

## Opportunities to Integrate Solutions to Water, Agriculture and Climate Crises in Global Processes

“Observational records and climate projections provide abundant evidence that freshwater resources are vulnerable and have the potential to be strongly impacted by climate change, with wide-ranging consequences for human societies and ecosystems.”

- IPCC Working Group II, in IPCC Technical Paper VI on Climate Change and Water, 2008

### 1. Introduction

What policies and practices are needed to ensure food security for all, to help individuals realize their “right to food” and “right to water,” in a climate challenged world? First, we must understand the interrelationship, mediated through water, of three contemporary crises with each other: the climate crisis, the food crisis and the global water crisis itself. There is widespread recognition that “the poorest countries and communities will suffer the earliest and the most from the climate crisis,” aggravating development challenges, including that of achieving the Millennium Development Goals (MDGs) to ensure food security and/or reduce poverty.<sup>i</sup> However, somewhere along the way from knowledge creation to policy formulation and proposals for action, this understanding of the interconnectedness and the underlying principles of development—equity, justice and extraterritorial responsibility—is lost, and the challenges loom larger than ever.

There are several events in 2009, such as the 5<sup>th</sup> World Water Forum, (March, Istanbul), UN Commission on Sustainable Development (May, New York) G8 Meeting on Food Security, (April, Treviso), and UN conference on Climate Change -COP 15, (December, Copenhagen) that will once again attempt to find solutions to these three crises. This paper attempts to contribute to all these international efforts with an analysis of these challenges and proposes policy directions.

It argues for a fundamental redesigning of the current model of agriculture and food production systems to ensure food security and water security in a just and sustainable manner, and also to help address the crises of the commons—water and climate. Changes need to start in agriculture because of how it is fundamentally different from other sectors. It provides employment to 45 percent of workers worldwide; it is the source of livelihood for 42.8 percent of the global population.<sup>ii</sup> Any adverse impact on this sector, such as climate change induced water problems, will not only affect the world’s ability to feed itself, but more importantly, tip the balance for the more than 40 percent of world’s population who are already on the edge.

Agriculture is also multifunctional (i.e. a multi-output activity producing not only commodities – food, feed, fibers, biofuels, medicinal products and ornamentals – but also non-commodity outputs such

as environmental services, landscape amenities, social and cultural heritages), and has the potential to help address the multiplicity of challenges we face today.<sup>iii</sup> Solving the food and water crisis requires not only an understanding of the ways in which the climate crisis impact food and water security, but also how appropriate agricultural policies have the potential to solve these development challenges.

#### 1. Reaching Limits in an Unequal World

Worldwide, 1.069 billion people do not have access to safe drinking water; 2.612 billion people do not have water to meet their basic sanitation needs.<sup>iv</sup> This crisis is not simply a result of lack of water but also results from the way water is used. Mostly, the water crisis is precipitated by the unsustainable way in which much of our food is produced. The water crisis now presents challenges for achieving future food security.

We are already in the midst of a food crisis: in December 2008, the number of undernourished people worldwide stood at 963 million, an increase of over 40 million since the last estimate.<sup>v</sup> It has been estimated that if current water use patterns continue, by 2050 the world will not have enough water to meet the food and nutritional requirements of the growing population.<sup>vi</sup>

According to a recent study in *Science*, rising temperatures associated with climate change will severely impact agricultural production in the future.<sup>vii</sup> Food deficit nations, almost all of them in the south and already water scarce, are further compromised by climate change as they have limited resources for climate adaptation or to undertake mitigation efforts. In fact The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007) predicts that in some countries, “yields from rain-fed agriculture could be reduced by up to 50 percent by 2020.”<sup>viii</sup> This will worsen the food crisis in water stressed and poor countries in sub-Saharan Africa and Asia, with perhaps the worst long-term impact being in South Asia.<sup>ix</sup>

We are approaching the limits of the planet’s resources, as far as the current model of food production system goes – be it land, water or fossil fuel. There are not enough new land or water sources that can be diverted for agricultural production without incurring huge environmental and social costs. Solutions must be comprehensive and will require a radical departure from the way the agricultural food system is functioning today. Even though the World Bank, the World Water Council and other organizers of the World Water Forum recognize these limits, the strategies they propose to address the crises, involve more of the same. An alternative agricultural policy should be the center piece of the recommendations by the World Water Forum to help achieve food and water security.

## 2. Agriculture and Climate Change

The agricultural sector (without counting the indirect use of fossil fuel), accounts for 60 percent of methane emissions and 50 percent of the nitrous oxide emissions, the other two major components of anthropogenic Green House Gas (GHG) emissions.<sup>x</sup> The climate impacts from GHG emissions include rising sea levels and rising temperatures, extreme variations in frequency and patterns of precipitation (be it rainfall, snowfall or snow melt) that result in floods and droughts, as well as an increase in pathogens and pests.

These climate-related changes are expected to affect fresh water availability for a whole range of human uses including agriculture. As a sector accounting for the lion's share of global water use, this will have tremendous implications for food security, and questions of adaptation have been high on the agenda. According to a recent FAO paper, "Climate change, water and food security," "rain-fed systems will continue to offer the greatest scope of adaptation in terms of area, number of farmers and overall contribution to global food production."<sup>xi</sup> The report also recognizes that, "there is a significant difference in adaptation potential between the large-scale mechanized production of rain-fed cereals from North America, Europe, Brazil and Australia and the small-scale systems that characterize cereal production in many developing countries."

A glaring omission in these discussions, however, is the lack of attention to the impacts that are specific to the current industrial agricultural practices and related water use practices on climate change. An early 2008 study in Science reported that "hydrological cycle of the western United States changed significantly over the last half of the 20th century" and that "up to 60% of the climate-related trends of river flow, winter air temperature, and snow pack between 1950 and 1999 are human-induced."<sup>xii</sup> These human-induced changes surely include the transformation of agriculture.

A systematic assessment of climate implications of the entire chain of activities endemic to industrial food system (the climate footprint of manufacturing of farm machinery and agro-chemical inputs; of transporting these inputs from factory to farms; of diverting water for industrial farms; of generating electricity/ fuel for direct use in the farm for ground water mining and/or for operating the machinery, and of mono-cropping / confined animal feeding operations) will likely find that the industrial model of food production system has contributed substantially to Green House Gas (GHG) emissions, and thus to the current climate crisis.

