In Defense of Modern Industrial Agriculture, Agribusiness and Our Food Supply: A Spirited Response to the Critics by Professor Thomas R. DeGregori, Professor of Economics, University of Houston.

In some circles, there is now what appears to be an established, unquestioned and largely unchallenged consensus that modern agriculture is an unsustainable failure and responsible for any number of ills in our society. The media and our larger cultural discourse are riddled with well-orchestrated misinformation about our food supply and how it is produced. Every ill is blamed on modern food production. An outbreak of E coli 0157:H7 in spinach was widely blamed on industrial xxx**. Months later when the source was identified as being organically grown spinach and that the E coli probably came from free range cattle in a low density ranch across the river, it was old news and largely unreported. In fact, it is difficult to find any reporting of it in either mainstream media or alternative media. There are numerous other incidences such as avian influenza or swine flu where the initial news got it totally wrong. In the case of avian influenza, the mythologies cumulated through time from its origins to its transmission. The anti-modern agriculture ideologues know the cause of all our food ills before they happen and are quick to put in Op-Ed pieces (including in the Houston Chronicle, in this case via the L.A. Times) and otherwise voice their opinions blaming "industrial agriculture." Those who await the evidence from scientific inquiry will find that contrary opinions are again not accepted because they are no longer news. Unfortunately the internet and the abiding faith of the anti-modern true believers means that no matter how thoroughly the original myths are factually refuted, they tend to live on in cyberspace to be called forth years later as needed.**

All too often, what the critics propose would make our food less safe in the name of protecting us from the evils of industrial agriculture. A demagogic cooking program on a major television network initiated a tirade against "lean textured beef" (LTB) which was called pink slime. This was followed by news stories that were almost as bad on that same network and by a national campaign led by a local activist that succeeded in school districts across the country no longer serving it in school lunches and supermarket chains no longer selling it. The local activists proudly wrote an op-ed piece for the Houston Chronicle which had an editorial praising it and endorsing her work. What the overall publicity succeeded in doing was closing three of the four meat processing plants that were considered by both industry and food safety experts as among the safest if not the safest in the country. A call to the Texas A&M Center for Food Safety or the **A**&M **Department of Animal Science would have obtained an informed contrary view. If the local network affiliate, the Chronicle or the activist contacted A**&M, it was lost to me in the voluminous noise on the subject. I have a huge file on this matter and I would both like to comment further and debate both the activist and the editorial writer when libel suit filed against several of the parties including the network and the local activist is settled. **To my knowledge, it has not been but I could be wrong.**

One of the proffered remedies for the alleged dangers of lean textured beef was for the consumer to pick out a cut of beef and either have the butcher grind it for you or for the consumer to grind it at home. Any food safety expert can see the real dangers in doing this and I will leave it to the reader to find out why. When confronted with the safety procedures at the LTB plants such as testing for toxins (STECs) not tested for by other producers, an activist dismissed this added safety procedure on the grounds that the 2011

sprouts outbreak in Germany that killed 53 and sickened 3,950 was caused by a -previously unidentified bacteria, E. coli 0104:H4. Somehow, we were confronted with the logic that because of the possibility of unknown bacteria lurking out there somewhere, food safety would be furthered by closing the safest plants. May I add that the sprouts were organically grown.

Sprouts have been continuing source of E coli and salmonella. One national chain with local outlets had salmonella outbreak in one area of operation followed by an E coli outbreak in another. Following these and a multitude of other instances another chain also with local outlets suspended its offering of raw sprouts as did several grocery chains. Basically the humidity and temperature for sprouting seeds are almost perfect for culturing various harmful bacteria from even the slightest contamination. Most all known methods of cleaning them with solvents are not effective as there are a multitude of niches in which the bacteria can be safe. There is one sure safe way of cleaning sprouts – irradiation – but restaurants and food stores know the demagogic campaigns that will be waged against them if they offered them. Forget the dirty little secret that many spices have been irradiated and for very good food safety reasons. I will forego revealing which brands are irradiated and which are cleaned in other ways since it is likely that none of the readers could tell the difference. To clarify a possible point of misunderstanding, "irradiation" does not make food radioactive, and numerous studies have shown that irradiated food is not only safer, but just as nutritious and as tasty.

Let us step back a bit and look at some population data to get an idea of what modern agriculture has achieved. In other words, let us look at how many people are being fed today compared to previous times and how quickly this transformation has taken placed. These are numbers that I go over repeatedly in class because they are illustrative of the changes in food production that had to take place. Let us start about 500 years ago in 1500 in the Common Era when world population was around 400 million people. That number was to double to 800 million people in 1800 reaching 1 billion in 1830 and 1.6 billion in 1900. Population reached 2 billion in 1930 adding another billion to 3 billion in 1960 and doubling to 6 billion in 2000. Today, world population is between 7.2 and 7.4 billion. This means that world population has increased nine times in a little over 200 years. Even if one uses other population estimates for the pre-1900 populations such as population reaching 1 billion by 1800, it still means more than a seven fold increase in population in a little over two hundred years.

Let me add as I will argue below, the world is better fed today than ever before. Let us look at the dates such as 1800. This was two years after the 1st edition of "An Essay on the Principle of Population" by Reverend Thomas Malthus which was first published in 1798. If someone in the 1790s had forecast a seven or nine fold increase in population in the next 200+, even William Godwin or the Marquis de Condorcet against whom Malthus was arguing would have had trouble being optimistic about the prospects of feeding 7+ billion people.

From 1960 to 2000 when world population doubled, food supply increased 270% or 35% per capita with the largest increase in the developing world such as East Asia where the per capita increase was closer to 70%. In fact since 1960, per capita food production and availability has increased on every continent except Africa. Africa has seen a number of countries turn their food production around in the last decade. In the 1960s, we had Paul Ehrlich and others making wild predictions about famine and almost unimaginable mass deaths. Some of the doomsday forecasters are still around today and remain unabashedly critics of the modern agriculture that helped us to avert the mass catastrophes that they so confidently expected. None will ever admit that they were wrong.

Looking more closely at the population data, historically, global population growth has been associated with declining death rates and not increasing birth or fertility rates. Increasing food supplies and standard of living in previously poor/hungry countries leads to dramatic decreases in fertility rates. So while we all may want to control population growth, control by starvation is not only unethical, but counterproductive (as a population modulates birth rates). Humans are unusual in this regard: most animals will increase birth rates under conditions of excess food, in order to take advantage of the situation. In other words the very process that helped people to feed themselves and keep them and their families alive, was part and parcel of the process that along with a number of health interventions led to rapidly decreasing fertility rates.

Economists such as Simon Kuznets have looked at population growth in Europe and often found that countries with the fastest rates of population growth also had the highest rates of economic growth. It is not always clear in which direction the causality runs but it does show that the population issue is much more complicated than the catastrophists realize.

Since 1950, it is certainly true as one writer has claimed mixing his metaphors that global population has grown not because ~~we are~~ breeding like rabbits but because we are not dying like flies. From 1950 to the present, decade by decade data indicate the most rapid decline in the global birth rate that is known to us. In 1950, fifty million people died of all causes. For the next 30 plus years as world population was close to doubling from 2 ½ billion to close to 5 billion in the 1980s, the number of people dying each year was fifty million or below. Now with a population close to three times that of 1950, the number of people dying this year will likely be less than 60 million. An aging population is an important factor in the increase number of deaths in addition to an increase in population.

It should be noted that if the births and death rates of 1950 were projected to the year 2000, the population would have also reached just over 6 billion only with a lot more births and deaths along the way. Projecting these rates to 2050 would give us over 15 billion people. Current projections are for about 9 billion, possibly 10 billion for 2050 with some demographers predicting a declining population after 2050. In other words, the best way to control population is to bring down the infant and child deaths. Thus far, this has led people to want fewer children knowing that the smaller number will survive. Population programs promoting voluntary population control can be helpful maybe even essential but they work best when other factors such as declining death rates are operating. To ignore these other factors dooms population control programs to likely failure.

In other areas, the data ~~is~~ are as spectacular. The infant mortality rate today is about 1/3rd of what it was in 1950. In 1960, the first year in which the under-five child mortality figures were calculated, close to 20 million children died. ~~Than~~ That number fell to 12 million in 1990 and declined slowly until about 2004 when the decline accelerated reaching 6.9 million in 2011 and 6.6 million in 2012. That number is clearly lower today. If the 1990 rate prevailed currently, 14,000 more children would be dying each day. Maternal mortality has also accelerated in its decline being down 47% since 2000. Global life expectancy has increase more than 20 years since the 1950s. One of the class projects for both of my classes this semester will be a presentation with graphs and charts etc. showing the number of people, adults, infants and children who are not dying each year because of the transformations of the last half century.

There are many factors that account for these declines in death rates. Immunization and antibiotics clearly top the list. It is hard to imagine these interventions working their magic without an improvement in food availability beginning in the womb. This observation is re-enforced by the global increases in average height which require improved nutrition.

In 1950, close to 60% of the world's population was in hunger. In 1960, roughly 50% of the world's 3 billion people were in hunger. Since then, there has been an almost continuous decline in in the rate of hunger reaching around 12 to 13% today. These figures also reflect an absolute decline in people in hunger from 1.5 billion to about 800 million today. Add in another 1.2 billion malnourished human beings and that gives us a total of 2 billion people malnourished with 800 million of them in hunger also. However, horrific these numbers maybe, they also mean that over 5 billion people are getting adequate food today – is an extraordinary achievement!
From the press release for the Human Development Report 2013 (I have read the entire report for which this release is accurate): "Over the past decades, countries across the world have been converging towards higher levels of human development, as shown by the Human Development Index," says the 2013 Report. "All groups and regions have seen notable improvement in all HDI components, with faster progress in low and medium HDI countries. On this basis, the world is becoming less unequal (Human Development Report 2013: The Rise of the South: Human Progress in a Diverse World , UNDP, http://www.undp.org/content/undp/en/home/librarypage/hdr/human-development-report-2013/).
However spectacular these trends maybe, they are not grounds for complacency. There is a critical need to understand the basis of these trends if we are to continue or even accelerate them. One would hope that in the lifetime of readers of this article that they will see the spectacular changes that I have been privileged to see and in a small way be involved in. With enough effort and understanding hunger, malnutrition and preventable deaths will be eliminated. It will not be achieved by shouting feel-good slogans or by romantic visions of nature and agriculture.

Apart from the favorable trends just noted, at some level of discourse, one has to credit modern industrial agriculture with simply its ability to accommodate these increases in population without the predicted catastrophes and to ask whether there were alternate pathways that could have gotten us to the Twenty-first century. It would be naïve to believe that we could have achieved these levels of population growth and food supply increases without creating problems. Contrary to fairy tales of living in harmony with nature, agriculture however it is carried out disrupts the environment. If we act intelligently, we can try to minimize the disruption and try as best as possible to work with various forces of the environment rather than against them. But some disruption is inevitable and the larger the change in population and food production, the greater the potential for disruptions that have to be corrected.

If you look at the population growth data from 1500 to 1900, you will find that it was concentrated in two population groups, Chinese and Western European peoples in Europe and the areas of the world in which they colonized. For the Chinese it was improved varieties of paddy rice that allowed for an additional crop each year and new crops such as sweet potatoes from the New World. For Europe and emigrants of European descent around the globe, it was as we will argue the rise of science, technology and the industrial revolution. For both the Chinese and the European populations, the addition of new crops from the New World was also important.

Part of the transformation of European agriculture after 1500 was simply to catch up with agriculture as practiced in China for hundreds of years. In the European Middle Ages, China was obtaining about a ton of wheat per hectare while Europeans were generally getting about 500 pounds. For every wheat seed planted, Europeans were getting (by the best estimates available) about 4 ½ + seeds back. Needing to plant one meant that the farmer received a net of about 3 ½ seeds for eating. Plant breeding in the 17th and 18th centuries got the seed to yield ratio for wheat to about 1 to 7 or 8. For the activists with their slogans of save the seed and claims that farmers have been doing that since time immemorial, it should be noted that the 17th century English plant breeders were frequently criticized for replanting their own seeds instead of importing them from north England or Scotland. Today, the seed to yield ratio for wheat is about 1 to 20.

