more widespread through socially responsible investing), resources of microfinancial institutions would increase substantially. The money invested in these institutions from for-profit institutions could be directed towards providing credit, savings, and insurance for the poor, while money donated from the non-profit community can be used for services like training and education.

11. FOOD FOR THOUGHT

Strategic summary: Increase food availability and decrease malnutrition in every food short region of the world by instituting school lunch programs; expand markets for local farmers while increasing school attendance, enrollment, and health of students.

By Milly Barolette and Jennifer Bodenstab

Introduction

Over 100 million school-age children do not attend school in the developing world. Many of these children are forced to drop out to earn money for their families so that food can be purchased. Some drop out because there is not enough food for them to eat, and attending school on an empty stomach is not viable.

Strategy

Feeding students while they are at school through a school lunch program will solve a number of problems as well as increase the capacity and well-being of the local economy. Students will be healthier as well as better students as they will not be distracted by hunger. Parents will have a strong incentive to send their children to school and the students will have an equally strong incentive to stay. In addition, local farmers and the local economy will benefit as farmers gain access to a reliable and steady market. The income they receive will cycle through the local economy as they purchase products with their new wealth.

Instituting school lunch programs in every school in food short regions of the world will go a long way towards eliminating hunger. This action will provide an important stimulus to the expansion of local commercial food markets by providing local farmers with an assured market for some of their crops, as well as improving the nutritional well-being of students. Markets for surplus crops are essential for providing incentives for local farmers to increase production. The added income from these markets will help reduce the level of poverty in rural regions and increase the capacity for further wealth generation. In addition to a school lunch program, hospitals, restaurants, and government offices could purchase additional surplus crops produced by local farmers. Such programs should have incentives so that small farmers have a competitive advantage in this budding market.[14]

SUMMARY

The strategies described in the previous pages outline an eleven-pronged program for dealing with the food problems of our world. Taken individually, each makes a significant contribution in addressing some aspect of the global food situation. Taken collectively, they are more than the sum of their parts. Together, they will move the world toward the reaching of the Millennium Development Goal #1—and beyond, to a world free of hunger.

By increasing food production through increased use of non-synthetic fertilizers made from locally available biological resources (in both rural and urban environments), increased use of water efficient irrigation, agrarian reform, production of food in urban environments, integrated whole systems food production, school lunch programs, reduction of post-harvest loss of food, microfinance, and subsidy reduction—financed through carbon abatement programs, subsidy transfers, reallocation of existing national and city government funds, corporate investment, and civil society—we are convinced by the technological, environmental, and economic evidence that the MDG #1 can be met in ten years, and that the Design Science Lab Preferred State can be reached in twenty years.

We welcome your feedback, suggestions for improvements, and critiques of our work. We also welcome you to join us for next summer's program where we will be taking this work further with more of the Millenium Development Goals.

—Medard Gabel
Director, Design Science Lab

APPENDIX 1

Design Science

By Medard Gabel

Very briefly, design science is the comprehensive and anticipatory application of the principles of science to the creative design of solutions to the problems of society. It is a way of changing the world in preferred directions that is based on innovation and thrives on transparency.

The core of this approach to problem solving and planning is both a concern with whole systems—the whole Earth, the entire history of the planet, the global economy, all of technology, and all of humanity; both those living now and those yet to be born—as well as a recognition that everything is implemented locally, and that the "whole" is merely the context for the local. It is the local upon which the success or failure of a particular design solution will thrive or die.

Design science is:

- Comprehensive, in that it starts from the whole system and works back to the special case; it deals with all facets of a problem including the larger system of which the problem is a part; in this sense, design science seeks to build capacity, not just solve problems;
- Anticipatory, in that it seeks to recognize the threats coming down the pike before they arrive full blown on an unsuspecting or ill-prepared society; it deals with the way things are going to be when the solution is going to be implemented, not just the way things are in the present;
- A design strategy, in contradistinction to a political or let's pass-a-law-and-change-human-behavior approach, seeks to change the larger system of which the specific problem is a part through the introduction of innovative artifacts or policies;
- A science–based methodology that uses the latest advances of science and technology to benefit humanity.