Agriculture is not only a contributor to human-induced climate change; it also has the potential to mitigate climate change if the right practices are used.<sup>xiii</sup> An FAO report published in mid 2007 suggests that organic agricultural systems have to potential to be less damaging to the climate, even

when compared with industrial food production systems that adopt no-till agriculture. For example, the report found that the carbon dioxide emissions from organic agricultural systems are 48-60 percent less than industrial agricultural systems, since adoption of conservation agriculture practices in industrial farming systems still entails intensive agro-chemical use, as well as intensive livestock production off-site.<sup>xiv</sup>

According to an IPCC Technical Paper I (1996) on "Technologies, Policies and Measures for Mitigating Climate Change," there are several agricultural technologies for mitigating GHG emissions.<sup>xv</sup> For example, increasing carbon sinks through better soil management – especially restoring degraded land by adding organic matter–would account for close to 50 percent of the estimated potential reductions of annual emissions of carbon dioxide from agriculture. Improving livestock management–especially in terms of improved diet quality and the nutrient balance of ruminants (i.e moving away from confined animal feeding operations or CAFOs) – would account for half the estimated potential reductions of annual emissions of methane from agriculture. Increasing nitrogen use efficiency in fertilizer use would in itself accounting for close to 80 percent of the estimated potential reductions of annual emissions of nitrous oxide from agriculture.

While these figures need to be updated, it is evident that shifting from several practices associated with industrial farming systems to agricultural systems with high use of organic matter will help reduce emissions and climate impacts. Indeed, the reductions could be even greater than the IPCC envisages. IPCC estimates of the potential reduction of emissions from fossil-fuel based energy use in agriculture are estimated from changes in very limited areas– in expanded use of minimum and no tillage, irrigation scheduling, solar drying of crops and improved fertilizer management– and do not consider possible the mitigation potential of converting fossil fuel based food production systems to sustainable food production systems.

Recommendations on climate and agriculture: The climate mitigation potential of converting industrial farming systems to organic farming systems has not yet made it to the UN Framework Convention on Climate Change (UNFCCC) agenda, or to the other international initiatives such as the World Bank's Strategic Framework on Climate Change and Development (SFCCD). It should be. It is absolutely crucial that other processes such as CSD-17 and high level G8 meeting on food security leading up to the upcoming high level negotiations in Copenhagen consider it as a priority as well, not only to help address regional water crises and food security challenges as we will see below, but also help the UNFCCC address the climate crisis in a comprehensive manner.

### 3. Water Use in Irrigated Agriculture<sup>xvi</sup>

Globally, irrigated agriculture accounts for almost 70 percent of total water withdrawn for human use from rivers, lakes, reservoirs, ponds and aquifers (this does not include water used in rain-fed farming systems or water used in food processing). There are huge variations in irrigation water use across continents, countries and agricultural systems

While irrigated agriculture has long been practiced around the world to a varying extent, its expansion in the 20<sup>th</sup> century coincided with the introduction of industrial agricultural practices. Substantial amounts of water were fundamental to the success of the new industrial agriculture. With the development and use of high yielding varieties of seeds (HYV seeds) with higher nitrogen absorption capacity, easy availability of water became an even more essential component of industrial agriculture. Industrial agriculture also requires an increasing amount of water. The application of inorganic compounds reduces the water retention capacity of soil, increasing the frequency of irrigation application. On the other hand, the application of organic fertilizers can help increase/ maintain the water retention capacity of the soil, and thus help reduce the need for frequent irrigation in farms. It is also noteworthy that most traditional agricultural systems do not have access to modern water extraction mechanisms, and thus, their use of irrigation water is limited.

Depending on irrigation technology, type of irrigated agricultural systems, as well as humidity/ aridity, temperature and soil type of the region, there are huge variations in water use efficiency in irrigated agriculture, making global estimates of irrigation efficiency (proportion of water withdrawn for irrigation that is actually consumed by crops) close to 43 percent.<sup>xvii</sup> While irrigation water use efficiency can be as low as 25 percent in some surface irrigation systems in South Asia (due to high seepage rates and high levels of evaporation during water storage and delivery), it is much higher in systems that use farm water saving technologies such as drip irrigation or in traditional canopy farming systems.

Recommendations in irrigation efficiency: There is much opportunity for improvements in irrigation water use efficiency both at the stage of delivery from source to farm gate (lining of the canal, repairing of leaks), and at the farm level (shifting to more efficient irrigation technology and better water management practices, including moisture management). These simple efficiency measures would provide some of the “low hanging fruit” that will help many poor countries adapt to climate change’s effects on irrigated agriculture.

However, in most developing countries, water policies are formulated in accordance with the country-specific water sector strategy papers of the World Bank. They tend to prioritize new, capital intensive water infrastructural development. To a lesser extent, they also stress rehabilitation of

existing infrastructure. These strategy papers do not prioritize investment in training and extension for better water management practices. Nor do they prioritize incentives that will help adopt improved water use efficiency practices. Such low cost/ cost effective measures are not only ecologically appropriate but also build on community knowledge as a way to address water availability problems. Any water use efficiency discussions must have local level, low cost investments to as a crucial component for addressing the water crisis. World Water Forum Ministerial must support such investments.

#### 4. Rain-fed crops and Food security

While irrigated agriculture attracted more attention till recently, there has been belated recognition of the continuing centrality of rain-fed agriculture, practiced many parts of the developing world and in temperate regions of the north are rain-fed. Most rain-fed agricultural land is in Sub-Saharan Africa (96 percent of cultivated land in the region), Central America, South America, South and South East Asia, and supports the livelihoods of marginal groups that practice small-holder agriculture. In 2002, it was estimated that about 1.4 billion people –three fourth of them in Africa and Asia–eke out a living from these marginal lands.<sup>xviii</sup>

It is these marginal lands that are most vulnerable to climate change. According to the FAO, “The combined effects of climate change and low adaptation capacity will increase vulnerability and local food insecurity in poor developing countries that depend on rain-fed production.”<sup>xix</sup> It calls for specific efforts in these regions, such as adaptation techniques and capacity building. The Comprehensive Assessment of Water for Agriculture (IWMI 2006) too recognizes the importance of rain-fed systems to achieving food security, and advocates investing in such systems, in addition to achieving efficiency improvements in irrigation.<sup>xx</sup>

These calculations, moreover, overlook a myriad of rain-fed crops that are locally specific, sustain communities living in marginal areas. For example, it has been estimated that about 600 million people in the world today could depend on unmanaged natural systems for their livelihoods.<sup>[1]</sup> Similarly, a large number of forest products (wild tubers and fruits), and food gathered from natural systems, (such as fish from streams that contribute to food security of poor communities), is not part of these calculations. Firewood, essential to ensure food security in most rural households, is also largely gathered from rain-fed systems, and is not included in these accounts.

