

Climate Change and its Effects on Agriculture

Robert L. Zimdahl¹

Climate change and global food security are inextricably linked and therefore climate change and agriculture are inextricably linked. We really don't need much more evidence of the linkage than the food riots that have occurred around the world particularly in Haiti and Cameroon in 2008. Food riots, all in developing countries, result from growing populations and more affluent people who want to live as we in the U.S. do. Food riots also result from short-term market failures and reactions to increased energy and food costs, and climate-induced crop losses - that is to reduced food availability.

When people do not have enough food it will affect us because they will, and do, export their misery in many ways (Brown, 2009):

- By generating violence and refugees which may, and often does, lead to immigration,
- By spreading disease,
- By offering sanctuary to terrorists,
- Through spreading the sale of drugs and weapons, and
- By creating politically extreme governments.

All of these are threats to general global security.

When discussing the future of agriculture, the effect of growing human populations should not be ignored. The earth now has about 6.9 billion people. The figure² shows population projections for 2010 to 2050. Clearly they do not agree but all project a population higher than the earth now has. World population projections by 2050 range from the United Nations high fertility variant of about 10.5 billion people to the UN low fertility variant of about 7.9 billion. A billion is something most people think

¹ Robert L. Zimdahl is Professor Emeritus in the Department of Bioagricultural Sciences and Pest Management at Colorado State University

² All figures can be found in the power point presentation also available on the Convention web site - (www.usdbc.com)

they understand. I suggest most people do not understand the size of a billion or what it means when (because it will happen) another billion or more people are added to the world. For example a billion seconds is 31 years and 8 months ago, a billion minutes was about 1,900 years ago, a billion hours ago nothing walked on two feet. A billion dollars however is only a few minutes in Washington, D.C. No one should ignore the effects of population growth when they consider the effects of climate change on agriculture or on the future of your business - dry beans.

In spite of the unprecedented speed of man-made climate change there are those who deny that the climate is really changing. Some, but certainly not all are in Washington, D.C.. Among scientists there is some disagreement about the trajectory but not about 90% of the fundamental facts of climate change (Friedman, 2008, p. 124).

There are three stages or kinds of skepticism about climate change and its effects on agriculture (Friedman, 2008, p. 125):

1. In the first the skeptic tells you you're wrong but cannot prove it. So the idea is rejected.
2. The second kind of skepticism says you are right, but it doesn't matter. The problem is here but it is insignificant.
3. The third skeptic says, it matters but it is too late, too costly, or too difficult to do anything. So nothing is done.
4. Or, in some cases, the idea is seen as so important to skeptical early opponents that they claim to have thought of it first.

It is not uncommon for skeptics to believe the scientific basis for climate change and doubt the ability of the political realm to develop timely and significant policy responses to climate change. It is skepticism based on doubt that the world's policy makers will act in time to forestall the disaster the science predicts.

The year 2007 was tied with 1998 as the second warmest on record; the average global temperature was 14.6°C (58.2F). Arctic temperatures have risen twice as fast as the global average and spring arrives earlier in the arctic. Loss of arctic sea ice has been much faster than the Intergovernmental Panel on Climate Change (IPPC) forecast. The island nation of Tuvalu Tuval, has nine islands and atolls and illustrates the very real problem of global warming (Velasquea-Manoff, 2009). The nation is about

halfway between Australia and Hawaii. The highest point of its ten square miles of land is only 14.7 feet above sea level and most land is only about 3 feet above the sea. The ocean is already encroaching. The island's 12,000 residents and the residents of the even lower Maldivian islands may be the first victims of global warming caused primarily by carbon dioxide emissions from developed (rich) countries? Do the rich have any obligations to others? The problem is not just tropical. Much of Siberia's taiga (the world's largest forest) rests on permafrost. If global warming melts the permafrost the forest's future is in doubt and huge amounts of the potent greenhouse gas methane, will be released (Frazier, 2009).

The average global temperature in 2007 was about 0.6°C (2.4F) greater than the average temperature between 1951 and 1980. In addition it was more than 0.8°C (2.6F) greater than the average temperature between 1881 and 1910 (see Power Point figure on Global average land-ocean temperatures - 1880-2007). The temperature increase from 1880 to 2007 was 56.5 to 58.3F or 1.8C. The change was not too great; in fact, it looks rather small and inconsequential. However, when the extent of human misery is combined with tightening energy supplies, increasing extinction of species, strengthening petro-dictatorships, and unprecedented climate change (Friedman, 2008, p. 5), it becomes obvious that the earth has a problem. The problem is - Humans. In view of global warming, the consensus is that if we don't take major actions to change our effects on climate by 2012, it will be too late to correct the downward trend in crop yields for agriculture and the instability of the world's ecosystems.