However important the plant breeding of the gentleman farmers was, even more important was the new crops that came to Europe. Maize and potatoes came from the New World in what is called the Columbian Exchange. Though sugar cane came from India, Europeans would be getting it from the Caribbean at a critical time in their history. Corn (maize to the rest of the world), potatoes and later sugar cane have been demonized by the critics of modern agriculture yet they played an absolutely essential role in allowing the transformations in Europe in the four centuries from 1500 to 1900. Corn with its high yields per hectare or acre and its high sugar content made excellent silage for cows and its seeds for chickens increasing the milk, meat and eggs for the population. There is a growing literature in economics on potatoes with their high yields both for feeding animals and allowing fewer people on the land to feed a growing urban population not only allowing for the Industrial Revolution but also for the growth in Universities with their arts and music and their science. Urban life and all of its manifestations as it developed in Europe from the 17th and 18th century onward would not have been possible without corn and potatoes. As Robert Fogel has shown, by the end of the 18th century, much of the population received barely enough calories for basal metabolism and the work that they had to carry out. In the 19th century, sugar from the Caribbean, those proverbial empty calories, provided the additional energy to help drive the expansion in population and the economy.

By the 19th century, Europe’s success in getting ever increasing amounts of food out of the same amount of land began to take its toll. If you grow food one place and eat it someplace else, you will be mining the soil. Farmers can use various strategies to try to mitigate the decline in fertility but eventually they will have to replenish the lost soil nutrient. Agriculture is not a form of magic though many seem to view it that way. Repeat it was the increasing success at growing more food to feed a rapidly growing population that created the potential crisis.

Fortunately chemistry was able to provide new understandings that allowed for the emergence of modern agriculture and its ability to address these problems. It was believed that humans could not create organic compounds; only living matter could. In 1928, Friedrich Wöhler was able to synthesize urea providing at least some of the foundation for organic chemistry and signaling the end of vitalism. How and why he did it is a matter of some controversy but the fact is he did it. Justus von Liebig followed in the 1830s and 1840s analyzing the chemical constituents of plants and what chemicals were needed in the soil to grow them. He argued that minerals from non-living sources in the soil could be used to provide the required nutrients for plants. He also posited his famed Law of Minimum stating that a plant or other organism was limited in its growth by the least available nutrient.

In 1843, John Bennet Lawes founded the Rothamsted Experimental Station to study organic and inorganic fertilizers and their impact on crop yields. It is now the longest continuously operating agricultural station in the world. What Rothamsted showed and has continued to show was that Liebig was essentially correct and that non-living matter can provide plant nutrients.

Opposition to Liebig formed the basis of the modern organic or biodynamic (as it is called in Europe) movements. First it was argued that it would not work. Rothamsted and the growing effective use of fertilizers proved the critics wrong. So others conceded that it would work but that the plants lacked vital properties. Currently the litany runs that these plants are less nutritious. Writers such as Michael Pollan seem almost obsessed with Liebig as they offer a gross distortion of his ideas. In accusing him of "NPK mentality" reductionism, they clearly do not understand or maybe are not even aware of his Law of Minimum. Pollan's work such as the "Omnivore's Dilemma" is so riddled with basic errors of fact that it can best be described as empty calories for nutritionally deficient intellects.

Chemistry was necessary but not sufficient to solve the problems of 19th century declining soil fertility in Europe and parts of North America. One of the most interesting chapters in world history was the mad rush by various countries including the United States to claim uninhabited islands for their guano. Guano was definitely a depletable resource but by the early 20th century, chemistry once again came to the rescue with the Haber-Bosch creation of synthetic fertilizer.

Modern Scientific Agriculture as land sparing

Had crop yields had remained at the 1900 level, "the crop harvest in the year 2000 would have required nearly four times more land and its total (nearly 60 MKm2) -would have claimed nearly half of all ice-free continental area rather than the less than 15% the agricultural lands claim today" (Harvesting the Biosphere: What We Have Taken from Nature by Vaclav Smil, The MIT Press, December 2012, p. 248, "less than 15%" is actually about 12%).

Had crop yields remained at 1961 levels, "agricultural land area would have had to more-than double its actual 1998 level of 12.2 billion acres to at least 26.3 billion in order to produce as much food as was actually produced in 1998 . Thus, agricultural land area would have had to increase from its current 38 percent to 82 percent of global land area. Cropland would also have had to more than-double, from 3.7 to 7.9 billion acres. In effect, an additional area the size of South America-minus-Chile would have to be plowed under.

Thus increased land productivity forestalled further increases in threats to terrestrial habitats and biodiversity" (http://goklany.org/library/Water%20International%202002.pdf , Comparing 20th Century Trends in U.S. and Global Agricultural Water and Land Use By Indur M. Goklany, *Water International*, Volume 27, Number 3, Pages 321–329, September 2002 , International Water Resources Association).

Currently, about 12% of ice free land is being cultivated while another 24 to 26% is pasture for a total of circa 38%. Statements by Smil and Goklany about how much land that we would need to produce current output assume that the additional land would be of equal quality to that already in production. In other words, as these authors well know, their estimates of land needed are considerable understatements. At either 1900~~))~~ or 1961 yields, it is quite likely that we could not produce today's output. In the U.S. today, we have less land under cultivation for corn than we did in 1925 yet our output is at least seven times higher.

From my own article http://www.butterfliesandwheels.org/2004/green-myth-vs-the-green-revolution/

Green Myth vs. the Green Revolution (2004)

The yield-increasing, land-saving nature of the Green Revolution has reduced the pressure to put more land under the plow. Indeed, the recent data bear out this interpretation: Indian food grain output has continued to grow at a healthy rate of 3 percent annually through … 1981-1991 while the land under cultivation has actually decreased annually (Nanda 2003, 243 citing Sawant and Achuthan 1995; Hanumantha Rao 1994). The enhanced Green Revolution yields in the primary food/calories source, makes more land available for a variety of other crops and greater diversity in the population's diet. This is counter to the conventional wisdom about the Green Revolution and its impact upon diet and nutrition. Sawant and Achuthan found the "decisively superior performance of non-foodgrains vis-a-vis foodgrains" to be the "most striking feature of India's agricultural growth in the recent period (Sawant and Achuthan 1995, A-3). For 1981-1992 in India, the compound annual growth rates (CAGR) of non-foodgrains of 4.3 per cent "exceeded significantly that of foodgrains" at 2.92 per cent. Though there was annual decline of O.26% in the area of foodgrain cultivation, "it is important to recognize that foodgrains output continued to grow at the rate of 2.92 per cent as the growth in yield per hectare exceeded 3 percent" for a CAGR of 3.19 per cent, all of which indicates an "an increasing shift of land from foodgrains to non-foodgrains" (Sawant and Achuthan 1995, A-3). "The entire output growth in this period can, therefore be attributed to the increase in yields per hectare" (Hanumantha Rao 1994, 12). -

Hanumantha Rao, C. H. Agricultural Growth, Rural Poverty, and Environmental Degradation in India. Delhi and New York: Oxford University Press, 1994.

Nanda, Meera. "Is Modern Science a Western Patriarchal Myth? A Critique of the Populist Orthodoxy." South Asian Bulletin XI(1991):32-61.

Nanda, Meera. Breaking the Spell of Dharma: A Case for Indian Enlightenment. Delhi: Three Essays Press, 2002.

Nanda, Meera. Prophets Facing Backward: Postmodern Critiques of Science and Hindu Nationalism in India, New Brunswick, N.J.: Rutgers University Press, 2003

Water and Fertilizer

The modern rice varieties have about a threefold increase in water productivity compared with traditional varieties. Progress in extending these achievements to other crops has been considerable and will probably accelerate following identification of underlying genes…Genetic engineering, if properly integrated in breeding programs and applied in a safe manner, can further contribute to the development of drought tolerant varieties and to increase the water use efficiency…Overall, The best estimates are that "the water needs for food per capita halved between 1961 and 2001″ (FAO 2003 28). Higher yields "require" more fertilizer, as the more nutrient is extracted from the soil, the more has to be replaced. Norman Borlaug in his Nobel Prize acceptance speech states: "If the high-yielding dwarf wheat and rice varieties are the catalysts that have ignited the Green Revolution, then chemical fertilizer is the fuel that has powered its forward thrust … The new varieties not only respond to much heavier dosages of fertilizer than the old ones but are also much more efficient in their use" (Borlaug 1970). The old tall-strawed varieties would produce only ten kilos of additional grains for each kilogram of nitrogen applied, while the new varieties can produce 20 to 25 kilograms or more of additional grain per kilogram of nitrogen applied (Borlaug 1970). Not only are the Green Revolution plants more efficient in fertilizer use, but equally important has been the improvement in the use and application of fertilizer. For example, there has been a 36% increase in "N efficiency use in maize" in the United States over the last 21 years as a result of improved knowledge and technology (Blair and Blair 2003). –

Blair, Graeme and Nelly Blair. Fertilizer is Not a Dirty Word, Paper prepared at the IFA-FAO Agriculture Conference, "Global Food Security and the Role of Sustainable Fertilization," Rome, Italy, March 26-28, 2003.

FAO (Food and Agriculture Organization of the United Nations). Unlocking the Water Potential of Agriculture. Rome: Food and Agriculture Organization of the United Nations, 2003.
http://www.fao.org/ag/AGL/aglw/aquastat/kyoto/index.stm.
ftp://ftp.fao.org/agl/aglw/docs/unlocking_e

Borlaug, Norman. The Green Revolution, Peace, and Humanity, Nobel Peace Prize Lecture, December 11, 1970. **http://www.nobel.se/peace/laureates/1970/borlaug-lecture**

Interesting Studies on increase efficiencies in Dairy, Beef and Poultry
https://www.academia.edu/195371/The_environmental_impact_of_dairy_production_1944_compared_with_2007
The environmental impact of dairy production: 1944 compared with 2007 by Jude Capper, Journal of Animal Science, Vol. 87, March, 2009, pp.2160-2167.

ABSTRACT:

"A common perception is that pasture-based, low-input dairy systems characteristic of the1940s were more conducive to environmental steward-ship than modern milk production systems. The objective of this study was to compare the environmental impact of modern (2007) US dairy production with historical production practices as exemplified by the US dairy system in 1944. A deterministic model based on the metabolism and nutrient requirements of the dairy herd was used to estimate resource inputs and waste outputs per billion kg of milk. Both the modern and historical production systems were modeled using characteristic management practices, herd population dynamics, and production data from US dairy farms. Modern dairy practices require considerably fewer re-sources than dairying in 1944 with 21% of animals, 23%of feedstuffs, 35% of the water, and only 10% of the land required to produce the same 1 billion kg of milk. Waste outputs were similarly reduced, with modern dairy systems producing 24% of the manure, 43% of CH 4, and 56% of N2O per billion kg of milk compared with equivalent milk from

historical dairying. The car-bon footprint per billion kilograms of milk produced in2007 was 37% of equivalent milk production in 1944. To fulfill the increasing requirements of the US population for dairy products, it is essential to adopt management practices and technologies that improve productive efficiency, allowing milk production to be increased while reducing resource use and mitigating environmental impact."