Now, even the corporate world recognizes the significance of rain-fed farming as a new horizon for industrial agriculture and corporate profits. The heading of a recent advertisement by Monsanto

asks: "How can we squeeze more food from a RAINDROP."<sup>xxi</sup> The text says: "non-irrigated agriculture produces 60% of worlds' food." The advertisement goes on: "the challenge for farmers is squeezing the most out of unpredictable rain fall. That requires putting the latest science based tools in farmer's hands, including advanced hybrid and biotech seeds" that "significantly increase crop yields and can help farmers use one third less water per unit produced ... That's' Sustainable agriculture. And that's what Monsanto seeds are all about."

While there is increasing recognition in mainstream circles of the centrality of rain-fed farming to global food security, most mainstream initiatives to strengthen rain-fed farming seek to do so by incorporating it into industrial agriculture. Thus, most attention so far seems to be in finding technological and infrastructural solutions: in terms of increasing water use efficiency and drought resistance of crops through an array of biotechnological tools including genetic modification, or in terms of increasing water storage capacity and irrigation efficiency through infrastructural investments. Increasing investments in small holder agricultural productivity is identified as a priority, but most of these investments are likely to be in making these systems adopt industrial agricultural practices. This would be tantamount to ignoring the very large potential of sustainable agricultural practices have in mitigating climate crisis, solving the water crisis and meeting food security.

It is certainly necessary to strengthen the rain-fed systems to deal with climate change related weather and rainfall variability.

Recommendations to Bolster Rain-fed Agriculture: It entails rediscovering traditional/ local foods that are ignored in industrial food production systems, growing less meat and diversifying our food sources, changing our food habits to eat locally as much as possible (especially in wealthy countries that import a lot of food) as well as diversifying our food sources. It also requires recognizing the importance of multifunctional agriculture and supporting policies building the resilience of such agricultural systems. Strengthening the multi-functionality of the agricultural sector, not only as a source of a number of tangible benefits but also a way of life, should become part of the climate and development strategy of multilateral institutions addressing the triple crisis in agriculture, water and climate. These institutions include International Financial Institutions (IFI) such as the World Bank and Consultative Group on International Agricultural Research (CGIAR), institutions such as International Water Management Institute (IWMI), intergovernmental agencies such as FAO and the commissions and agencies of the United Nations.

There are several initiatives advocating policy shifts to address the ills of the current food and agricultural system, and some of them have touched on various elements of this strategy. These include

International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD), (2008) and Comprehensive Assessment of Water Management in Agriculture (2007); Intergovernmental Panel on Climate Change Report (2007). By understanding the problems of climate change, water crisis and food security in terms of fairness and equity, and rights and responsibilities, we can use the knowledge systems so that the real beneficiaries are small holder farmers, poor communities in urban and rural areas, and women in particular. The IAASTD recommendations offer a comprehensive set of tools that need to be supported at the World Water Forum Ministerial. The ministerial should advocate inclusion of IAASTD recommendations in the UNFCCC.

#### 5. Industrial Agriculture Undermining Resiliency

The competition between commercially oriented agriculture and more locally oriented agriculture becomes most evident when it comes to water and impact on women. One cannot talk about water without recognizing the central role that women play in accessing it and using it for the multiple needs of their families, and in both rain-fed and irrigated farming systems, or without acknowledging their resultant knowledge of quality and reliability of local water sources and of appropriate management practices. Yet it is consistently ignored, or limited to lip service, in the global debates that are seeking to address— scarcity, access, quality, control, and stewardship – all issues that relate to women. The transformation of locally oriented agriculture to export oriented agriculture has a particularly negative gender impact.<sup>xxii</sup> Also, such women face a greater risk still from climate change related variability in precipitation, as they lack resources to adapt to climate changes.

As water becomes a scarce resource, even basic staple crops need to compete with fiber and fuel crops as well as high value cash food crops for access to water. In this race, the export agricultural sector commands better access to water, at the cost of subsistence farms or even local drinking water needs. A striking example is the flora-culture industry in Colombia. One out of two flowers bought in the United States is produced in the Bogotá Savanna, causing tremendous water stress among the local populations.<sup>xxiii</sup> The pursuit of flora-culture has resulted in lowered water table, pesticide contaminated water and disrupted local water supply and has had a negative impact on food production, as a result of crop displacement and soil contamination.<sup>xxiv</sup>

The direct impact on water came through several other vectors as well. In many countries such as Bolivia and Argentina, World Bank loans were made conditional on the multinational-led privatization of the public water service. As a result, water charges increased significantly, reducing people's access to affordable water.

Second, though the World Bank had been a major lender for state supported irrigation development since the beginning, it began requiring governments to reduce their expenditure in agricultural services including investing in already existing irrigation infrastructure. area. Governments began disengaging from maintenance, making many existing irrigation projects dysfunctional, resulting in crop- failure, sometimes pushing small holder farmers into debt and destitution, especially in areas where, they did not have access to alternative water source to support chemical agriculture.

In many countries, trade barriers and the deregulation of the agriculture sector undermined food self-sufficiency and shifted production to mono-cultural, export oriented, industrial production that is water intensive.

Recommendations: International Financial Institutions continue pursuing these policies now through their poverty reduction strategies such as the World Bank's Poverty Reduction Strategy Papers (PRSP). With increasing climate challenges, now PRSPs and other such initiatives are likely to be informed by Bank's analysis of climate adaptation and mitigation strategies. Unfortunately their analysis still emphasizes an industrial agriculture model of production and trade to achieve food security. In order to ensure the food security and water security of local populations are not further compromised, projects proposed under these proposals should include a water, climate and food security impact assessment before being implemented.

## 6. Water Transfers Wreak Havoc

The most revealing way of evaluating the global impact of chemical-intensive industrial agricultural food systems is by focusing on the way they have transformed fresh water systems.