This "comprehensive anticipatory design science" is at least as much a perspective on the problems of the world as it is a methodology for tackling those problems. When applied to contemporary problems, it can lead to strikingly fresh insights and solutions.

Design science is a tool that is based on a global perspective and a systems approach to the problems of the world. It assumes that globalization has made the world an ever more interconnected whole, and any successful problem solving of society's systemic ills needs to be an approach that is global, comprehensive, visionary, and based on science, not politics, ideology, or wishful thinking. The entire world is now the relevant unit of analysis, not the city, state, or nation. We are onboard, as Buckminster Fuller

pointed out, "Spaceship Earth," and the illogic of 200+ nation state admirals all trying to steer the spaceship in different directions is made clear through this metaphor—as well in Fuller's more caustic assessment of nation states tending to act as "blood clots" in the world's global metabolism.

The design science process is augmented by vast quantities of statistical information about the state of the world, its resources, human trends, needs, and technology. With the advent of personal computers and the Internet this information became almost universally available—and with it, design science found its perfect complement. Coupled with the tools of the information age, design science gains the power to reach its potential. The Internet has not leveled the global playing field so much as expanded it, and the good-ol'-boy-status-quo-maintaining political process can now be subverted by a process that brings Thomas Jefferson into the twenty-first century.

In Fuller's words, design science is a process where individuals or teams of people can "Make the world work, for 100% of humanity, in the shortest possible time, through spontaneous cooperation, without ecological offense or the disadvantage of anyone."

Making the world work for 100% of humanity reflects Fuller's global perspective as well as his values. We are not here just to make ourselves rich, famous, or top consumer of the day or decade, or here just for the 5% living in our part of the world; we are here for all of humanity. The "spontaneous cooperation" is instructive in light of the previous discussion. The phrase does not read, "Make the world work for 100% of humanity through a central government, or through enforced coercion by a strong military" but through a cooperation that arises from a fundamental transparency of society and its needs. If everyone knows what the situation is, has a clear vision of what should be and what needs to be done, we cooperate to get it done—as we do as a society in times of emergency.

Fuller said:

> I am enthusiastic over humanity's extraordinary and sometimes very timely ingenuities. If you are in a shipwreck and all the boats are gone, a piano top buoyant enough to keep you afloat that comes along makes a fortuitous life preserver. But this is not to say that the best way to design a life preserver is in the form of a piano top. I think that we are clinging to a great many piano tops in accepting yesterday's fortuitous contrivings as constituting the only means for solving a given problem.

Design science is a method for developing the life preserving and enhancing solutions to society's problems.

APPENDIX 2

The UN Millennium Development Goals

Goal #1: Eradicate extreme poverty and hunger

- Reduce by half the proportion of people living on less than a dollar a day.
- Reduce by half the proportion of people who suffer from hunger.

Goal #2: Achieve universal primary education

- Ensure that all boys and girls complete a full course of primary schooling.

Goal #3: Promote gender equality and empower women

- Eliminate gender disparity in primary and secondary education preferably by 2005, and at all levels by 2015.

Goal #4: Reduce child mortality

- Reduce by two thirds the mortality rate among children under five.

Goal #5: Improve maternal health

- Reduce by three quarters the maternal mortality ratio.

Goal #6: Combat HIV/AIDS, malaria and other diseases

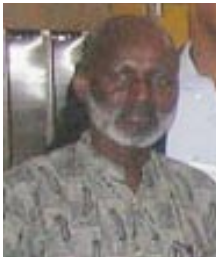
- Halt and begin to reverse the spread of HIV/AIDS.
- Halt and begin to reverse the incidence of malaria and other major diseases.

Goal #7: Ensure environmental sustainability

- Integrate the principles of sustainable development into country policies and programmes; reverse loss of environmental resources.
- Reduce by half the proportion of people without sustainable access to safe drinking water.
- Achieve significant improvement in lives of at least 100 million slum dwellers, by 2020.