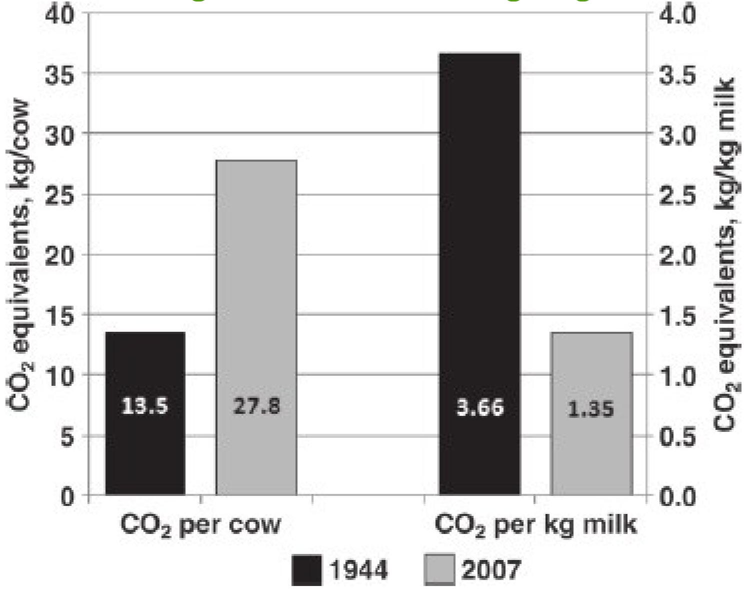
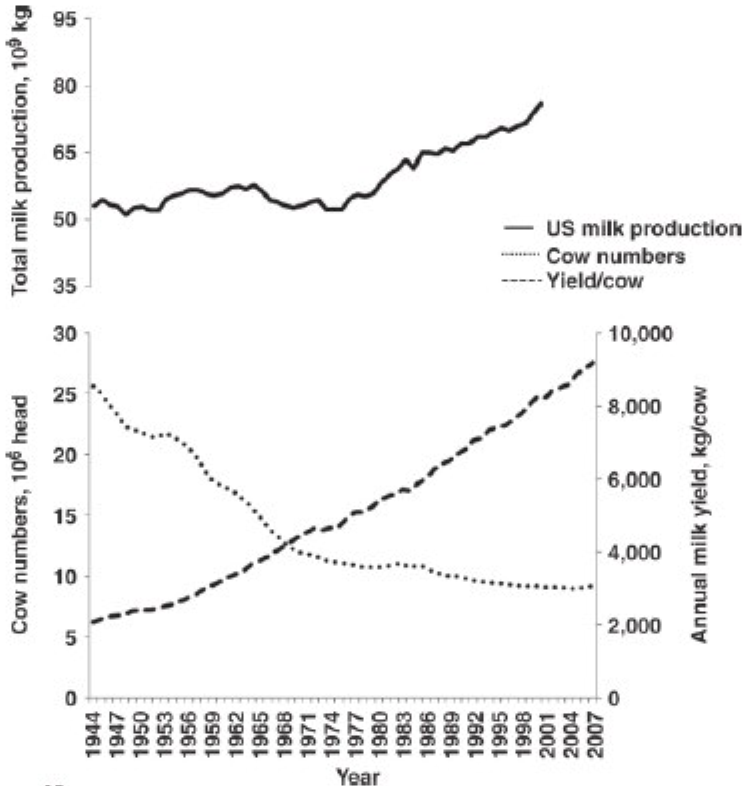


Figure 3. Carbon footprint per cow and per kilogram of milk for1944 and 2007 US dairy production systems. The carbon footprint per kilogram of milk includes all sources of greenhouse gas emissions from milk production including animals, cropping, fertilizer, and manure.



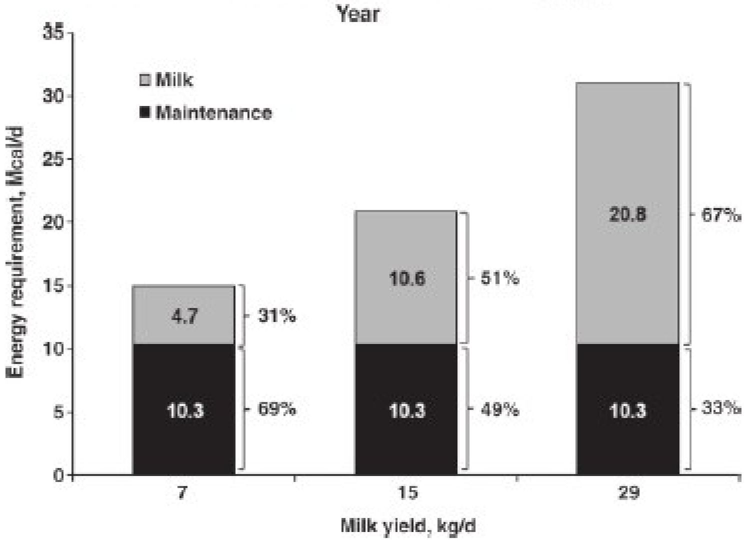


Figure 1. Changes in total US milk production, cow numbers, and individual cow milk yield between 1944 and 2007.

Figure 2. The dilution of maintenance effect conferred by increasing milk production in a lactating dairy cow (650 kg of BW, 3.69%milk fat).

"In 1950, the U.S. had 22 million head of dairy cows producing an average of 2,415 kg of milk per year. In 2,000, the U.S. dairy industry had 9.2 million cows averaging 8,275 kg milk per year. Total U.S. milk production in 1950 was 53 MT, compared to 76.2 MT in 2000. The dairy industry produced 44% more milk in 2000 with 58 percent fewer cows than in 1950" (Blayney, 2002, cited in Havenstein, 2006). Blayney, D. P., 2002. The

changing Landscape of U.S. Milk Production, USDA/ERS, Stat. Bull. 978, June, http://ers.usda.gov/publications/sb978/sb978.pdf

“The data can be used to project that the modern broiler in 2001 reached 1800 g body weight at about 32 days of age with a feed conversion ratio of 1.46 (Havenstein et al., 2003), while the ACRBC would have needed an additional 17 days to reach the same BW, and its feed conversion at that age would have been approximately 4.42. Thus, genetics, nutrition and other management changes over the 44 year period from 1957 to 2001 resulted in a broiler that requires approximately 1/3 the time and 1/3 the amount of feed to produce an 1800 g broiler.” - http://www.lohmann-information.com/content/l_i_41_2006-12_artikel5.pdf

Performance changes in poultry and livestock following 50 years of genetic selection By Gerald B. Havenstein, Lohmann Information, Vol. 41, Dec. 2006, -and **Havenstein, G. B., P. R. Ferket, and M. A. Qureshi. 2003. Growth, Livability and Feed Conversion of1957 vs 2001 Broilers When Fed representative 1957 and 2001 Broiler diets1 Poultry Science 82: 1500-1508).**

Contrary to the critics of modern agriculture, there is no scientific evidence that "organic" is healthier. There is substantial evidence in peer reviewed scientific literature that there is no appreciable difference. Nor is it more sustainable. Yet too often, the media simply assumes these to be true as do the grocery chain stores ex. - "Stores find organic food is the natural way to go" Houston Chronicle 01/19/2013.

Per unit of output, organic agriculture as it is allowed to be practiced has a larger carbon footprint and is often less environmentally friendly overall. This includes consideration of nitrogen and other nutrient run-off in food production. Further, conventional agriculture is more amenable to improvement through scientific research. Feedlots animal wastes present a problem but feedlot finished cattle are so much more efficient in animal production, particularly in terms of carbon footprint, that strict regulation of containment ponds to control environmental contamination would be warranted and cost effective.

Being "organic" does not necessarily mean being pesticide free or even being grown without synthetic pesticides. In fact, some of the “all natural” pesticides such as copper sulfate are highly toxic and persistent in the environment. The USDA’s organic program has a list of approved pesticides including some synthetic pesticides. Nor was pre-modern agriculture pesticide free as there was a long history of using toxic substances such as arsenic to protect plants. In agriculture when you grow and concentrate nutrient for human use, you are also concentrating nutrient for birds, rodents, insects, bacteria, fungi and viruses. Plants had to be protected and often substances far more persistent and toxic than those used today were applied to the fields. Again agriculture is not magic and though there were various protective strategies that farmers could use, too often they had to use a toxic substance.

Being organic does not mean being free of toxins - in fact, in many instances, organic produce is likely to have a higher load of toxins. Plants are chemical factories that produce

a variety of toxins to defend themselves many of which are carcinogens. According to toxicologist Bruce Ames, over 99% of the toxins that we ingest each day are from those produced by plants. Michael Pollan and others claim that organic produce is more nutritious because it is "less-well protected." This means that if a plant is invaded by micro-organisms or insects, it will express toxins to defend itself. What is toxic to one organism is not necessarily toxic to another but the proponents of the organic/anti-GMO play word games not using the word toxin when it suits them but use the term toxin (or even poison) to identify plant proteins that protect against micro-organisms or insects but are harmless to humans. The supposedly "more nutritious" parts of the "less-well protected" plants turn out to be antioxidants – flavonoids and phenolics - that are now considered to be of questionable benefit. (Note: Fruits and vegetables are loaded with antioxidants and are considered to be beneficial to human health. Is it because of the antioxidants or the form in which they take in fruits and vegetables? Are fruits and vegetables beneficial because we eat less of other things that might be harmful? Clinical studies on adding antioxidants to diets not only fail to show any benefit but often find significant evidence of harm.) Not mentioned are the other toxins produced by the invading micro-organisms of the less-well protected organic plants some of which are very toxic to humans. Many chemical food preservatives are also antioxidants.

USDA certification of a product as being organic has no meaning other than it was grown using certain means (and not others) - it has no implications about quality, nutrition etc. as clearly stated by the USDA. These standards were largely the creation of those who either wish to grow or to consume "organic."

The most sustainable form of contemporary agriculture is what is called "conservation tillage" (AKA - no tillage or minimum tillage) using a genetically engineered herbicide tolerant (Ht) crop with a broad spectrum pesticide such as Glyphosate.

There is no scientific controversy concerning the safety of transgenic transformations using rDNA (AKA GMOs, "frankenfoods," genetically modified among others) food crops nor is there about cisgenics, intragenics or antisense technologies (RNAi) though the anti-GMO groups have convinced large segments of the public and the media that there is. This point could easily be documented in detail along with the multitude of examples of activist's ignorance of some of the basic understandings of modern science. Michael Pollan's claim in the early editions of "Omnivore's Dilemma" that carbon was the most common element in the human body and in all life forms would be risible if it were not so pathetic. What about the activist promoted referendum for an ordinance banning the growing of GMOs in Mendocino County, California that defined DNA as a complex protein found in every cell in the body. It passed. Or what about the polls in Europe that found that a majority or sometimes just a plurality of the population believed tomatoes did not have genes unless biotechnologist put them there? In the U.S. we did a little better with a plurality but not a majority believing the claim to be in error. This is just a sample of the activist errors of fact.

In the media and on the internet, much of the opposition to genetic engineering of plants focuses on Monsanto even instances where Monsanto is not involved. Monsatan as the

clever activist wordsmiths call it. One of the enduring myths of the anti-transgenic is that farmers are sued by Monsanto for pollen drift on to their fields. This is widely claimed, endlessly repeated in a multitude of different media and widely believed even though there is not a scintilla of evidence for it. The myth is repeated so often that I periodically would called a friend of mine who is considered a leading expert on agricultural law who would reassure me that in no instance in the cases settled in court did the defendant claim accidental pollen drift. It is one thing to make a claim in a documentary film and another to make it under oath in court.

Much as we are all must trust the expertise of others since it is impossible for any one of us to know everything first hand. On a controversial issue like farmers being sued by Monsanto, I would prefer to have direct knowledge but there was no way I was going to read all the many court cases. Fortunately, the activists overplayed their hand and filed a suit to enjoin Monsanto from suing farmers for being the recipients of pollen drift. The case was Organic Seed Growers and Trade Association v. Monsanto Co., 11cv2163, U.S. District Court for the Southern District of New York (Manhattan) filed in March 2011 with a ruling on January 2012 by Judge Naomi Buchwald, Clinton appointee**.**

Judge Buchwald dismissed the case since the plaintiffs could not offer in court a single instance where Monsanto had sued a farmer for accidental pollen drift. It was dismissed, not tried because there was not a case to be made. Her dismissal was affirmed June 2013 (Organic Seed Growers and Trade Association v. Monsanto Co., 12-1298) by the U.S. Court of Appeals for the Federal Circuit (Washington).

The anti-Monsanto activists have also been peddling the tale of the Canadian canola grower Percy Schmeiser who it is claimed was the innocent victim of a lawsuit by Monsanto. ***Monsanto Canada Inc. v. Schmeiser*** is a case that I have read and re-read multiple times to make sure that I was not missing something that those who use it for ant-GMO propaganda were finding. I encourage those who are interested in these issues to read the case themselves. A reasonable person would find that numerous claims made by Schmeiser were rather preposterous.

“The courts at all three levels noted that the case of accidental contamination beyond the farmer's control was not under consideration but rather that Mr. Schmeiser's action of having identified, isolated and saved the Roundup-resistant seed placed the case in a different category” (Quoted from Wikipedia, September 2013). The judge in the initial case ruled that Schmeiser had either known or ought to have known that he was planting a patented seed.

Pollen drift is not "*contamination" unless one can demonstrate harm in that the resulting crop actually harms those who eat it. By clever use of language such as “contamination,” activists seek to control the discourse by controlling the language. Historically, those producing a specialized crop are responsible for maintaining its genetic identity. Similarly, those whose religion requires food to be halal or kosher assume the full cost and responsibility for maintaining it. I respect that.*

The proponents of organic agriculture, unlike those who require halal or kosher expect other farmers and producers of food to bear the cost of sustaining their ritual purity for a product for which they receive a price premium. The rules for what could be labeled organic were established following a series of town hall meetings. Organic farmers were prohibited from planting GMOs. The USDA certified organic label strictly applies only to the way that a crop was raised and has no implications concerning sustainability of the production system or the nutritional quality of the food produced.