In the twentieth century, governments around the world began building massive water infrastructures and water diversions, damming rivers for irrigation, for hydro-electric power and in some cases for flood control and by the end of the century there were more than 45,000 major dams globally. While the bilateral and multilateral financial investment in dams was small at about 15 percent, IFIs played a key role in spreading the technology, lending legitimacy for new dams and facilitating financial arrangements as well as in training personnel.<sup>xxv</sup>

A Pilot Analysis of Global Ecosystems (PAGE) by World Resources Institute estimated that "dams, diversions or canals fragment almost 60 percent of the world's largest 227 rivers."<sup>xxvi</sup> As a result of extreme modifications to river systems, many rivers, such as Yellow River in China, Nile River in North-eastern Africa, Amu Darya and Syr Darya in Central Asia and Colorado and Rio Grande in North America, no longer reach the sea for at least parts of the year.

While such transfers help irrigation and power, sustain urban sprawl and enable several cities to accommodate populations far beyond their carrying capacity, the cost has been high. Freshwater systems around the world are modified to such an extent that their basic functions are affected. Agro-ecological transformations in the region negatively impact not only traditional agricultural systems but also local biodiversity through habitat degradation and/or loss. Such changes in the natural resource base affect the food security of vulnerable members of community (poor) and family (women, children) who depend on these systems for their livelihoods. In many cases such water diversion projects also result in massive displacement of communities, destruction of cultures and social disruption.

The most recent examples of such massive water diversions include the Three Gorges Dam in China and the Narmada Valley Project in Central India. Similar projects are under way in the Amazon River system in Brazil and Mekong in China, both home to some of the most diverse fisheries in the world. The Lower Mekong River Basin being one of the most culturally diverse (over 60 million people belonging to over 100 different ethnic groups) regions. Any water diversion to mainland China will not only displace these communities but also will impact livelihood sources downstream, in Laos, Cambodia, Vietnam and Thailand, affecting some of the largest rice producing regions in the world.<sup>xxvii</sup>

Recommendations on Water Transfers: The World Commission on Dams, a truly multi-stakeholder process (involving grassroots anti-dam protestors, multinational dam construction firms, government officials and representatives of multilateral development banks), initiated by the World Bank, in its report “Dams and Development” offer suggestions for future actions based on five core principles: equity, efficiency, participatory decision making, sustainability and accountability.<sup>xxviii</sup> The WCD report advocates for small scale irrigation and hydro power projects that are sustainable and supportive of local economy.

Although WCD report helped slow the Bank’s lending for large dams for a few years, with the new challenges of climate crisis, the bank and its allies once again support such water infrastructure. Ignoring the potential GHG emissions from reservoirs, they tout hydro-power (often a part of the irrigation project) as clean energy source. Thus in the context of climate adaptation and mitigation strategies the World Water Forum as well as the World Bank should take the recommendations of World Commission on Dams.

## 7. Excessive Groundwater Withdrawals

A major technological transformation in the second half of 20<sup>th</sup> century enabled the Green Revolution to expand to areas where such massive water transfers were not feasible: the tube-well.

Unlike traditional wells, tube-wells gave access to water in large quantities by driving a tube into deep aquifers and using a pump to suck water up. Easy access to state subsidized energy services and equipment, enabled expansion of industrial farming to otherwise water-stressed areas of Asian countries such as China, India and Pakistan.

In 2004, New Scientist reported that the tube-well revolution, whose technology is adapted from the oil industry, was driving Asian countries towards an environmental catastrophe.<sup>xxxix</sup> Deep tube-well irrigation has resulted in most of the hand-dug wells and shallower tube wells going dry, as ever-deeper wells get dug. Farmers, whose wells go dry, dig deeper, “chasing the deep waters” (at times to their economic peril) when their wells go dry yet again, as happened in coastal Gujarat in India.<sup>xxx</sup> In these areas, deep drilling has contributed to salinity ingress (seepage of sea water inland through underground water flows) resulting in the salinization of groundwater. Villagers are forced to use the saline water to meet their basic water needs, and when the salinity destroys the land’s fertility, they end up abandoning their land/ village in search of livelihood. Often over-drafting of groundwater for industrial agriculture comes at the cost of basic water needs of the poor and traditional farming systems.

Withdrawals exceeding natural recharge rates of aquifers are leading to the lowering of water tables, salinization of groundwater and land subsidence in many other parts of the world as well. For example in the United States, where 45 percent of irrigation water comes from underground, in the High Plains aquifer (which includes the Ogallala aquifer) water levels have declined more than 100 feet in some areas.<sup>xxxi</sup>

## 8. Agriculture and Water Pollution

The intensive irrigation water use in industrial farming systems has resulted in widespread soil and water contamination from pesticide and fertilizer runoffs, affecting quality and quantity of water available for other uses and resulting in habitat degradation. It is one of the biggest causes of water quality deterioration and environmental degradation in North America and Europe.

In Australia, it is reported that more than 5.7 million hectares of land are at risk of salinity damage mostly due to over irrigation and from salts present agro-chemicals.<sup>xxxii</sup> In India, intensive irrigation and other Green Revolution practices have resulted in large tracts of agricultural land in the irrigation command areas becoming water logged, saline/ alkaline. In the United States, increased nitrogen concentration in the Mississippi river has resulted in the proliferation of algae (that block sunlight/ impede photosynthesis), and toxic algae bloom outbreaks. About half of the nitrogen reaching

the Gulf comes from fertilizer; 15 percent comes from animal manure from confined animal feeding operations (CAFOs). Such industrial farming practices have played a huge role in the environmental crisis of hypoxia (a condition in which dissolved oxygen levels are too low to sustain marine organisms) in the Gulf of Mexico.<sup>xxxiii</sup>

Similarly, herbicides and fumigants applied directly to the soil are commonly found in groundwater sources in Europe and elsewhere.<sup>xxxiv</sup> In the United States, the most often detected herbicides are the ones mainly used for industrial farming—atrazine, metolachlor, cyanazine, alachlor, and acetochlor—found in water samples from streams in agricultural areas with their greatest use.<sup>xxxv</sup> Agro-chemicals use in mono-cultural grain cultivation has resulted in high levels of surface water pollution and ground water contamination in many Asian countries.