Goal #8: Develop a global partnership for development

- Develop further an open trading and financial system that is rule-based, predictable and non-discriminatory. Includes a commitment to good governance, development and poverty reduction—nationally and internationally.
- Address the least developed countries' special needs. This includes tariff- and quota-free access for their exports; enhanced debt relief for heavily indebted poor countries; cancellation of official bilateral debt; and more generous official development assistance for countries committed to poverty reduction.
- Address the special needs of landlocked and small island developing States.
- Deal comprehensively with developing countries' debt problems through national and international measures to make debt sustainable in the long term.
- In cooperation with the developing countries, develop decent and productive work for youth.
- In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries.
- In cooperation with the private sector, make available the benefits of new technologies—especially information and communications technologies.



Left and top right: Scenes from the Design Science Lab, summer 2005.
Middle right: U.N. Representatives responding to final DS Lab presentation, from left: Broddi Sigurdparson, Social Policy and Development/DESA; Florence Cheowith, Director, UN Food and Agricultural Organization; Albert Cho, UN Millennium Campaign.
Bottom right: Dr. Lidana Jalilvand and Jean-Baptiste Bassene.

ENDNOTES

[1] For more details on Design Science, see Appendix 1, *Design Science,* page 40.
[2] For more information on the Millennium Development Goals, see http://www.un.org/millenniumgoals/
[3] For more information on these organizations, see Appendix 2 and http://www.bigpicturesmallworld.com; http://www.bfi.org; and http://www.gem-ngo.org/.
[4] *The State of Food Insecurity in the World,* Food and Agriculture Organization of the UN annual hunger report, November 2005.
[5] Elizabeth Becker, "Number of Hungry Rising, UN Report Says" *New York Times*, 12-8-04
[6] "Stop blaming the weather," (*The Economist,* June 10, 2002, p.13); Hunger strikes," (*The Economist*, October 21, 2001, p. 76); "Food shortages," (*The Economist*, October 28, 2000, p. 102)
[7] UN FAO, AQUASTAT http://www.fao.org/waicent/faoinfo/agricult/agl/aglw/aquastatweb/main/html/background.htm
[8] FAO, *Water and Food Security* (Rome, Food and Agriculture Organization of the UN, 2002) www.fao.org
[9] Ibid.
[10] Elizabeth Becker, "Number of Hungry Rising, UN Report Says" *New York Times*, 12-8-04
[11] Ruskin, F.R. (Ed.). (1984). *Leucaena: Promising Forage and Tree Crop for the Tropics.* Washington, D.C.: National Academy Press
[12] ibid.
[13] It could possibly also be part of the UNDP, FAO, or UNEP.
[14] Assuming 3.2 billion people live in urban environments and each produce one pound of organic waste/day.
[15] The Fertilizer Institute http://www.tfi.org/Statistics/worldfertuse.asp
[16] http://www.jepsonprairieorganics.com/compostprocess.htm
[17] http://www.japanfs.org/db/database.cgi?cmd=dp&num=1175&dp=data_e.html
[18] http://www.japanfs.org/db/database.cgi?cmd=dp&num=1076&dp=data_e.html
[19] More productive as measure by total output per hectare.
[20] Various nomenclatures are used in different parts of the world and academia to describe the core practices here referred to as regenerative farming. These include alternative, sustainable, low-input, organic, agro-ecological, ecological, and information intensive agriculture. Each name comes with its own emphasis and nuances, but all are distinct from "modern" resource intensive, mechanized and large-scale agriculture.
[21] See for example, M. Gabel, "The Regeneration of Africa: Resources, Needs and Capacities" (Philadelphia: World Game Institute, 1985) and M. Gabel and A. Heiland, "National Implications of Resource-efficient Farming Methods for Tanzania" (Emmaus, PA: Rodale Press Inc., 1985).
[22] See, for example, M. Gabel and A. Heiland, "National Implications of Resource-efficient Farming Methods for Tanzania," pp. 3-4. (Emmaus, PA: Rodale Press Inc., 1985)
[23] Quoted text from *Seven Billion Billionaires,* Sierra Club Books/University of California Press, forthcoming 2006.
[24] "Waterment" is a contraction of government water management and as such refers to the strategy of government-led initiatives to provide the basic human right to water to all citizens.
[25] FAO, Water and Food Security (Rome, Food, and Agriculture Organization of the UN, 2002) www.fao.org
[26] Developed in Kisii, Kenya, by a Dutch NGO.
[27] UN FAO, AQUASTAT http://www.fao.org/waicent/faoinfo/agricult/agl/aglw/aquastatweb/main/html/background.htm
[28] FAO, Water, and Food Security (Rome, Food and Agriculture Organization of the UN, 2002) www.fao.org
[29] UN Millennium Campaign: http://www.millenniumcampaign.org/site/pp.asp?c=grKVL2NLE&b=1184423