Not satisfied with the rules that they created, organic consumers and others demanded even stricter prohibitions against any pollen drift into a field of organic production even though it would still qualify for USDA organic certification. It is a free country and if that is what they want and they are willing to pay for it, then that is their privilege. But instead of paying for it, they are seeking to use the courts to shift the burden from the roughly those who grow 1 to 5% of the sugar beets and the alfalfa to those who grow the roughly 95 to 99% of these crops. This is the antithesis of democracy.

Many of those involved in lawsuits and organizing for labeling laws have made it clear that there ultimate objective is to eliminate genetically modified food from the marketplace. There is more than a bit of hypocrisy or even fraud for those who rail against Monsanto for allegedly tyrannizing American farmers then filing a lawsuit that would have forced GMO Alfalfa growers (representing at least 95% of all Alfalfa grown) to pull up their already planted crop, a crop that they had been growing for five seasons. The basis of the lawsuit was not any evidence of harm but on a technicality in the previous approval process. Fortunately, an Appeals court overturned the initial court decision ordering the uprooting of the plants.

This has become a common tactic of claiming to represent the "oppressed" farmers while working to impose restrictions on the choices of the vast majority of farmers. It should be noted that in the above cases, the organizations representing the majority of the affected farmers stood in opposition to the activist's legal position. This is part of a larger narrative in economic development where NGOs claim to offer a bottom up process of development as opposed to the alleged traditional top down approach to development. Yet when those they presume to want to help fail to follow their development prescriptions, they inevitably turn to the UN or supporting governments or institutions in the developed world to try to impose their agenda.

In Brazil, it was Greenpeace that sued to block the planting of GMO soybeans. It was farmers illegally planting GMO soybeans smuggled in from Argentina that eventually forced the Lula government to reverse course and approve their use. In India, planting Bt. cotton was banned by the Government in spite of the fact the a 30 person panel of leading scientist tasked to study the issue and rule on it found them to be safe. Some farmers were illegally planting the Bt. cotton seeds anyway. When a devastating attack of the Asian Bollworm wiped out field after field of cotton in Gujarat, the largest cotton growing state in India, it was the fields of the illegally planted Bt. cotton that were left standing. After initially threatening to destroy the unaffected fields, the Government capitulated and approved the planting of Bt. cotton.

From 20,000 farmers growing Bt cotton in India the 1st year of approval, it grew to 7.4 million farmers growing it in a few years. It has continued at this level to the present as over 90% of cotton grown in India is GMO. India has gone from being the largest importer of cotton in the world to being one of the world's largest exporters of cotton. The farmer's real income is up which is reflected in a recent study by Matin Qaim and Shahzad Kouser finding improved health and nutrition among those growing Bt. cotton. Numerous other peer-reviewed studies including some by Qaim have found increased real income from growing Bt. cotton for farmers, for women and for field workers.

If you can't beat them then lie by claiming that f*armers in India have been driven to suicide by the failure of transgenic cotton.* This has been refuted by numerous careful studies such as one by IFPRI (International Food Policy Research Institute). More important, it is refuted by the fact that 7.4 million Indian farmers continue to grow it. Some of these are farmers who have switched to cotton from other crops because of the more reliable yields and higher income. Yet the myth of Bt. cotton leading to farmer's suicides continues with some clever activists branding them as suicide seeds.

GMO soybeans in Brazil and Bt. cotton in India are only two of many instances where European and North American based ideological NGOs have worked to thwart the choice of farmers and others in the developing world while claiming to be defending them. In some areas, such as India, they frequently work with urban based elite groups. Not content to restrict themselves to a variety of propaganda and legal tactics, the anti-GMO activists have attacked research labs, slimeing transgenic plant researchers and going into the fields destroying crops in test plots. The most recent destructive rampage of a test plot of Golden Rice in the Philippines gave rise to a letter condemning it signed by over 6,000 scientists from around the world many of them being leaders in their field.

One can't even begin to tell the story of Golden Rice and the 400 to 500 million children in the world who are Vitamin A deficient with horrendous consequences for life and for death. *Opposing some forms of transgenic agriculture such as Golden Rice (Vitamin A enhanced – actually enhanced with Beta carotene the precursor of Vitamin A) has very serious consequences for poor children in developing countries. Those who engage in disruptive activities or support organizations that do, have to accept responsibility for the adverse consequences that flow from their actions. What we are talking about is children going blind and dying from Vitamin A deficiency.* Today over 1,000 children will directly die as a result of Vitamin A deficiency. Another 5,000 are estimated to die each day because their immune system was weakened by Vitamin A deficiency for a total of 6,000 deaths each day. On an annual basis, this comes to 350, 000 children dying each year directly of Vitamin A deficiency while the best estimates are that the direct and indirect deaths from Vitamin A deficiency are 2 to 2 ½ million (some estimates run as high as 3 million) deaths each year. A significant number of these are children of subsistence rice farmers and their deaths could have been prevented by Golden Rice. Will those opposed to Golden Rice accept responsibility for this outcome? The safety and potential benefit of Golden Rice has been demonstrated by multiple projects with their results being published in leading peer reviewed journals such as the American Journal of Clinical Nutrition.

See for example:
Golden Rice - Lifesaver? – by Amy Harmon, The New York Times, August 24, 2013.
www.nytimes.com/2013/08/25/sunday.../golden-rice-lifesaver.html
Golden Rice is an effective source of vitamin A1–4 by Guangwen Tang, Jian Qin, Gregory G Dolnikowski, Robert M Russell, and Michael A Grusak, *American Journal of Clinical Nutrition*, vol. 89 no. 6, June 2009 , pp. 1776-1783; DOI: 10.3945/ajcn.2008.27119

β-Carotene in Golden Rice is as good as β-carotene in oil at providing vitamin A to children[1],[2],[3],[4]

1. **Guangwen Tang,**
2. **Yuming Hu,**
3. **Shi-an Yin,**
4. **Yin Wang,**
5. **Gerard E Dallal,**
6. **Michael A Grusak, and**
7. **Robert M Russell**

***American Journal of Clinical Nutrition*, vol. 96 no. 3, September 2012, 658-664**

For some earlier articles see Stein A.J., Sachdev H.P.S., Qaim M. . "Potential impact and cost-effectiveness of Golden Rice." Nature Biotechnology 24(10),2006 1200-1201.
http://www.nature.com/nbt/journal/v24/n10/extref/nbt1006-1200b-S1.pdf and

Genetic Engineering for the Poor: Golden Rice and Public Health in India by Alexander J. Stei, H.P.S. Sachdev and Matin Qaim 2008. World Development 36(1): 144-158, January 2008.

It is more than ironic that the list of organizations actively opposed to modern agricultural science such as transgenics are largely those who have never done anything, I mean never done anything to help poor people obtain the food they need or in any way contributed to the food production in general. Tragically, those they most often attack are they very persons and organizations that have done so much to reduce to help produce the food to feed the needy and who are working constantly to continue fight against hunger and malnutrition. For some inexplicable reason, much of the media and the public give credibility to ideological organizations whose main functions seems to be to disrupt the work of those seeking to solve problems.

What we are trying to show is that there are a multitude of very favorable trends in the world from declining infant, child and maternal mortality to increases in food supply and decreases in hunger and malnutrition. In agriculture, there are trends in efficiency in milk, meat and grain production including decreases in fertilizer and pesticide use per unit of output. As the UNDP report that I cited indicates, there are many more favorable trends then I can even begin to enumerate. These trends can neither be denied -nor- ignored. They must be included and protected in solutions to problems that we face. In many respects, they are a vital part of the pathway to progress on our environmental problems.

Unfortunately, too many activists seek to condemn and eliminate the very important means necessary to solve our problems.

Let me close with a cogent statement by Rajiv Shah, Administrator, United States Agency for International Development:

"What's really at stake in the genetic engineering debate? Better nutrition and incomes for poor families everywhere.

"Throughout history, our greatest development advances have come from introducing safe, proven and appropriate technologies to the world's most vulnerable people. That's how we helped hundreds of millions of people avert starvation during the Green Revolution. Today, stresses from climate change, conflict and poverty make this approach more urgent than ever.

…..

"It's taken 25 years of ingenuity and perseverance to bring Golden Rice from vision to reality. Who will stand between it and millions of undernourished children?"

Are those members of or in any way supportive or connected to the organizations opposed to Golden Rice who read this or who hear my lecture willing to take responsibility for their actions? Are they willing to consider the possibility that their actions may be costing the lives of poor children around the world?

In the following Appendixes, we provide a a selection of authors and their data that reinforce the argument being made here.

Appendix I – Dairy production - Capper

https://www.academia.edu/195371/The_environmental_impact_of_dairy_production_1944_compared_with_2007

The environmental impact of dairy production: 1944 compared with 2007 by Jude Capper, Journal of Animal Science, Vol. 87, March, 2009, pp.2160-2167.

ABSTRACT:

A common perception is that pasture-based, low-input dairy systems characteristic of the1940s were more conducive to environmental steward-ship than modern milk production systems. The objective of this study was to compare the environmental impact of modern (2007) US dairy production with historical production practices as exemplified by the US dairy system in 1944. A deterministic model based on the metabolism and nutrient requirements of the dairy herd was used to estimate resource inputs and waste outputs per billion kg of milk. Both the modern and historical production systems were modeled using characteristic management practices, herd population dynamics, and production data from US dairy farms. Modern dairy practices require considerably fewer re-sources than dairying in 1944 with 21% of animals, 23%of feedstuffs, 35% of the water, and only 10% of the land required to produce the same 1 billion kg of milk. Waste outputs were similarly reduced, with modern dairy systems producing 24% of the manure, 43% of CH 4, and 56% of N2O per billion kg of milk compared with equivalent milk from

historical dairying. The car-bon footprint per billion kilograms of milk produced in2007 was 37% of equivalent milk production in 1944. To fulfill the increasing requirements of the US population for dairy products, it is essential to adopt management practices and technologies that improve productive ef-ficiency, allowing milk production to be increased while reducing resource use and mitigating environmental impact.

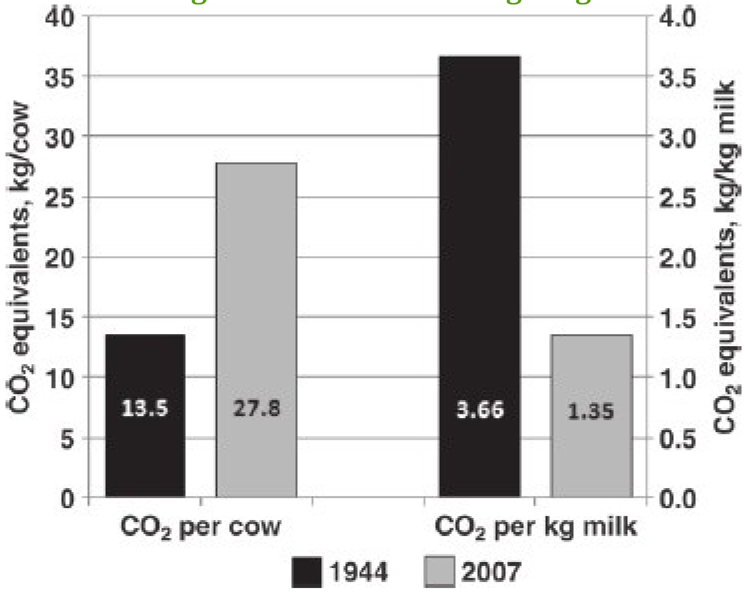
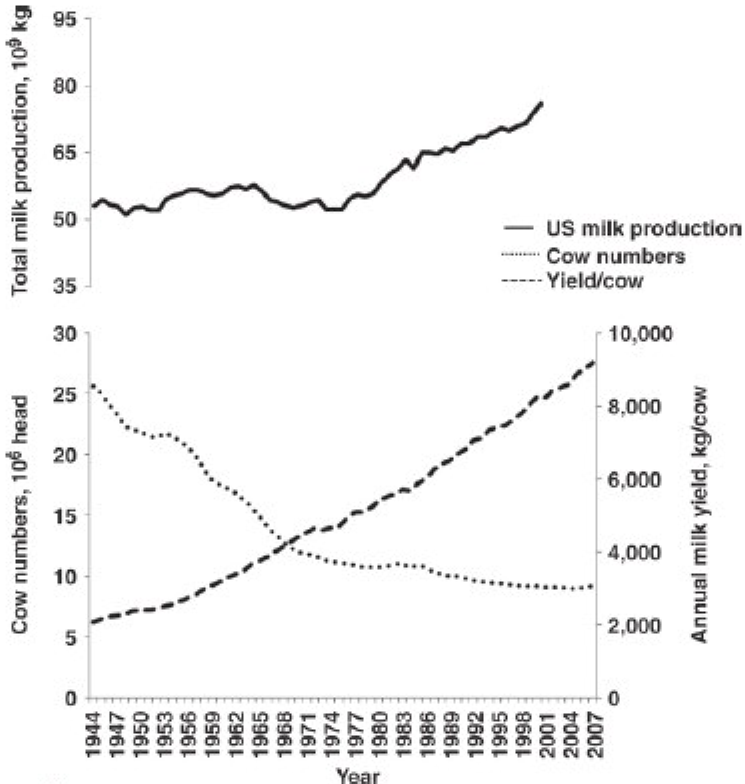


Figure 3. Carbon footprint per cow and per kilogram of milk for1944 and 2007 US dairy production systems. The carbon footprint per kilogram of milk includes all sources of greenhouse gas emissions from milk production including animals, cropping, fertilizer, and manure.