When such contaminated water is the only drinking water source or when it reaches the human food chain, they pose public health risks. In 2003, Center for Science and Environment in India reported that bottled beverages produced by global firms such as Coca Cola in India had pesticide residues at much higher levels than considered safe for human consumption, apparently as a result of their use of contaminated groundwater.<sup>xxxvi</sup> In countries such as Mexico, where about 75 percent of drinking water comes from ground water, agro-chemical contamination is affecting ordinary peoples' access to clean water for meeting basic needs.<sup>xxxvii</sup>

Recommendations for Water Pollution and excessive water withdrawals: Environmental regulations, as well as national policies and international instruments in accordance with Right to food (UN General Comment 12) and Right to water (UN General Comment 15) to ensure food security of poor and that will ensure water availability for ecosystem needs and for basic needs of people, should be recommended by the World Water Forum. Advancing legally protected rights to water for poor people and all residents in a community to meet their basic needs and legally recognized access to water for practicing subsistence livelihood activities including food production in member countries of the United Nations are two necessary elements of this.

#### 9. Some International Responses to the multiple crises in Agriculture, Food, Water and Climate

There are different spaces where leaders, institutions and private initiatives are seeking to address the multiple crises, each with implications for water and food security for poor. For example The 17<sup>th</sup> session of the United nations Commission on Sustainable Development focuses on agriculture, Africa, rural development, drought and desertification issues directly affected by the crises. It offers tremendous potential to include multifunctional agriculture as the center piece of water security, food

security and a sustainable development agenda.

The Global Partnership on Food and Agriculture, officially introduced in June 2008 at the UN Food Summit, is another such initiative. Its direction is unclear but it is largely be spearheaded by members of the G8, the World Bank and the private sector to push for more immediate, coordinated investment for agriculture that will result in high yields.

The World Bank is calling for investment in agriculture and rural development to help alleviate poverty. However, it is focused on the Green Revolution, to raise GDP, to create jobs, and to manage natural resources. The “New Deal on Global Food Policy” is designed around provision of social safety nets, seeds and fertilizer for increased agricultural production, and trade reform to reduce distorting subsidies and barriers.<sup>xxxviii</sup>

The World Bank’s Strategic Framework on Climate Change and Development (SFCCD)’s purpose is to mainstream climate change considerations into the World Bank’s development strategy by integrating climate actions for adaptation and mitigation in development processes, and by promoting private sector financing, market mechanisms and concessional financing for innovative climate friendly projects. SFCCD rightly prioritizes “strengthening the resilience of communities and economies to climate risk,” through “increasing resilience in agriculture and its linkages with food security,” and through “water resource development including support to coastal areas and country-driven trans-boundary programs” in its country-led work. However, its inherent bias is to focus on a few large infrastructure projects or capital intensive technology at the expense of a multitude of smaller initiatives which could benefit vulnerable communities more directly.

The biggest agricultural investment initiative in recent decades is not from the World Bank or other Multilateral Development Banks (MDBs) but from private foundations. The Alliance for a Green Revolution in Africa (AGRA), established in 2006 by the Rockefeller and Bill and Melinda Gates Foundations, has emerged as an important new global actor in response to the food security crisis in sub-Saharan Africa.

With its focus on seed development suited to markets and monoculture agriculture, AGRA attempts to boost food productivity by promoting industrialized agricultural systems in Africa. It is closely associated multinational seed companies that have been trying to popularize genetically modified seeds around the world. Thus for example, Africa Harvest Biotechnology Foundation International (AHBFI), a recipient of AGRA’s Yara award has been working with Pioneer Hi-Bred International, a subsidiary of DuPont, to develop nutrition enhanced sorghum.<sup>xxxix</sup> The bio-fortification of single-crops is an initiative supported by Bill and Melinda Gates Foundation.<sup>xl</sup> One of the major

limitations of “modern biotechnology” (which involves overcoming natural physiological reproductive or recombination barriers, such as in the case of genetic modification for bio-fortification) is the lack of transparency surrounding its development.<sup>xii</sup> The call to apply the precautionary principle before adopting GMO technology has been ignored or resisted so far. In addition, high patent and technology costs mean that, even if this specific GMO was found safe, other claims remain valid, such as the fact that multi-trait GMOs would not be affordable for most developing countries, and local control of the technology will be near impossible.

In fact these global partnerships initiatives will likely lead to the further consolidation of chemical intensive industrial agriculture that is corporate-led and owned. This process may well put the last nail on the indigenous food production systems in Africa.

#### 10. Old Wine in New Bottles: Evaluating Current Proposals

Several sessions at the upcoming World Water Forum (Istanbul, March 2009) recognize the challenges posed by the three crises discussed above. But most mainstream water management strategies proposed for responding to these challenges and ensuring food and water security may even end up worsening the crisis. Consider four main themes that run through mainstream policy proposals to deal with the water challenges, advocated by the World Bank and many members of the World Water Council, the main organizer of the of the World Water Forum:

1. Faced with a water crisis and climate related uncertainties, proponents of free trade have been advocating virtual water trade. They advocate maximizing comparative advantage (in water) as one of the policy options for dealing with unequal spatial distribution of water and ignore the environmental footprint of such transfers. Trade in crops grown in water rich areas, they suggest, will free the water for more pressing needs or for economically more valued production processes in importing countries. But such dependence on large-scale food imports not only raise local food security concerns but also national security considerations. The proponents of free trade do not recognize that multifunctional agriculture too is about maximizing comparative advantage(s) but along multiple vectors/ axes. It is about growing locally appropriate crops, in order to meet local food needs, and supplementing it with other food if necessary.
2. Policy advocacy to develop water markets and other economic instruments to maximize the economic efficiency of water use, (help address allocation problems and help avoid wasteful water use) has been especially popular among the institutions such as the World Bank. Given

that under the current system economic returns from agriculture is low this sector will lose out to industry and other high value uses, if such policies, a) are not adopted across the economy as a whole, b) do not recognize the socio-cultural relevance of agriculture (e.g. in ceremonies practiced by indigenous groups/ religion) to society. Such a policy, moreover, will not have a space in a multi-functional agricultural model, where agriculture is not just a productive activity with multiple benefits, to which values can be assigned; it is a way of life.