There will be survivors of global warming. The principal survivors will be pest species - insects and weeds, which can evolve rapidly. There is a term for species that can't keep pace with climate change—cannot evolve rapidly. The species include large trees, large mammals, and humans. The word is - Extinction (Walsh, 2009). That is what we humans, one of the large, slow to evolve species, must face and deal with if we and the other large species are to survive.

The World Meteorological Association ranks the decade 1998 to 2007 as the warmest on record. Our planet is getting hotter. Cumulative warming by 2100 will be between 3 and 5C (5.4 to 9F). (Friedman, 2008, p. 44). I assume it is hotter where you

live? It is getting hotter because of anthropogenic emissions plus natural emissions. Unfortunately it is the anthropogenic emissions that are the biggest cause of warming. (See Power Point sources of important greenhouse gases).

Agriculture (see table) is not entirely responsible for carbon dioxide but it certainly plays a major role. Similarly agriculture is not entirely responsible for all methane emissions (a greenhouse gas) but it is not innocent (rice paddies and cattle emit methane). The share of these emissions absorbed by ocean and terrestrial sinks is decreasing which, of course, increases the rise in atmospheric carbon dioxide.

Parts of Europe experienced winter and spring temperatures more than 4°C above average in 2007, extreme drought struck North America and China, massive floods cause devastation in England, South Asia and many South American countries. It has been noted that Scotland's sheep are becoming smaller due to global warming (Walsh, 2009). Huge parts of the Canadian provinces Saskatchewan and Alberta have suffered the driest winter and spring in at least 50 years. Rainfall has been less than 40% of normal (Anonymous, 2009). These and other examples of extreme weather and the effects of a warmer earth are consistent with the expectations of atmospheric scientists and those who study climate change.

We also know that land based ice melting is increasing, which has serious implications for coastal communities, wildlife, ecosystems, and agriculture. You would be well advised to sell your coastal land or at least not buy anymore! For example, two major glaciers in SE Greenland have lost approximately 122 km³ of ice each year since 2001 (Russell, 09). That means just two glaciers in Greenland are contributing approximately 0.036 cm/yr (or 0.014 in/yr = 0.3 in 20 yrs) to increasing sea level. Further calculation reveals Greenland's ice loss would cover the entire U.S. (if it was all flat) with 1.3 cm of water/yr or 1.3 meters (approx. 10 feet) in 100 yr. If all arrived in Colorado, it would be 80 cm/yr or approximately 1 yard per year - assuming CO was level. To put this in agricultural terms—Greenland's 2 glaciers make an annual contribution of 800,000 acre feet of water, which is equal to 22,222 yards deep over an acre or 222 football fields deep. Greenland's contribution to rising sea levels do not, of course, come from just two glaciers. The island's total mass is losing 52 cubic miles of ice a year (Begley, 2009). The IPCC projected that sea levels would rise 16 inches this

century. With new data it is now projected that sea levels may rise one meter (39 inches) this century and at least half or more is due to Greenland's ice loss.

My charge was to comment on the effects of climate change on agriculture, not specifically on dry beans, although my comments on general agriculture certainly apply to dry beans.

Here are the key factors in food shortages (Brown, 2009) (see Power Point figure). Note the special role of global warming and population in so many other things. Global warming leads to rising sea levels which leads to loss of topsoil that leads to food shortages. Global warming leads to droughts, floods and the necessity of pumping from deeper wells. Global warming, which is rising temperatures, reduces crop yield causes food shortages, and contributes to increasing human misery, which affects all, not just the miserable. The only logical conclusion is that global warming interacts with a tangled web of causes, effects and feedbacks whose interactions intensify the effects of any one factor alone and all lead to food shortages. All the interactions are about climate change and all affect agriculture. This paper could stop here because the diagram really tells the whole story - Nearly all effects of climate change will affect agriculture negatively, not positively.

The Earth is losing its topsoil, which is not just dirt but the most important environmental resource. Without soil there will be no food. It takes a century to make an inch of soil, which can be lost in minutes. Hotter climates will reduce crop yields, pests will survive well. Our dominant agricultural system and the dominant crops have been shaped by a climate that has changed very little in the 11,000 history of farming. The crops, including dry beans, were developed for maximum production under the stable climate system of the last 11,000 years. Climatic stability has contributed to increased yields but the climate not been regarded as a particularly important factor. Its importance becomes obvious when we note that crop ecologists believe that for every rise of 1°C. (1.8°F) yield of our major crops, wheat rice and corn, will decline 10%. At this point, the data that showed a temperature change from 1880 to 2010 of only 1.8F (1C) in land-ocean temperature immediately look rather ominous.

