



public **IN** review

Environmental Impacts of Agriculture: Conventional and Organic Farming Systems

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Abstract: *Starting with the wide-spread publication of the residual effects of pesticide use on the health of humans and the environment by Rachel Carson's *Silent Spring* in the 1970's, U.S. conventional farming techniques have been placed in an undesired spotlight. More recently, the Global Warming crisis has led to another expansion of the American consumer's environmental- consciousness, which has been reflected in the consumer's choice in terms of food purchases. According the Organic Trade Association's 2011 Organic Industry Survey, "U.S. sales of organic food and beverages have grown from \$1 billion in 1990 to \$26.7 billion in 2010. Sales in 2010 represented 7.7 percent growth over 2009 sales." Perceived effects of organic farming systems include increased sustainability of soil fertility and*

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avoidance of nutrient pollution, while conventional farming techniques are expected to produce a higher crop yield. This paper will focus on the environmental impact of conventional versus organic farming systems on nutrient pollution and crop yield.

Conventional Farming Systems

According to the United States Department of Agriculture (USDA) (Gold, 2012), conventional farming is characterized by the following techniques: “rapid technological innovation; large capital investments in order to apply production and management technology; large-scale farms; single crops/row crops grown continuously over many seasons; uniform high-yield hybrid crops; extensive use of pesticides, fertilizers, and external energy inputs; high labor efficiency; and dependency on agribusiness.” In Indiana, 99.92% of the acres used for agriculture are conventionally cultivated and in the entire United States, 99.98% of acres used for agriculture are conventionally cultivated (USDA 2010). Public consensus ties conventional means of agriculture to the abundance of inexpensive food in the U.S. and the World Bank estimated that these practices are responsible for the 70 to 90 percent increase in food production over the past 50 years (Gold, 2012).

Traditional fertilizers used by conventional farms are pumped with synthetic phosphates and nitrates, which are essential nutrients for plant growth that have been proven to greatly increase size and even speed up growth of plant life. Nitrogen synthetic fertilizers are applied to increase the ammonification and nitrification processes within the soil that increase the speed of the Nitrogen cycle and in turn are intended to increase the growth of crops (Poudel et al., 2002). With the widespread use of these fertilizers, the risk of over-fertilization that causes an imbalance of nutrients in the soil is an all too common occurrence. According to the University of California Integrated Pest Management Program (“Healthy Lawns Fertilizers vs. soil amendments,” 2009), over fertilization is not possible when organic fertilizer is used because it is a “slow-release” fertilizer, meaning the impact of the fertilizer is spread out over time, lessening the likelihood of imbalance in the soil.

Organic Farming Systems

Under the USDA’s National Organic Program (USDA 2012), a food or product may only be labeled as organic if it “a) has been produced through approved methods that integrate cultural, biological, and mechanical practices that foster cycling of resources, b) promotes ecological balance, and conserve biodiversity and c) avoids use of synthetic fertilizers, sewage sludge, irradiation, and genetic engineering.” Although the acreage for organically cultivated land in the U.S. is a marginal number relative to conventionally cultivated land, this number has nearly doubled over the past few years (USDA 2012), from approximately 2.9 million acres in 2006 to 4.8 million acres in 2008. Also, in Indiana, the number of organically cultivated acres

has more than tripled; from 5,290 acres in 2006 to 18,662 acres in 2008, and the number of certified organic operations went from 49 to 180 (USDA 2010).

Organic farming systems use organic fertilizer, bacterium, mammal urea, and cover crops in place of conventional fertilizers. Bacteria are intended to increase efficiency of the denitrification processes in the Nitrogen cycle, while cover crops grow to enrich soils through nitrogen fixation and phosphorous mobilization (USA 2010; Thomas, 2006). A Washington State University study (Kramer et al., 2006) found that organically tended soils had higher organic matter, higher denitrification potential and efficiency, with a greater microbial activity than conventionally-farmed soils. Soil samples were taken from organic, integrated, and conventionally treated sections of an apple orchard. Analysis reported an overall reduction in Nitrogen pollution due to organic farming techniques and concluded that organic and integrated practices reestablished balance of N₂ emissions, and nitrate losses (Kramer et al., 2006).

Trials completed by the Rodale Institute Farming Systems (Rodale Institute 2011) concluded that organically treated soils had greater biomass than the conventionally-treated soils. Organic systems showed that a decrease in synthetic fertilizers and pesticides increased biomass in soils, leading to an increase in biodiversity. Biodiversity helps to derail pest populations and increase an insect's ability to pollinate crops, which speeds up crop growth, causing a surge in crop yields (Pimentel et al., 2005).