3. Policy advocacy on efficiency improvements in agricultural water use is extremely important, given the very low irrigation water use efficiency in the sector. There are two ways in which efficiency improvements can be achieved,
  - 3.a Irrigation efficiency improvement that involves physical interventions and knowledge of farm management covers an array of activities including, improving the efficiency of storage (by reducing evaporation loss) and delivery mechanisms (lining of canals etc.), improving the water-use efficiency of on-farm operations (changing the method of water application from flood irrigation to deficit irrigation, or to drip or subsurface irrigation), as well as reducing the evaporation by increasing ground cover.
  - 3.b. Water use efficiency improvement that involves biological interventions including improving water absorption capacity of the roots, improving the ability of plants to use the absorbed water efficiently to produce appropriate biomass (grain/ leaves), at appropriate time (controlling the time required for crop to mature). While there is a broad spectrum of biotechnological tools available for increasing yield, the techniques used for improving water use efficiency can be more sophisticated and may belong to what is known as “modern biotechnology.” Interventions for water use efficiency improvements (that are not capital intensive) are extremely important, given the very low irrigation efficiency in the sector. These policy proposals concern themselves with efficiency improvement with regard to water quantity. (Water quality problems associated with chemical intensive irrigated agricultural systems can be addressed through biological interventions that are not capital intensive).
4. Policy advocacy to invest in modern biotechnology to combat climate change impact on Agriculture: Earlier advocated in the context of water crisis, call for developing drought resistant varieties has gained further prominence in the context of recent findings regarding climate change impacts on agriculture. For example the World Bank advocates this strategy in its Strategic Framework (SFCCD), and outlines investing in “technological innovations” as the main agriculture related adaptation strategy; It further calls for establishing new global partnerships

“to develop and deploy the next generation of technologies”. Modifying plant organisms to withstand other forms of stress, such as that from pests and pathogens (that are expected to increase as a result of climate change), will be yet another focus under this strategy.

Unlike, simpler biotechnological interventions, capital intensive biological interventions for improving water use efficiency of the crop varieties as well as increasing their tolerance to drought, pest and pathogens, is a more controversial strategy , especially in view of the reports on lack of transparency in research, regarding their impact on human health and environment.

#### 11. Policy alternatives and options for action

Solutions to the water crisis, food security and climate change, need to be considered in terms of fairness and equity, as well as in terms of rights, responsibilities and stewardship will help us formulate policies that will address water security and food security concerns as a first step and addressing the crisis of the commons as a long term goal.

Adopting a Rights-based approach: The General comments on Right to Food (UN General comment 12)and Right to Water (UN General Comment 15), as well as the conclusions of the intergovernmental initiative, International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD), (2008), will inform these policy recommendations, that call for investing in strengthening the multi-functionality of rain-fed agricultural systems and enhance the role of agriculture as a viable livelihood option as well as a way of life.

Further, we recommend at the multilateral/ intergovernmental level,

1. the inclusion of the climate mitigating potential of multifunctional agriculture, in the agenda of agreements which will be defined at the COP15 in Copenhagen this December (2009), as the most crucial agricultural strategy that will help reduce GHG emissions from current levels and at the same time help meet, food security in a sustainable way.
2. the World Water Forum Ministerial (March 2009) and at the UN Commission of Sustainable Development (UNCSD-17), May 2009 recommend the inclusion of sustainable, multifunctional agriculture in the UNFCCC (December 2009) agenda.
3. The World Water Forum Ministerial call for national policies in accordance with Right to food (UN General Comment 12) and Right to water (UN General Comment 15) to ensure food security of poor.
4. The World Water Forum Ministerial to call for environmental regulations, as well as national and international instruments that will ensure water availability for ecosystem needs and for basic

needs of people. (This for example will ensure that water transfers, as has been proposed as part of climate resilience building strategy by World Bank, are not undertaken at the cost of biodiversity; or water withdrawals do not exceed recharge rates of the aquifer concerned.)

5. The UN CSD-17 should invest in research, knowledge creation and dissemination regarding climate change mitigating potential of multifunctional agriculture, as opposed to agro-chemical intensive practices, as an implementation target to be carried out by UN Water..
6. International investment initiatives such as AGRA, that support the use of biotechnology to help meet food security, should invest in helping countries comply with the Cartagena Protocol on Biosafety, by investing in their capacity for evaluating biotechnology.
7. Promote national agricultural policies that support research, extension services and investment towards agro-ecologically appropriate multi-functional agriculture to help address crisis in agriculture, food systems, water and climate, in accordance with IAASTD recommendations.

The coming together of a multiplicity of crises – environmental, economic and humanitarian – today, makes it ever more clear that we are compromising our ability to meet future demands by wasting water in unsustainable production, such as that in the industrialized food system. Meeting challenges in climate and water calls for switching to food systems that conserve water and that is net emission-mitigator. This generation has the opportunity to strengthen the multifunctional nature of such agricultural systems, and build vibrant rural communities for whom agriculture is a rewarding way of life. It is for us to act.

---

<sup>i</sup> World Bank: “Development and Climate Change: A Strategic Framework for the World Bank Group,” World Bank, Washington DC, October 2008 (January, 2009) [http://siteresources.worldbank.org/DEVCOMMINT/Documentation/21928837/DC2008-0009\(E\)ClimateChange.pdf](http://siteresources.worldbank.org/DEVCOMMINT/Documentation/21928837/DC2008-0009(E)ClimateChange.pdf)

<sup>ii</sup> Food and Agricultural Organisation FAO, “Indicators for world (2.2.1) and for economic, regional and continental groups” in Compendium of Agricultural – Environmental Indicators (1989-91 to 2000), Rome, FAO Statistics Division, 2003 (January, 2009) [http://www.fao.org/es/ess/os/envi\\_indi/part\\_221.asp](http://www.fao.org/es/ess/os/envi_indi/part_221.asp) whole document available at [http://www.fao.org/es/ess/os/envi\\_indi/agr\\_env\\_indic.pdf](http://www.fao.org/es/ess/os/envi_indi/agr_env_indic.pdf)

<sup>iii</sup> International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD): “Executive Summary of the Synthesis Report”, Island Press, Washington DC, 2009 (January, 2009) [http://www.agassessment.org/docs/IAASTD\\_EXEC\\_SUMMARY\\_JAN\\_2008.pdf](http://www.agassessment.org/docs/IAASTD_EXEC_SUMMARY_JAN_2008.pdf)

<sup>iv</sup> World Health Organization/ UNICEF, “Meeting the MDG drinking water and sanitation target: the urban and rural challenge of the decade”, Global Water Supply and Sanitation Assessment, 2006 World Health Organization and United Nations Children’s Fund 2006, p:6-7 (January 12, 2009) [http://who.int/water\\_sanitation\\_health/monitoring/jmpfinal.pdf](http://who.int/water_sanitation_health/monitoring/jmpfinal.pdf)