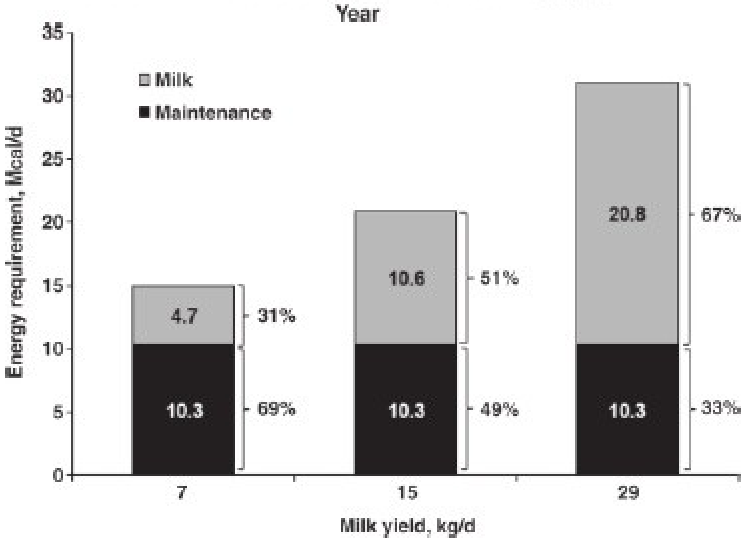


Figure 1. Changes in total US milk production, cow numbers, and individual cow milk yield between 1944 and 2007.

Figure 2. The dilution of maintenance effect conferred by increasing milk production in a lactating dairy cow (650 kg of BW, 3.69%milk fat).

Appendix II – Beef production - Capper

https://www.academia.edu/1123092/The_Environmental_Impact_of_Beef_Production_in_the_United_States_1977_Compared_with_2007

JOURNAL OF ANIMAL SCIENCE
The Premier Journal and Leading Source of New Knowledge and Perspective in Animal Science

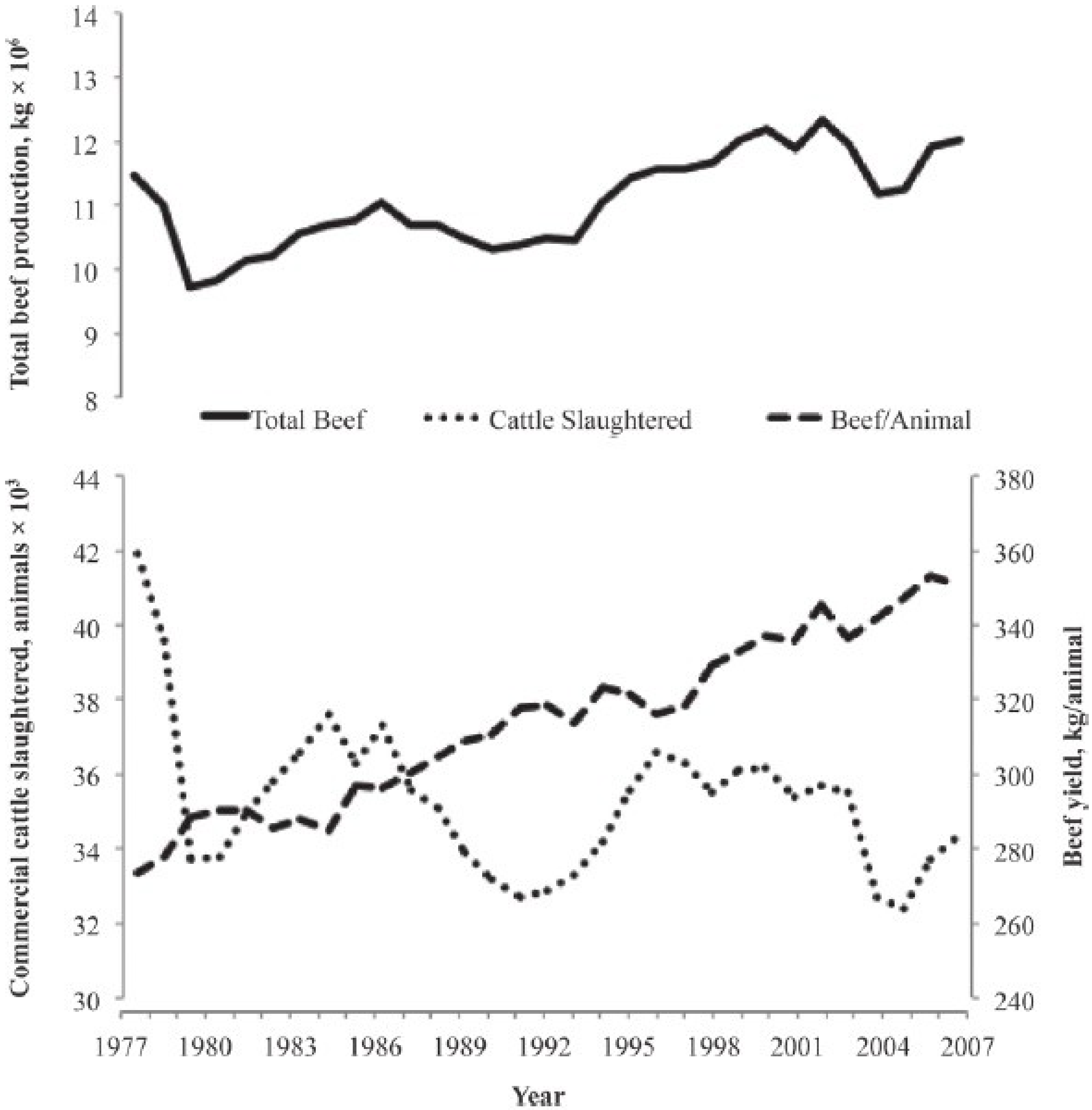
American Society of Animal Science

The environmental impact of beef production in the United States: 1977 compared with 2007 by Jude. L. Capper, Journal of Animal Science, Vol. 89 July, 2011, pp. 4249-4261

ABSTRACT:

Consumers often perceive that the modern beef production system has an environmental impact far greater than that of historical systems, with improved efficiency being achieved at the expense of greenhouse gas emissions. The objective of this study was to compare the environmental impact of modern(2007) US beef production with production practices characteristic of the US beef system in 1977. A deterministic model based on the metabolism and nutrient requirements of the beef population was used to quantify resource inputs and waste outputs per billion kilograms of beef. Both the modern and historical production systems were modeled using characteristic management practices, population dynamics, and production data from US beef systems. Modern beef production requires considerably fewer resources than the equivalent system in 1977, with 69.9% of animals, 81.4% of feedstuffs, 87.9% of the water, and only 67.0% of the land required to produce 1 billion kg of beef. Waste outputs were similarly reduced, with modern beef systems producing 81.9% of the manure, 82.3% CH_4, and 88.0% N_2O per billion kilograms of beef compared with production systems in 1977. The C footprint per billion kilograms of beef produced in 2007 was reduced by 16.3% com-pared with equivalent beef production in 1977. As the US population increases, it is crucial to continue the improvements in efficiency demonstrated over the past30 yr to supply the market demand for safe, affordable beef while reducing resource use and mitigating environmental impact.

Figure 3. Changes in total US beef production, number of commercial cattle slaughtered, and beef yield per animal from 1977 to 2007



Total beef production, kg × 10⁶
14
13
12
11
10
9
8
Total Beef
Cattle Slaughtered
Beef/Animal
Commercial cattle slaughtered, animals × 10³
44
42
40
38
36
34
32
30
Beef yield, kg/animal
380
360
340
320
300
280
260
240
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
Year

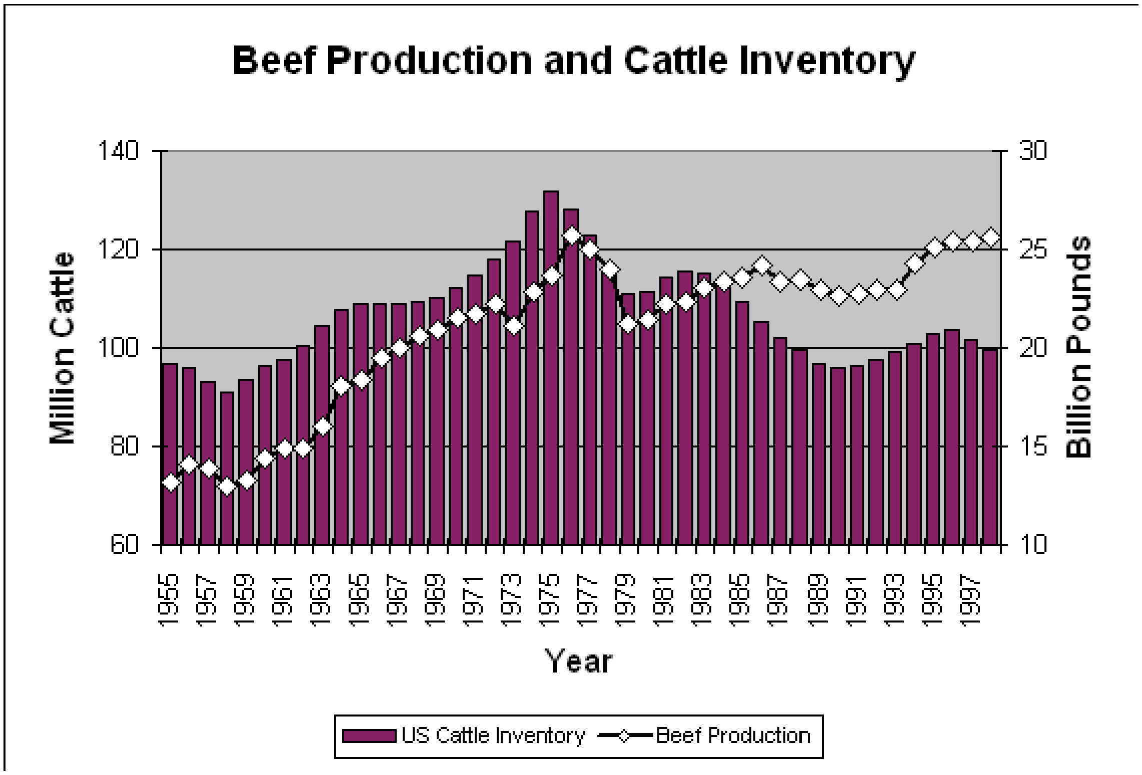
Appendix III – Poultry and eggs - **Havenstein**
Performance changes in poultry and livestockfollowing 50 years of genetic selection By Gerald B. Havenstein, Lohmann Information, Vol. 41, Dec. 2006, Page 30
http://www.lohmann-information.com/content/l_i_41_2006-12_artikel5.pdf

Trends in population growth and consumption of animal products
Not only has the performance of our livestock and poultry changed, but many aspects of the world have changed as well. Before providing evidence as to how quantitative genetics has affected U.S. and worldwide animal production, we need to begin with a little background on the food-animal industries, and specifically how meat and egg consumption has changed over the past half-century, especially in context with the changes in our human population. The animal industries and the types of animals we produce for human food are very different today from what they were 50 years ago. The following summary shows not only how animal production has changed, but also how the human population has changed in terms of the consumption of animal foodstuffs.