[30] Oxfam briefing paper 76, "A Round for Free" http://www.oxfam.org.uk/what_we_do/issues/trade/bp76_modalities_and_dumping.htm

[31] http://www.oxfam.org.uk/what_we_do/issues/trade/bp30_cotton.htm

[32] Oxfam briefing paper 76. "A Round for Free"

[33] http://www.oxfam.org.uk/what_we_do/issues/trade/art_bloomer_cottsug.htm

[34] Ibid

[35] http://www.oxfam.org.uk/what_we_do/issues/trade/bp30_cotton.htm and CIA World Factbook

[36] Oxfam Briefing Paper 76, "A Round for Free." The de minimis clause allowed developed states to exempt a maximum of 5% of total agricultural output and a maximum 5% of subsidized products from a subsidy-reducing scheme known as the Amber Box. Developing states were permitted an exemption of up to 10% of agricultural output and up to 10% of subsidized products.

[37] *Seven Billion Billionaires,* Sierra Club Books/University of California Press, forthcoming 2006.

NOW • World population: 6.4 billion • Percent of hungry or malnourished people in 1970: 24% • Percent of hungry or malnourished people in 2005: 13% (852 million) • **This reduction, and the continuing yearly removal of 5 to 8 million additional people from the rolls of the malnourished, is one of humanity's greater accomplishments** • At the rate we are "improving" it will take 100 to 163 years to eradicate hunger from the world • Hunger and malnutrition are killing nearly six million children each year—roughly equal to the entire pre-school population of Japan. Many die from a handful of treatable infectious diseases including diarrhea, pneumonia, malaria and measles. They would survive if their bodies and immune systems had not been weakened by hunger and malnutrition • Over 170 million people living in urban areas are hungry • People living in rural areas (50% of the world's population) constitute nearly 80% of the hungry people in the world. Over 50% of these are small, subsidence farmers • There are over 1 billion people in the world without access to clean water and 1.6 billion without access to sanitation • Water resources play a critical role in the global food system. Not only is water essential for human survival, it is needed for producing crops. Irrigated farmland, which accounts for less than 20% of global food-production land, produces 40% of all food. Irrigation increases yields of most crops by 100 to 400% • Fertilizer plays a key role in global food production. Without adequate fertilizer, total food production would not be enough to feed the world • The global economic system and social/political arrangements play at least as big a role in the global distribution of food and hunger as does the weather. Subsidies given to wealthy country's farmers to encourage their production has serious negative impacts on the farmers in the poorer parts of the world • Lack of access to credit keeps low-income food producers impoverished • Lack of access to land, or ownership of land, keeps low-income food producers impoverished.

THEN • **By 2015:** Halve the proportion of people whose income is less than one dollar a day • Halve the proportion of people who suffer from hunger • **By 2025:** 100% of humanity are well nourished with safe, abundant, affordable food supplies • The production of food is done in environmentally regenerative ways • There is an ever-increasing diversity of food choices and biological resources • There is an ever-increasing resource efficient food system that is knowledge, rather than energy, intensive • There is ever-increasing local self-reliance and global interdependence of our food systems and supplies • National and local food systems are subsidy-free and open-market based • There are emergency backup systems and anticipatory crisis management systems in place • Local and global food systems are adaptable, flexible, and transparent • Local and global food systems are conflict free; food is never used as a weapon or bargaining chip • The global commons are managed for global well being, not national, local or individual gain.

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