<sup>v</sup> Food and Agricultural Organisation: FAO News Room, “Number of hungry people rises to 963 million” Rome, FAO News Room, December 2008, (January 2009) <http://www.fao.org/news/story/en/item/8836/icode/>

- 
- <sup>vi</sup> Comprehensive Assessment of Water Management in Agriculture. 2007. Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture. London: Earthscan, and Colombo: International Water Management Institute. (January, 2009) [http://www.iwmi.cgiar.org/Assessment/files\\_new/synthesis/Summary\\_SynthesisBook.pdf](http://www.iwmi.cgiar.org/Assessment/files_new/synthesis/Summary_SynthesisBook.pdf)
- <sup>vii</sup> David S. Battisti and Rosamond L. Naylor, "Historical Warnings of Future Food Insecurity with Unprecedented Seasonal Heat", Science, Vol. 323 No.5911 (2009) pp. 240–244 (January 2009) <http://www.sciencemag.org/cgi/content/abstract/323/5911/240>
- <sup>viii</sup> Inter-Governmental Panel on Climate Change (IPCC): "Report by Working Group II: Climate Change Impacts, adaptation and vulnerability", (April 2008) <http://www.ipcc-wg2.org/>
- <sup>ix</sup> International Food Policy Research Institute (IFPRI): Food Policy Report, "The World Food Situation: Driving Forces and Required Actions", Table 3, p.4, Expected impacts of climate change on global cereal production, (January 2009) <http://www.ifpri.org/pubs/fpr/pr18.pdf>
- <sup>x</sup> International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD): Summary for Decision Makers of the North America and Europe (NAE) Report, IAASTD, Island Press, Washington DC 2008 (January 2009) [http://www.agassessment.org/docs/IAASTD\\_NAE\\_SDM\\_JAN\\_2008.pdf](http://www.agassessment.org/docs/IAASTD_NAE_SDM_JAN_2008.pdf)
- <sup>xi</sup> Food and Agricultural Organisation (FAO): "Climate change, water and food security", Synthesis Paper, Expert Meeting held in Rome 26–28 February 2008, in preparation for the FAO High Level Conference (HLC) on World Food Security and the Challenges of Climate Change and Bioenergy in June 2008 (January 2009), <ftp://ftp.fao.org/docrep/fao/meeting/013/ai783e.pdf>
- <sup>xii</sup> Tim P. Barnett etc.: "Human-Induced Changes in the Hydrology of the Western United States," Science, 319. # 5866, (2008) pp. 1080 – 1083 (January 2009) <http://www.sciencemag.org/cgi/content/abstract/319/5866/1080>
- <sup>xiii</sup> International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD): Summary for Decision Makers of the North America and Europe (NAE) Report, IAASTD, Island Press, Washington DC 2008 (January 2009) [http://www.agassessment.org/docs/IAASTD\\_NAE\\_SDM\\_JAN\\_2008.pdf](http://www.agassessment.org/docs/IAASTD_NAE_SDM_JAN_2008.pdf)
- <sup>xiv</sup> Food and Agricultural Organisation (FAO): Report of the International Conference on Organic Agriculture and Food Security, Rome, May 2007 (January 2009) <ftp://ftp.fao.org/docrep/fao/meeting/012/J9918E.pdf>
- <sup>xv</sup> RT Watson, MC Zinyowera, RH Moss (Eds): "Technologies, Policies and Measures for Mitigating Climate Change", Table 12: Agricultural technologies for mitigation of GHG emissions and potential reductions of annual emissions of carbon dioxide, methane and nitrous oxide IPCC Technical Paper I - November 1996, IPCC, Geneva, Switzerland; (January 2009), <http://www.ipcc.ch/pdf/technical-papers/paper-I-en.pdf>
- <sup>xvi</sup> Comprehensive Assessment of Water Management in Agriculture (CA) 2007: "Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture", London: Earthscan; Colombo: International Water Management Institute (January 2009) [http://www.iwmi.cgiar.org/Assessment/files\\_new/synthesis/Summary\\_SynthesisBook.pdf](http://www.iwmi.cgiar.org/Assessment/files_new/synthesis/Summary_SynthesisBook.pdf)
- <sup>xvii</sup> Keith Wiebe and Noel Gollehon, "Irrigation Economics, Global" In Encyclopedia of Water Science, ed. Bobby A. Stewart, and Howell, T.A. (Marcel Dekker, 2003), 461.
- <sup>xviii</sup> World bank, World development Indicators, Section 3. Environment, Table 3.1, 2006, (February 2009) [http://devdata.worldbank.org/wdi2006/contents/Section3\\_1.htm](http://devdata.worldbank.org/wdi2006/contents/Section3_1.htm)
- <sup>xix</sup> Food and Agricultural Organisation (FAO): "Climate change, water and food security", Synthesis Paper, Expert Meeting held in Rome 26–28 February 2008, in preparation for the FAO High Level Conference (HLC) on World Food Security and the Challenges of Climate Change and Bioenergy in June 2008 (January 2009), <ftp://ftp.fao.org/docrep/fao/meeting/013/ai783e.pdf>
- <sup>xx</sup> Comprehensive Assessment of Water Management in Agriculture. 2007. Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture. London: Earthscan, and Colombo: International Water Management Institute. (January, 2009) [http://www.iwmi.cgiar.org/Assessment/files\\_new/synthesis/Summary\\_SynthesisBook.pdf](http://www.iwmi.cgiar.org/Assessment/files_new/synthesis/Summary_SynthesisBook.pdf) p.3
- <sup>[1]</sup> Food and Agricultural Organisation (FAO): "Agriculture, food and water", A contribution to the World Water Development Report, 2003. (January 2009) <http://www.fao.org/docrep/006/y4683e/y4683e00.htm>; [http://www.fao.org/docrep/006/y4683e/y4683e06.htm#P10\\_2399](http://www.fao.org/docrep/006/y4683e/y4683e06.htm#P10_2399)
- <sup>xxi</sup> Monsanto Advertisement, Back Cover, The New Yorker, February 9&16, 2009
- <sup>xxii</sup> Shiney Varghese, "Water Crisis and Food Sovereignty from a Gender Perspective", Institute for Agriculture and Trade Policy, January 2007 (February 2009) <http://www.tradeobservatory.org/library.cfm?refid=97668>
- <sup>xxiii</sup> Naila Maharaj and Donovan Hohn: "Fleurs Du Mal: Thorny truths about the global flower Trade," Harper's Magazine, February 2001, pp.66-67

---

<sup>xxiv</sup> Patricia Jaramillo and Nora Flem, Case study of Floriculture in Columbia and Ecuador in “Transforming Women’s Livelihoods in relation to food, agriculture and trade” by in International Gender and Trade Network (IGTN) and Institute for Agriculture and Trade Policy (IATP), 2007, (February 2009)  
[http://web.igt.org/home/index.php?option=com\\_docman&task=doc\\_download&gid=557&&Itemid=6](http://web.igt.org/home/index.php?option=com_docman&task=doc_download&gid=557&&Itemid=6).