The agricultural production system includes irrigation. Eighteen percent of world crop land is irrigated but it produces 36% of the world's food. Irrigated land produces

60% of the world's wheat and rice and 25% of the corn. Water is a key factor in climate change and food shortages. Water shortage leads directly to food shortages. We see the effects in deeper wells and saltation of coastal aquifers.

Between 1950 and 1990 the world's farmers increased grain production by more than 2% a year (Brown, 2009). That was greater than population growth for the same decades. Since then the increase in grain production has been 1 to 2 % a year, which is less or about equal to population growth and food stocks have declined significantly.

An important question is - can agriculture do anything to help mitigate or reduce climate change = global warming? The answer is Yes. But the necessary changes will not be popular. In the US, much of Europe, Australia, and other places farmers are locked into a system of industrial farming that relies on extensive capital, chemical, and technological inputs. The fear is that reducing these kinds of resources will lead to significant reduction in yield and profit.

Agriculture is part of a highly successful capitalist system. A problem with any capitalist system is that it may collapse because it does not allow markets to tell ecological truth. Similarly all socialist systems may collapse because they do not allow markets to tell economic truth. One who advocates major changes in the dominant capital, chemical and technological system is frequently accused of wanting return to "40 acres and a mule". However, if our agricultural system does not change as the earth warms, production will decrease, food shortages will affect more people and cause more human misery, which will be exported and cause worldwide problems.

Agriculture, including land-use changes for farming (the best example is deforestation) is responsible for an estimated 17 to 32% of human induced greenhouse gas emissions. A major contributor comes from overuse of fertilizers. More than half of the fertilizer applied to US crop fields each year ends up in the atmosphere or local waterways. That is not desirable and is preventable. Overuse of fertilizer leads to an estimated 2.1 billion tons of carbon dioxide equivalent in the form of nitrous oxide, which is 298 times more potent as a greenhouse gas than carbon dioxide.

Methane from livestock is the second largest source of greenhouse gases in agriculture and it is 25 times more potent as a greenhouse gas than carbon dioxide.

Deforestation and destruction of other natural cover to create land for grazing and crop production destroys important carbon sinks.

Reducing the global demand for meat to limit the numbers of methane producing animals and land cleared for animal production will contribute to reduced global warming. Of course we all know that it would be okay if somebody else reduced their consumption of meat – but we are reluctant to do so. It is indisputable that as people become richer, people eat more meat.

Other changes in agricultural practice that will reduce global warming and climate change include:

Keeping rice paddies dry in the off-season to reduce methane emissions

Growing cover crops especially in the off-season to serve as carbon sinks

Reducing or at least changing mono-cultural agriculture because mono-cultural agriculture discourages local food self-sufficiency, local food production and consumption, and tends to eliminate small farms, rural agricultural communities and the culture many of us grew up in and value.

There are essentially five strategies for reducing agriculture's effects on climate change and making it more climate friendly (Herro, 2008; Scherr and Sthapit, 2009).

The strategies are:

1. Enrich soil carbon. This can be accomplished by developing cropping systems that build soil organic matter rather than depleting it.

2. Creating high-carbon cropping systems. Techniques include developing new soil fertility management practices that increase soil organic matter and siphon carbon from the atmosphere. These practices include green manures, composting, nitrogen-fixing cover crops, intercropping, and incorporation of livestock manure in cropping systems. Minimizing soil tillage is a proven technique for increasing organic matter

3. Promoting climate friendly livestock production systems. Good practices include intensive rotational grazing, feed supplements designed to reduce methane emissions, and biogas digesters of manure to produce energy.

4. Protecting existing carbon stores in natural forests and grasslands. Successful techniques include: Developing perennial grasses, using agro-forestry intercropping, and tree crop alternatives for food, feed, and fuel. Such practices are designed to

produce and encourage a perennial agriculture - a permanent perennial agriculture rather than a permanent monoculture

5. Restoring vegetation in degraded areas. Techniques include restoring the vegetation of degraded watersheds and range lands, and reestablishing forest and grassland cover in biological corridors .

None of these will be easy and many will be resisted by established agricultural interests . What is required is a reconsideration of the way we practice agriculture. Developed country agriculture is a heavily subsidized industry that over harvests the environmental resources. Exploitation of the land is never sustainable and the existing and very productive system over exploits environmental resources. Agriculture's effects on climate change are intimately allied with its attempts to achieve sustainability, which will not be achieved by adjustments to the present capital, chemical, and technological intensive system. It is more likely that sustainability will be achieved by a new system. It is a challenge that must be considered by the agricultural community.

I conclude with a comment by Thomas Friedman, the New York Times foreign correspondent (Friedman, 2008, p. 117). He asked us you to remember when we were a kid and Mom asked - "What do you want to do when you grow up?" Some of said "I want to change the world!" Guess what? Tell Mom - we did.

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