Environmental and Economic Benefits

The American Institute of Biological Sciences (Pimentel et al., 2005) recently published an article comparing organic to conventional farming methods that disputed the trade-off with data from the National Research Council proving that organic methods are not only safer for the environment and human health, but also more cost and energy efficient. This was concluded through an experiment done by the Rodale Institute Farming Systems (Rodale Institute 2011) that tracked the inputs for conventional, legume, and animal farming of soybeans and corn. Inputs were used to measure energy efficiency including the impact from use of fertilizers, pesticides, seeds, machines running on fossil fuels, and herbicides. Data proved that energy inputs (kcal) of legume and animal (organic) farming were about 28% and 32% less than that of conventional farming respectively (Pimentel et al., 2005). Studies by the Rodale Institute also concluded that organic soils were sustainably healthier in terms of fertility, nutrient availability, maintenance of soil temperature, and aeration; over time, the organic soils became healthier, while the conventional soils remained the same. With moderate drought, organic corn yields were about 30% higher than conventional varieties. Economic analysis proved that organic farming was approximately three times more profitable than the output from conventional farming methods when comparing the statistics of income, expenses, and returns. In addition, organic farming systems are job creators due to the need for increased employees to oversee the use of conventional system machinery. Energy inputs of organic farming were 45% less and

greenhouse gas emissions were almost 40% less than that of conventional methods (Rodale Institute 2011).

Nutrient Pollution

Nutrient Pollution is characterized in the U.S. by excess nitrogen and phosphorous in air and water, and is “one of America's most widespread, costly and challenging environmental problems” according to the United States Environmental Protection Agency (EPA) (EPA 2012). Nutrient pollution has adverse effects on human health, the environment, the economy, and wildlife. More specifically, excess Nitrate in groundwater may cause Blue baby syndrome, a condition causing labored breathing, blue-tinted skin, and possible death. Nitrate in the air leads to excess ground level ozone, which increases the likelihood of asthma attacks among young people. Environmentally, this pollution causes fish kills, smog in urban areas, and acid rain (a product of burning fossil fuels, which contain Nitrogen). Each year, “the tourism industry loses close to \$1 billion due to losses in fishing and boating activities, as a result of bodies of water that have been affected by nutrient pollution” (EPA 2012). Main sources of excess Nitrogen and Phosphorous come from agriculture, stormwater, wastewater, fossil fuels, and household products containing these elements.

Inputs of Nitrogen and Phosphorous nutrient pollution generally result from overfertilization. Nitrogen and Phosphorous leach into the groundwater causing outputs, which include the erosion of particulate Nitrogen and Phosphorous and the subsequent release of Nitrogen and Phosphorous from the soil. The nutrients then enter the banks of bodies of water, whether it be a stream, lake, or otherwise, where there is an increase of Phosphorous reactivity. Nutrients then dissolve and are transported in the water through algal processes and into the sediment at the base of the body of water. Once these elements have entered the aquatic system, algae and phytoplankton grow rapidly and overpower the ecosystem. These algae blooms lead to hypoxia and fish kills, as seen in the Gulf of Mexico today. Such detrimental effects of agricultural runoff will continue until organic farming techniques such as organic fertilizer, bacterium, urea, and cover crops are applied for remediation.

Conclusion

Lag in application of organic techniques may be attributed to the pushback from agribusiness and public attitude towards food production. For agribusiness, distribution of capital is the main incentive to fight the growth of organics. The Food, Conservation and Energy Act of 2008 (U.S. Farm Bill) provides subsidies for farmers across the country. According to the Environmental Working Group's Farm Subsidy Database (Environmental Working Group 2011), about 10 percent of recipients of these subsidies collect 73 percent of the available funds, averaging at almost \$100,000 per farm. Support gained for the local, organic industry is support lost for commercial agribusinesses, so they lobby to sustain control of government funds and public support.

Following the Great Depression, the United States food policy focused on creating a cheap and stable food supply, which led to a greater emphasis on quantity over quality. This shift in attitude spread and has become the status quo throughout the country. This view has contributed to the current state of the American citizens, mainly the stark increase in cases of obesity in this generation. According to the United States Centers for Disease Control and Prevention (CDC) more than one third of adults living in the U.S. are obese and 17 percent of children in the U.S. are obese, which is three times the rate from the last generation (Centers for Disease Control and Prevention 2012). Political leadership has recognized these trends and is making a move towards changing this attitude; like Michelle Obama's *Let's Move* Campaign (Let's Move 2012), which is an outreach program aiming to fight childhood obesity. Influencing public behavior and decision-making is a long process, the attitudinal shift towards healthier food options will occur over time. Eventually, this behavioral shift will reach the organic industry and use of organic farming methods will be widespread and accepted as the proper means of food production.