The production of broiler meat today requires roughly one-third the amount of resources (feed, manpower, housing, etc.) and we are producing only about one-third of the waste nutrients that would be produced for the same amount of poultry meat using 1950-type chickens.

Because of these changes in growth rate, the feed conversion of broilers at a given age has dropped dramatically over the past 45 years, as shown in Table 3. Feed conversion by age, however, doesn't tell the whole story. The data can be used to project that the modern broiler in 2001 reached 1800 g body weight at about 32 days of age with a feed conversion ratio of 1.46 (Havenstein et al., 2003), while the ACRBC would have needed an additional 17 days to reach the same BW, and its feed conversion at that age would have been approximately 4.42. Thus, genetics, nutrition and other management changes over the 44 year period from 1957 to 2001 resulted in a broiler that requires approximately 1/3 the time and 1/3 the amount of feed to produce an 1800 g broiler.

The production of broiler meat today requires roughly one-third the amount of resources (feed,
manpower, housing, etc.) and we are producing only about one-third of the waste nutrients that would be produced for the same amount of poultry meat using 1950-type chickens.
…..
Average egg weight was 65.0 g/egg for the modern strain vs. 58.1 g/egg for the control, and the combination of improved production and egg size resulted in a 43 % increase in daily egg mass. Efficiency of egg production (egg mass/feed) improved by 32 % over this 43 year period. Body weights of layer strains have been reduced by about 20 percent during the same time, and in combination with the improved productivity, egg-layers require considerably less feed to produce a dozen eggs today than did the birds that were used a half century ago.
……..
Figures 3 & 4 0n Page 5 show the extraordinary change in the size of **Chikens and Turkeys.**
Figure 5: Changes in the U.S. beef industry from 1955 to 2000 (Source: USDA)



The dairy industry has been especially successful in improving the efficiency of milk production through the selection of superior performing cows and bulls from summaries of the Dairy Herd Improvement Association. In 1950, the U.S. had 22 million head of dairy cows producing an average of 2,415 kg of milk per year. In 2,000, the U.S. dairy industry had 9.2 million cows averaging 8,275 kg milk per year. Total U.S. milk production in 1950 was 53 MT, compared to 76.2 MT in 2000. The dairy industry produced 44% more milk in 2000 with 58 percent fewer cows than in 1950 (Blayney, 2002). Dry matter intake per dairy cow was about 12.3 kg per day in 1950 and had risen to about 20.9 kg per day in 2000 (from DART Ration program of the Dairy Records Management System, based on Brown et al., 1977). Again, these changes are largely the result of genetic selection applying the science of quantitative genetics.

Blayney, D. P., 2002. The changing Landscape of U.S. Milk Production, USDA/ERS, Stat. Bull. 978, June,
http://ers.usda.gov/publications/sb978/sb978.pdf

Brown, C. A., P. T. Chandler, and J. B. Holter. 1977. Development of predictive equations for milk yield and dry matterintake in lactating cows. J. Dairy Sci. 60: 1739-1754

Havenstein, G. B., P. R. Ferket, and M. A. Qureshi. 2003. Growth, Livability and Feed Conversion of1957 vs 2001 Broilers When Fed representative 1957 and 2001 Broiler diets1 Poultry Sci 82: 1500-1508

Appendix IV – Land Sparing

POPULATION AND DEVELOPMENT REVIEW

Peak Farmland and the Prospect for Land Sparing By Jesse H. Ausubel, Iddo K. Wernick and Paul E. Waggoner

Population and Development Review, Volume 38, Issue Supplement s1, pages 221–242, February 2013

The past 50 years have already witnessed important peaks for environment and resources. The rate of increase of world population peaked around 1970 and has slowed considerably since then. Peaks of forest destruction also have passed with a transition from less to more forests in many countries and regions. By the 1980s wooded areas in all major temperate and boreal forests were expanding. After 1990, growing stock expanded in many forested countries (Kauppi et al. 2006), and during 1990–2010 the density of forests grew in all world regions, albeit unevenly (Rautiainen et al. 2011). Like farms and their crops, the productivity of forests providing wood products has risen. Meanwhile consumption has fallen as e-readers replace paper and as demand for other wood products, such as railroad ties and telephone poles, has declined.

As we hinted above, peaks of farmers' use of nitrogen and water may also have passed.

The peak of cropland anticipated in Figure 9 does not derive from depletion of the resource. The envisioned cropland peak rises in part from another peak, that in the rate of population growth. Whether affluence will peak depends on the continuing competition between seemingly boundless desire for more and acceptance of the essential and possible.

In any case, the calories in the food supply per GDP, the use of affluence for nutrition, begins the inventory of tools to counter the environmental challenge of population and affluence. And unlike humanity's striving for affluence, its striving for food has limits that help meet the challenge. The survival level near 2,000 Kcal/person/day sets a lower limit. The upper limit at, say, 4,000 set by obesity is the one that moderates the ratio of food to GDP.

While the dematerialization common to staples such as food and calories helps counter the challenge of population and affluence, the limit of obesity adds another effect. Producing grain to feed animals represents an alternative to crops that directly adds calories to the food supply and so increases the ratio of crop production per calorie in the food supply. Fortunately for the sparing of cropland, meat consumption is rising only half as fast as affluence.

This broad sweep should not obscure the crucial, final role of yields and the shrinking of hectares per unit of crop production. The new varieties of the Green Revolution in the 1960s, bred to exploit better fertilization, water supply, and crop protection, accelerated the

shrinking of cropland. Precise interventions in DNA, fertilizer, irrigation, pest control, and weather forecasts offer improving tools to help continue lifting yields.

Another 50 years from now, the Green Revolution may be recalled not only for the global diffusion of high-yield cultivation practices for many crops, but as the herald of peak farmland and the restoration of vast acreages of Nature. Almost 20 years ago we made a wild surmise about land sparing (Waggoner 1994). Now we are confident that we stand on the peak of cropland use, gazing at a wide expanse of land that will be spared for Nature

.http://onlinelibrary.wiley.com/doi/10.1111/j.1728-4457.2013.00561.x/abstract
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010
0
20
40
60
80
100
million hectares (mHa)
Spared
actual
FIGURE 1 Actual and potential land used for wheat production, India 1961–2010 upper segment shows the hectares farmers would have tilled to produce the actual harvest had yields stayed at the 1960 level. SourCe: Fao (2012).

1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010
0
20
40
60
80
100
120
140
160
million hectares (mHa)
Spared
Actual

FIGURE 2 Actual and potential land harvested for maize production,
China 1961–2010 upper segment shows the hectares farmers would have tilled to produce the actual harvest had yields stayed at the 1960 level. SourCe: Fao (2012).

1850 1870 1890 1910 1930 1950 1970 1990 2010
0
2
4

6
8
10
12
14
16
18
area and production relative to 1866
FIGURE 3 Area of corn harvested and corn production, United States 1866–2010 (indexes, 1866 = 1) Corn harvested area
Corn production SourCe: uS Bureau of the Census (1975, 2012).

FIGURE 8 Corn yields, 1983–2011 the highest maize yields in iowa entered in the national Corn Growers association contest compared with uS and world averages. the percentages show average annual increases. SourCeS: rachel Jungermann, manager, national Corn Yield Contest, Chesterfield, mo, personal communication 2012; Fao (2012).

---

http://dotearth.blogs.nytimes.com/2012/12/17/scientists-see-promise-for-people-and-nature-in-peak-farmland/?_r=0

Scientists See Promise for People and Nature in 'Peak Farmland'

By ANDREW C. REVKIN

FIGURE 2 Actual and potential land harvested for maize production, China 1961–2010 upper segment shows the hectares farmers would have tilled to produce the actual harvest had yields stayed at the 1960 level.

……….

http://reason.com/archives/2013/05/27/peak-farmland

Peak Farmland? The landscape of the future has more wilderness.By Ronald Bailey from the June 2013 issue

http://www.farmingfutures.org.uk/blog/peak-farmland

Ausubel and his colleagues calculate that rising Chinese corn productivity spared 120 million hectares from the plow. In the United States, corn production grew 17-fold between 1860 and 2010, but more land was planted with corn in 1925 than in 2010. (The area planted in corn has started increasing again, thanks to the federal government's biofuels mandates and subsidies.) Today U.S. forests cover about 72 percent of the area that was forested in 1630. Forest area stabilized in the early 20th century, and the extent of U.S. forests began increasing in the second half of the century.

If global crop yields had remained stuck at 1960 levels, Ausubel noted in his lecture, farmers around the world "would have needed about 3 billion more hectares, about the sum of the USA, Canada, and China or almost twice South America." Plowing down this amount of the world's remaining forests and grasslands would have produced what Ausubel calls "Skinhead Earth

--."

Restoring the Forests

David G. Victor and Jesse H. Ausubel

SKINHEAD EARTH?

-*Foreign Affairs*, Vol 79, No. 6, (November/December 2000 pp. 127-144. Copyright 2000 *Council on Foreign Relations*

URL: http://phe.rockefeller.edu/restoringforests/

EIGHT THOUSAND YEARS AGO, when humans played only bit parts in the world ecosystem, trees covered two-fifths of the land. Since then, humans have grown in number while thinning and shaving the forests to cook, keep warm, grow crops, plank ships, frame houses, and make paper. Fires, saws, and axes have cleared about half of the original forestland, and some analysts warn that within decades, the remaining natural forests will disappear altogether.

But forests matter. A good deal of the planet's biological diversity lives in forests (mostly in the tropics), and this diversity diminishes as trees fall. Healthy forests protect watersheds and generate clean drinking water; they remove carbon dioxide (a greenhouse gas that traps heat in the atmosphere) from the air and thus help maintain the climate. Forests count -- not just for their ecological and industrial services but also for the sake of order and beauty.

Fortunately, the twentieth century witnessed the start of a "Great Restoration" of the world's forests. Efficient farmers and foresters are learning to spare forestland by growing more food and fiber in ever-smaller areas. Meanwhile, increased use of metals, plastics, and electricity has eased the need for timber. And recycling has cut the amount of virgin wood pulped into paper. Although the size and wealth of the human population has shot up, the area of farm and forestland that must be dedicated to feed, heat, and house this population is shrinking. Slowly, trees can return to the liberated land.

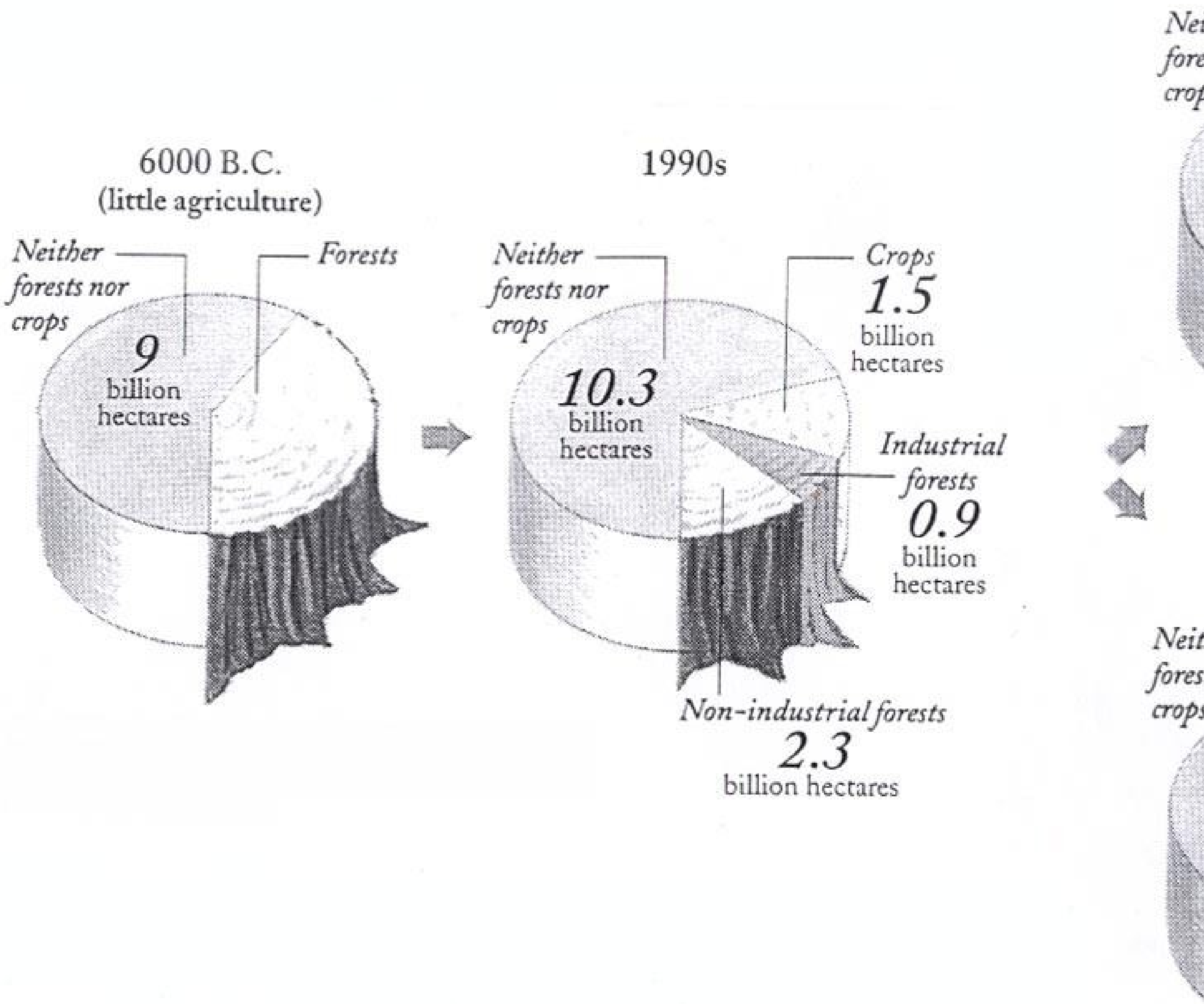
……

Since about 1950, U.S. forest cover has increased -- despite the country's emergence as the world's bread and wood basket