<sup>xxv</sup> World Commission on Dams, “Dams and Development: A New Framework for Decision-making : the Report of the World Commission on Dams”, Earthscan, 2001, p.171

<sup>xxvi</sup> World Resources Institute: “New WRI report reveals world’s freshwater systems in peril”, WRI News Release, October 2000, (Jan 12, 2009) <http://archive.wri.org/news.cfm?id=1&z=?>

<sup>xxvii</sup> Mekong River Commission, Regional Cooperation Programme for Sustainable Development of Water and Related Resources in the Mekong Basin October, 2005 (January 2009) [http://www.mrcmekong.org/mekong\\_program\\_ceo.htm](http://www.mrcmekong.org/mekong_program_ceo.htm)

<sup>xxviii</sup> World Commission on Dams, “Dams and Development: A New Framework for Decision-making : the Report of the World Commission on Dams”, Earthscan, 2001

<sup>xxix</sup> New Scientist, “Asia Faces Water Catastrophe”, Aug 26 2004, (November 2008)  
<http://www.lk.iwmi.org/Press/coverage/pdf/discovery.pdf>

<sup>xxx</sup> Varghese, Shiney: “Gender Assessment Report, Water Resources Development Project”, Govt. of Gujarat, 1997.

<sup>xxxi</sup> Ibid; United States Geological Services (USGS), 2003, Ground-water depletion across the Nation, USGS Fact sheet:103-03, <http://pubs.usgs.gov/fs/fs-103-03/>  
United Nations Environment Programme (UNEP) Press Release UNEP Urges Action to Better Manage the Globe’s Ground waters”, June 2003, (January 2009)  
<http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=321&ArticleID=4026>

<sup>xxxii</sup> North Central Catchment Management Authority, ‘Considering the Potential Impacts of Groundwater on Dryland Salinity in the Whole of the North Central Region’ Summary Report from Workshop Bendigo, Victoria, 7 November 2001 (February 2009)  
[http://www.ndsp.gov.au/salinitytools/basin\\_workshops/pdfs/north%20central%20rpt%20-%20bendigo2.pdf](http://www.ndsp.gov.au/salinitytools/basin_workshops/pdfs/north%20central%20rpt%20-%20bendigo2.pdf)

<sup>xxxiii</sup> Institute for Agriculture and Trade Policy, Hypoxia in the Gulf of Mexico, a growing problem, IATP, 2002 (November 2008)  
<http://www.iatp.org/iatp/publications.cfm?accountID=421&refID=36133>

<sup>xxxiv</sup> Imran Ali, and Jain, C. K. Groundwater contamination and health hazards by some of the most commonly used pesticides, Indian Academy of Science, Current Science - Volume 75, November 25, 1998 (10)  
<http://www.ias.ac.in/currensci/nov251998/articles17.htm>

<sup>xxxv</sup> United States Geological Services (USGS), Pesticides in the Nation’s Streams and Ground Water, 1992–2001—A Summary, March 2006, Fact Sheet 2006–3028 (November 2008) <http://pubs.usgs.gov/fs/2006/3028/>

<sup>xxxvi</sup> Pesticide Action Network North America (PANNA): Indian pop has POPs (and other pesticides) 2003 Pesticide Action Network Updates Service (PANUPS) August 2003, (November 2008)  
[http://www.panna.org/legacy/panups/panup\\_20030815.dv.html](http://www.panna.org/legacy/panups/panup_20030815.dv.html) Also see a CSE’s response to Coca Cola sponsored study at [http://www.cseindia.org/misc/cola-indepth/cola2008/cola\\_report14012008.htm](http://www.cseindia.org/misc/cola-indepth/cola2008/cola_report14012008.htm)

<sup>xxxvii</sup> Dinesh Kumar, M. and Tushaar Shah (2004), “Groundwater Pollution and Contamination in India: The Emerging Challenge,” Hindu Survey of the Environment 2004, 7-12 (January 2009) [http://www.indiawaterportal.org/tt/gwm/res/ground-pollute4\\_FULL\\_.pdf](http://www.indiawaterportal.org/tt/gwm/res/ground-pollute4_FULL_.pdf)

<sup>xxxviii</sup> World Bank: “Food Security Focus of Madrid Meeting” WB News and Broadcast, 23 January 2009, (January 2009)  
<http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:22043218~pagePK:64257043~piPK:437376~theSitePK:4607,00.html>

<sup>xxxix</sup> Alliance for a green revolution In Africa (AGRA): “Green Revolution in Africa Conference, Oslo” (January 2009) <http://www.agra-alliance.org/content/news/detail/831> and Pioneer (Dupont): “Biocertified Sorghum Project Boosts African Scientific capacity” News Release, 2008 (January 2009)  
<http://www.pioneer.com/web/site/portal/menuitem.e6d9269581c07a87b02e8062d10093a0/>

<sup>xl</sup> Donald G. McNeil Jr. “Better bananas, Nicer Mosquitoes” New York Times, December 2005, (November 2009)  
<http://www.nytimes.com/2005/12/06/health/06gates-all.html> and Africa Harvest: “Africa Harvest helping Africa fight Hunger and Malnutrition with biocertified Sorghum” (November 2009) <http://africaharvest.org/files/ABS.pdf>

<sup>xli</sup> Andrew Pollack, “Crop Scientists Say Biotechnology Seed Companies Are Thwarting Research” New York Times, February 19, 2009, Business Section, Online Edition, (February 2009) [http://www.nytimes.com/2009/02/20/business/20crop.html?\\_r=1&em](http://www.nytimes.com/2009/02/20/business/20crop.html?_r=1&em)