References

- Carson, Rachel. (1962). *Silent Spring*. New York: Houghton Miffler Company.
- Centers for Disease Control and Prevention. (2012). Overweight and Obesity. Retrieved from <http://www.cdc.gov/obesity/index.html>
- Covey, T., Green, R., Johnson, J., Jones, C., Morehart, M., Strickland, R., Traub, L., Brown, D., Reeder, R., McGath, C., Williams, B., Erickson, K., Mishra, A., Vogel, S., & Bagi, F. (2006, November). Agricultural Income and Finance Outlook. Retrieved from <http://usda.mannlib.cornell.edu/>
- D.D. Poudel, W.R. Horwath, W.T. Lanini, S.R. Temple, A.H.C. van Bruggen. (July 2002). Comparison of Soil N Availability and Leaching Potential, Crop Yields and Weeds in Organic, Low-Input and Conventional Farming Systems in Northern California. *Agriculture, Ecosystems & Environment*, 90, (125-137). doi: 10.1016/S0167-8809
- Environmental Working Group. (2011). Farm Subsidy Database. Retrieved from <http://farm.ewg.org/>
- Feinerman, E., Bosch, D.J., Pease J.W. (2004, February). Manure Applications and Nutrient Standards. Oxford University Press on behalf of the Agricultural & Applied Economics Association, 86 (1), 14-25. Retrieved from JSTOR. Retrieved from <http://www.jstor.org>.
- Gold, Mary V. (1999, September). Sustainable Agriculture: Definitions and Terms. Retrieved from <http://www.nal.usda.gov/afsic/pubs/terms/srb9902.shtml>
- Greene, Catherine. (2010, September 14). Table 3--Certified organic and total U.S. acreage, selected crops and livestock, 1995-2008. Retrieved from <http://www.ers.usda.gov/Data/Organic/>
- Greene, Catherine. (2010, September 14). Table 4--Certified organic pasture and cropland, 2008, by State. Retrieved from <http://www.ers.usda.gov/Data/Organic/>
- "Healthy Lawns Fertilizers vs. soil amendments". (2009). ipm.ucdavis.edu. Retrieved 2010-08-25.
- Kramer, S.B., Reganold, J.P., Glover, J.D., Bohannon, B.J.M., & Mooney, H.A. (2006, March 21). Reduced Nitrate Leaching and Enhanced Denitrifier Activity and Efficiency in Organically Fertilized Soils. *National Academy of Sciences*, 103, 4522-4527. Retrieved from JSTOR. Retrieved from <http://www.jstor.org>.
- Let's Move. (2012, May 2). Learn the Facts. Retrieved from <http://www.letsmove.gov/>
- National Organic Program. (2012, February 7). Welcome to the Natinoal Organic Program. Retrieved from <http://www.ams.usda.gov/AMSV1.0/nop>
- Nitrogen Applied Newswise, Retrieved on October 1, 2008.

- NRC (National Research Council). 1993. Managing wastewater in coastal urban areas. National Academy Press, Washington, D.C., USA.
- Parker, Tim. (2012, May 2). State Fact Sheets: Indiana. Retrieved from <http://www.ers.usda.gov/StateFacts/IN.htm#FC>
- Parker, Tim. (2012, May 2). State Fact Sheet: United States. Retrieved from <http://www.ers.usda.gov/StateFacts/us.htm>
- Pimentel, D., Hepperly P., Hanson, J, Douds, D., and R. Seidel. 2005. Environmental, Energetic, and Economic Comparisons of Organic and Conventional Farming Systems. *Bioscience*, 55(7): 573-582.
- Riedl, Brian. (2007, June 20). How Farm Subsidies Harm Taxpayers, Consumers, and Farmers, Too. Retrieved from <http://www.heritage.org/>
- Rodale Institute. (2011). Farming Systems Trial. Retrieved December 7, 2011, from <http://www.bioone.org/doi/pdf/10.1641/0006-3568%282005%29055%5B0573%3AEAAECO%5D2.0.CO%3B2>.
- S.R. Carpenter, N.F. Caraco, D.L. Correll, R.W. Howarth, A.N. Sharpley, and V.H. Smith. (1998). Nonpoint Pollution of Surface Waters with Phosphorus and Nitrogen. *Ecological Applications*, 8(3), 559-568. Organic Trade Association. (2011). Industry Statistics and Projected Growth. Retrieved December 3, 2011, from <http://www.ota.com/organic/mt/business.html>
- United States Environmental Protection Agency. (2012, April 23). Nutrient Pollution: The Problem. Retrieved from <http://www.epa.gov/nutrientpollution/problem/index.html>
- USA (2010-07-06). "Isolation and Study of Cultures of Chinese Vetch Nodule Bacteria". [Pubmedcentral.nih.gov](http://pubmedcentral.nih.gov). Retrieved 2010-08-25.
- Uphoff, Norman Thomas (2006). Biological approaches to sustainable soil systems. ISBN 9781574445831. Retrieved 2010-08-25.