….
But the Great Restoration is far from complete. Despite major gains in some areas, the world's sylvan balance sheet still bleeds trees, owing to widespread deforestation in the tropics. Yet even there, progress has begun to peek through. Preliminary satellite data suggest that the rate of tropical deforestation has slowed ten percent in the last decade
……

The seedlings and saplings of this transformation have already been planted. But the progress and potential of modern agriculture and forestry remain little known to many policymakers, and requisite techniques are reviled by others who prefer "natural," low-intensity production. And in much of the world, the conditions necessary for these new

methods, such as affordable commercial energy and effective land-use regulation, remain elusive.



Sources (rounded estimates): 6000 B.C., World Conservation Monitoring Centre, World Resources Institute, and World Commission on Forests and Sustainable Developments;

1990's, U.N. Food and Agriculture Organization Global Fibre Supply Model data; 2050, author's projections.

The chart illustrates the immense areas at stake. Two paths now stand open. Along one, leading to the "Skinhead Earth" scenario, quaint and inefficient agriculture and forestry will persevere. By 2050, forests will dwindle by 200 million hectares -- about five times the area of California -- and lumberjacks will regularly shave about 40 percent of forests. Along the other, however, farmers and foresters will intensify production and shrink their footprint. Forests will spread anew to more than 200 million hectares, and only 12 percent of forestlands will hear cries of "timber." This vision for a Great Restoration is realistic -- one that the right domestic and foreign policies can secure.

…………

If farmers sustain the 1.8 percent annual yield improvement they have achieved in recent decades, they could meet the growing demand for primary calories while releasing 200 million hectares of cropland.

But farmers can do even better than that and offer even more land to the trees. The authors' research with Paul Waggoner of the Connecticut Agriculture Experiment Station has shown that, with some extra effort, an increase in yield of two percent per year -- a plausible goal -- could spare a total of 400 million hectares. In other words, today's farmland could be cut by more than a quarter through smarter agricultural techniques. Sustaining a two percent rate of increase will not be easy, but history and technology suggest it can be done. Since sustained efforts to raise U.S. yields began in the 1940s, average yields for wheat and soybeans have almost tripled and corn yields have more than quadrupled. And farmers have hardly tapped the full potential. Champion American corn growers have lifted yields well above 20 tons per hectare without irrigation. Meanwhile, average U.S. corn yields stand at only 8 tons per hectare, and average world corn yields are a meager 4 tons.

……

Meanwhile, more efficient lumber and paper milling is already carving more value from the trees we cut. Because waste is costly, the best mills -- operating under tight environmental regulations and the gaze of demanding shareholders -- already make use of nearly the entire log. In the United States, for example, leftovers from lumber mills account for more than a third of the wood chips that are turned into pulp and paper; what is still left after that is burned for power. And further improvements in management and technology will squeeze even higher value out of products and spare more virgin wood. In British Columbia, since the mid-1980s, sawmills have lifted the lumber obtained per cubic meter of log at an average rate of 1.2 percent per year. Worldwide, the pulp and paper industry is shifting a significant share of production from chemical to mechanical pulping, which cuts the wood required for a ton of useful pulp by half. And recycling has helped close leaks in the paper cycle. In 1970, consumers recycled less than one-fifth of their paper; today, the world average is double that.
………

Lifting yields, however, will spare more forests. Raising average yields 2 percent per year would lift growth over 5 cubic meters per hectare by 2050 and shrink production forests to just about 12 percent of all woodlands -- the Great Restoration.

Industry has already taken big steps along the restoration path by sowing intensively managed "plantation" forests that act as wood farms. According to the U.N. Food and Agriculture Organization (FAO), one-quarter of industrial wood already comes from such farms, and the share is poised to soar once recently planted forests mature. At likely planting rates, at least one billion cubic meters of wood -- half the world's supply -- could come from plantations by the year 2050.

…..

Foresters can push trees even faster. Today, the most advanced tree-breeding programs are only in their second, third, or fourth generations, since trees, unlike annual wheat and maize, are slow to reach sexual maturity. Modern biology can already speed breeding, however, by spotting the genes for superior performance early and then growing plants with those traits through traditional methods. Genetic engineering, now in its infancy, will be able to insert or delete selected genes directly and should gradually gain acceptance. Big tree planters -- such as Westvaco Corporation -- are already placing large bets on biotechnology, which promises to boost the economic advantage of plantation forestry. Having spent heavily on state-of-the-art mills and to select and rejigger tree genes, the forest industry has come to prefer planted forests, which let it control what stock grows where.

……..

BOOK REVIEW

How Much of This Do We Use Up Every Year?

Written by: BILL GATES

'Humans will harvest roughly 17% of what the biosphere grows this year.'

Smil tries to figure out what portion of the biosphere's primary productivity — the amount of plant life generated each year by photosynthesis — is consumed by humans. He estimates that we will harvest roughly 17 percent of what the biosphere grows this year — mostly plants. (He admits it could be as little as 15 percent or as much as 25 percent.)

About 12 percent of the Earth's land mass is now devoted to farmland.

Twelve percent is a big number, but it would be even bigger if it weren't for innovations in crop breeding, field machinery, and other areas that made farming much more efficient. If crop yields had remained stagnant since 1900, in the year 2000 we would have needed nearly four times more crop land to feed everyone. That's practically half of all the ice-free land in the world.

We've also had a huge impact on the biosphere by building major cities, which essentially eliminate or drastically reduce any natural productivity from those areas. Smil notes that major cities now cover nearly five million square kilometers. If you clustered them all together, they would cover an area 50 percent larger than India.

Harvesting the Biosphere: What We Have Taken from Nature by Vaclav Smil, The MIT Press, December 2012, p. 248

"With crop yields had remaining at the 1900 level, the crop harvest in the year 2000 would have required nearly four times more land and its total (nearly 60 MKm2) would have

claimed nearly half of all ice-free continental area rather than the less than 15% the agricultural lands claim today."

----

http://goklany.org/library/Water%20International%202002.pdf
Comparing 20th Century Trends in U.S. and Global Agricultural Water and Land Use By Indur M. Goklany, *Water International*, Volume 27, Number 3, Pages 321–329, September 2002 , International Water Resources Association

Despite the pressures agriculture has brought to bear on global biological resources, similar to the situation in the U.S., those pressures could have been much worse had global agricultural productivity, and therefore yields, been frozen at, say, 1961 levels. This is equivalent to freezing technology, and its penetration, at 1961 levels. In that case, agricultural land area would have had to more-than double its actual 1998 level of 12.2 billion acres to at least 26.3 billion in order to produce as much food as was actually produced in 1998 (Goklany, 2001). Thus, agricultural land area would have had to increase from its current 38 percent to 82 percent of global land area (FAO, 2001; Goklany, 2001). Cropland would also have had to more than-double, from 3.7 to 7.9 billion acres. In effect, an additional area the size of South America-minus-Chile would have to be plowed under. Thus increased land productivity forestalled further increases in threats to terrestrial habitats and biodiversity.

Food and Agricultural Organization (FAO). 2001. *FAOSTAT Database, 2001*. http://apps.fao.org/ . 3 October 2001.

Goklany, I.M. 2001. "Agricultural Technology and the Precautionary Principle." Political Economy Research Forum (PERC), November29-December 2, 2001, Bozeman, Montana, USA:PERC

Appendix V – Food Safety

Food Safety News

Breaking news for everyone's consumption

The 10 Deadliest Outbreaks in U.S. History — Revisited

By Dan Flynn | April 4, 2012

The list of the 10 most deadly outbreaks of food- and waterborne illness in U.S. history, previously published by Food Safety News, has been revised for a presentation in Sacramento to the California Environmental Health Association.

Added to the list is a 1903 outbreak of typhoid fever in Ithaca, NY, which caused 82 deaths, among them 29 Cornell University students.

In 1903, Ithaca's public water, used for drinking and cooking, became polluted with Salmonella Typhi when the Six Mile Creek dam was being built by the privately held Ithaca Water Company. The Ithaca Water utility, which had only recently been purchased by William Morris, opted not to build a filtration plant before going ahead with the dam construction to increase capacity, even though the water had long been suspect.

To make matters worse, a worker camp at the construction site had only one outhouse, which was just 20 steps from Six Mile Creek, and often workers just used the creek. A construction crew included workers from an area of Italy that had seen frequent outbreaks of typhoid fever, and one or more of the Italian workers may have been asymptomatic carriers of the S. typhi pathogen.

Ithaca's typhoid outbreak was nearly forgotten after more than a century, but last year author David Dekok's book "The Epidemic" was published. In the fashion of gripping fiction, Dekok tells the true story with stunning detail.

Cornell students died not knowing their own university was supplying Ithaca Water's need for debt financing, and was declining to do anything that would help sick and dying students at the expense of the water utility. This included refusing to make Cornell University's own supply of safe artesian water available to off-campus boarding houses, where most of its students lived, and where many died.

The addition of the Ithaca typhoid fever outbreak to the most-deadly ranks drops from the list the 2006 E. coli O157:H7 outbreak involving bagged spinach grown at Paicines Ranch in San Benito County, California. There were five fatalities in that outbreak, in which about 200 people became ill after eating bagged spinach. (organically grown spinach – TRD)

The only other revision in the list involves the 1919 botulism outbreak caused by canned ripe olives, previously reported as being responsible for killing 15. The death toll was actually 19.

With the revisions, the nation's deadliest foodborne outbreaks have taken the lives of 423 people, with 232 of those succumbing to typhoid fever. The other deaths were due to Listeria (93), Streptococcus (70), botulism (19) and Salmonella Typhimurium (9).

The list uses an unofficial count of 36 deaths for last year's outbreak caused by Listeria-contaminated Colorado cantaloupes. The Centers for Disease Control and Prevention (CDC) says 30 died, but has not updated its final investigation report to include those who were confirmed to be part of the outbreak and have since died.

Finally, according to the historic record, there was a 60-year period, from 1925 to 1985, when there apparently were no foodborne illness outbreaks with enough fatalities to be included among these worst epidemics.

The ten deadliest food- and waterborne outbreaks are:

1. Typhoid fever, 1924-25

Oysters from Long Island, NY, held in polluted waters, sickened more than 1,500 in New York, Chicago, and Washington, D.C.; 150 died.

2. Typhoid fever, 1903

A public water source in Ithaca, NY, was polluted from a dam construction site, resulting in typhoid outbreak involving 1,350 people; 82 were killed, including 29 Cornell University students.

3. Streptococcus, 1911

Raw milk delivered door-to-door in the Boston area was responsible for a strep outbreak; 48 people died.

4. Listeria, 2011

"Rocky Ford" cantaloupes from Colorado became contaminated, probably in the packing facility, sickening at least 146 in 28 states; 36 died. (pesticide free – TRD)

5. Listeria, 1985

Mexican cheese made by a Los Angeles company sickened mostly Hispanic women, many who were pregnant; 28 died. (made from raw milk – TRD)

6. Streptococcus, 1922

Raw milk delivered door-to-door in Portland, OR was contaminated; 22 killed.

7. Listeria, 1998

Ball Park hot dogs and Sara Lee deli meats were recalled after Listeria was found in the Michigan processing plant; 21 killed.

8. Botulism, 1919

Canned ripe olives from California sold to inland states were contaminated and caused outbreaks in three states; 19 died.

9. Salmonella Typhimurium, 2008-09

Peanut butter and paste contaminated with S. Typhimurium caused at least 714 illiness in 46 states; 9 killed. (largest producer of organic peanut butter – TRD)

10. Listeria, 2002

Sliced turkey meats from Pilgrim's Pride were responsible for a multiple state outbreak; 8 killed.

© Food Safety News

Before 1950 when U.S. population was less than half of what it is today and food production was only nation in packaged or process foods and only a few items of produce. Very little was imported:

Top three deadliest before 1950

Five of the top ten before 1950

After 1950:

Two are from raw milk or raw milk cheese

One was pesticide free

Two – numbers 8 & 10 (out of ten) were from produce conventionally grown in the United States

The two large outbreaks outside the U.S.in recent times have both been attributed to sprouts, at least one of which if not both were organically grown..

Massive outbreak of Escherichia coli O157:H7 infection in schoolchildren in Sakai City, Japan, associated with consumption of white radish sprouts

Michino H, Araki K, Minami S, Takaya S, Sakai N, Miyazaki M, Ono A, Yanagawa H. Environmental Health Bureau, Ministry of Health and Welfare, Tokyo, Japan. Jonathan H. Mermin1- and Patricia M. Griffin, American Journal of Epidemiology, Volume. 150, No. 8, October 15, 1999, pp. 787-96.

In July 1996, Sakai City, Japan, experienced the largest outbreak of *Escherichia coli* O157:H7 infections ever reported, involving over 7,000 persons.

2011 Germany *E. coli* O104:H4 outbreak - **From Wikipedia, the free encyclopedia**

A novel strain of ***Escherichia coli*** O104:H4 **bacteria** caused a serious outbreak of **foodborne illness** focused in northern Germany in May through June 2011. The illness was characterized by bloody diarrhea, with a high frequency of serious complications, including **hemolytic-uremic syndrome** (HUS), a condition that requires urgent treatment. The outbreak was originally thought to have been caused by an **enterohemorrhagic** (EHEC) strain of *E. coli*, but it was later shown to have been caused by an **enteroaggregative** E. coli (EAEC) strain that had acquired the genes to produce **Shiga toxins**.

In all, 3,950 people were affected and 53 died, 51 of which were in Germany.[7] A handful of cases were reported in several other countries including **Switzerland**,[8] **Poland**,[8] the **Netherlands**,[8] **Sweden**,[8] **Denmark**,[8] the UK,[8][9] Canada[10] and the USA.[10][11] Essentially all affected people had been in Germany or France shortly before becoming ill.

A joint risk-assessment by **EFSA**/**ECDC**, issued 29 June 2011, made a connection between the German outbreak and a HUS outbreak in the **Bordeaux** area of France, first reported on 24 June, in which infection with *E. coli* O104:H4 has been confirmed in several patients.[51] The assessment implicated **fenugreek** seeds imported from **Egypt** in 2009 and 2010, from which sprouts were grown, as a common source of both outbreaks, but cautioned that "there is still much uncertainty about whether this is truly the common cause of the infections", as tests on the seeds had not yet found any *E. coli* bacteria of the O104:H4 strain.[52][53] The potentially contaminated seeds were widely distributed in Europe.[54] Egypt, for its part, steadfastly denied that it may have been the source of deadly E. coli strain, with the Minister of Agriculture calling speculations to that effect "sheer lies."[55]

Centers for Disease Control and Prevention
http://www.cdc.gov/foodsafety/rawmilk/nonpasteurized-outbreaks.html
Nonpasteurized Disease Outbreaks, 1993-2006
Raw milk was much more likely to cause outbreaks than pasteurized milk.

- **Probably no more than 1% of the milk consumed in the United States is raw, yet more outbreaks were caused by raw milk than by pasteurized milk.**

- **If you consider the number of outbreaks caused by raw milk in light of the very small amount of milk that is consumed raw, the risk of outbreaks caused by raw milk is at least 150 times greater than the risk of outbreaks caused by pasteurized milk.**

Centers for Disease Control and Prevention
http://www.cdc.gov/nczved/divisions/dfbmd/diseases/irradiation_food/

Which foodborne diseases could be prevented with irradiation?

Treating raw meat and poultry with irradiation at the slaughter plant could eliminate bacteria commonly found raw meat and raw poultry, such as *E. coli* O157:H7, *Salmonella*, and *Campylobacter*. These organisms currently cause millions of infections and thousands of hospitalizations in the United States every year. Raw meat irradiation could also eliminate *Toxoplasma* organisms, which can be responsible for severe eye and congenital infections. Irradiating prepared ready-to-eat meats like hot dogs and deli meats, could eliminate the risk of *Listeria* from such foods. Irradiation could also eliminate bacteria like *Shigella* and *Salmonella* from fresh produce. The potential benefit is also great for those dry foods that might be stored for long times and transported over great distances, such as spices and grains. Animal feeds are often contaminated with bacteria like *Salmonella*. Irradiation of animal feeds could prevent the spread of *Salmonella* and other pathogens to livestock through feeds.

…….

Alfalfa seeds used in making alfalfa sprouts can sometimes be contaminated with *Salmonella*.

Using irradiation to eliminate *Salmonella* from the seeds may require a dose of irradiation that also interferes with the viability of the seeds themselves. Combining irradiation with other strategies to reduce contamination with germs may overcome these limitations

Appendix IV

In response to an article titled - Blame factory farming, not organic food in Nature Biotechnology 25:165, 1 February, the editors of Nature Biotechnology stated the following:

"The most comprehensive peer-reviewed study to look at contamination of produce found that organic fruits and vegetables are three times more likely to be contaminated with bacteria than conventional produce; indeed, of all the produce tested, the study found the pathogen Salmonella exclusively in organic lettuce and organic green peppers. Of a total of 15 farms that had E. coli-positive samples, thirteen were organic and only two were conventional."

"There is a simple fix available, however, that could stem the rising tide of cases of food-borne illness in the United States.
<http://www.acsh.org/publications/pubID.1562/pub_detail.asp>Irradiation of fruits and vegetables would eliminate 99.999% of pathogens. It would have prevented or drastically reduced all of last year's E. coli outbreaks. And most important of all, it would have saved lives. It's hard to understand why a country that already irradiates its meat should not do the same to its fruits and vegetables "(Blame factory farming, not organic food: a response, Nature Biotechnology 25:165, 1 February 1, 2007).

Appendix V

NAS (National Academy of Sciences). Toxicants Occurring Naturally in Foods. Washington: National Academy of Sciences, Committee on Food protection, Food and Nutrition Board, National Research Council, 1973.
NRC. (National Research Council). Committee on Comparative Toxicity of Naturally Occurring Carcinogens, Board on Environmental Studies and Toxicology, and the Commission on Life Sciences, National Research Council. Carcinogens and Anticarcinogens in the Human Diet: A Comparison of Naturally Occurring and Synthetic Substances. Washington, D.C.: National Academy Press, 1996
Smale, Melinda; M. P. Reynolds; M. Warburton; B. Skovmand; R. Trethowan; R. P. Singh; I. Ortiz-Monasterio and J. Crossa. "Dimensions of Diversity in Modern Spring Bread Wheat in Developing Countries from 1965." Crop Science 42 (November-December 2002):1766-1779.
Smale, Melinda and T. McBride. Understanding global trends in the use of wheat diversity and international flows of wheat genetic resources. Part 1 of CIMMYT 1995/96 World Wheat Facts and Trends: Understanding Global Trends in the Use of Wheat Diversity and International Flows of Wheat Genetic Resources. Mexico, D.F.: CIMMYT (Centro Internacional de Mejoramiento de Maiz y Trigo – International Center for the Improvement of Wheat and Maize), 1996
Research, 1983, Vols 1-4

Rao, I and G. Cramer. Plant Nutrition and Crop Improvement in Adverse Soil Conditions. In M. Chrispeels and D. Sadava (eds.) Plants, Genes, and Crop Biotechnology, pp 270-303. Sudbury, MA: American Society of Plant Biologists, ASPB Education Foundation, and Jones and Bartlett Publishers. 2003.

Smalling, E.M.A; S.M. Nandwa; and B. H. Janssen. Soil Fertility in Africa is at Stake. In R.J. Buresh and P.A. Sánchez and F. Calhoun (eds.) Replenishing Soil Fertility in Africa, pp 46-61. Madison, WI: American Society of Agronomy and Soil Science Society of America, Special Publication No. 51, 1997

Appendix VI **A Modest Proposal –**

The issues that I have addressed involve the health and wellbeing, the life and death of tens of millions of people. The issues are no doubt controversial. If important and controversial, they should be debated on this campus and other Universities. I propose that the Cougar team up with the student newspapers at Rice and Texas A&M **to investigate whether there is actually a scientific controversy over the safety of transgenic plants and food stuff and on the efficacy of Golden Rice. Assign a reporter on each campus. Ask Greenpeace and other organizations to provide a clear statement of their claimed scientific reasons to oppose GMOs and Golden Rice. Give them a week or two to contact their national and international organizations so that we have a definitive and defining statement. Then have a reporter at UH and at Rice go to their respective Biology Departments and see if they can find just one tenure track faculty member that validate the science of the ant-GMO statement. I am not looking for a majority – just one who finds the "science" credible. At A**&M, the reporter would have a number of agricultural science departments to find just one who will validate the "science" of the critics. The reporters could then go to Baylor Med and obtain a response to the objections to Golden Rice. (Note - Baylor Med was involved in two of the peer-reviewed studies on the potential efficacy of Golden Rice.) When visiting these **programs, they**

might be asked if they can name a reputable national or international scientific organization that would validate what might be called "Greenpeace science."

Let us have an informed campus wide debate. Human lives are at stake.

Appendix VII

I could go on with more detail but I will stop here. My guess is that most of what I will be debunking is widely believed on campus and among faculty particularly in the Humanities. KUHT has run "documentaries" that have pushed the anti-GMO misinformation and I have noticed in the Cougar that speakers visiting classes have promoted the same agenda. A very well written student opinion piece in the Cougar in the Fall of 2011 brought a torrent of misinformed comment including one from a student who claimed to be a senior in the Biotech program in the College of Technology. He had list of points every one of which was factually in error. My fear is that as he claimed, he learned them in the classroom. I fervently hope that he did not.

There are number of programs on campus - for example the Food for Thought lecture series - that might be willing to co-sponsor a program. The above mentioned Biotech program might be interested as might also the Journalism program because some of the worst sins in the Houston Chronicle were defended to me by an ombudsman who was a UH graduate. Similarly, KUHT, KUHF and the Cougar might be interested since it will be controversial by intent only because one cannot cover the topic without stirring up emotions. KUHT has chosen to show at least one biased anti-GMO documentary and would not consider having a panel to discuss the accuracy of it. Presumably, propaganda is a legitimate function of a campus TV station but reasoned discourse and debate are not.

Let me state, I am not opposed to organic food, or Farmer's Markets or Urban agriculture (I very much favor the latter) but I do oppose the zealots who make claims about them and act to undermine modern agriculture and world food production.

I am willing to defend modern agriculture for its ability to accommodate an incredible increase in population and would argue that whatever are the problems of modern agriculture, the alternatives offered would make them worse.

Appendix VIII

Personal Statement – I have been involved in economic development for over 50 years. My first trip to Africa was in 1962, my first trip to Asia was nearly 40 years ago and though I was in the Caribbean nearly 40 years ago, my development work their began about a quarter century ago. I have returned to these areas on a regular basis and been to the developing world more times than I can count. I was in Africa this summer. I have been privileged to work in every aspect and every level in about everything that I have discussed above. I have known some of the people that I have worked with for close to 30 years and I am in regular phone and email contact with them in addition to meeting with them in London or Africa, Asia and the Caribbean. I say this because in my classes I illustrate many of my points with stories of my personal experience in development. I am likely to do that in a public presentation. Let me make clear that I do not offer my personal experiences as proof of anything. They are meaningful to me and I hope that they help my audience understand the point that I am making. But repeat, my personal experiences are not offered as evidence – merely illustration. I stand or fall on the factual accuracy what I write or say.