

# Conservation Classroom Resources

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“ Systematic yield increases were nonexistent before the advent of synthetic inputs. Producing more food on less land isn't a goal that's necessarily on nature's agenda. ”



## Fertility Treatments

By James McWilliams

When Fritz Haber first showed the world how to fix nitrogen from thin air, the results were earth-shattering. Synthetic fertilizer fueled the green revolution and set off a population bomb. Now, 100 years later, we need another soil fertility breakthrough—one without the ecological casualties.

### SUMMARY QUESTIONS

[worksheet available online](#)

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1. Describe the Haber-Bosh process (answer: turning nitrogen gas into a solid and pressurizing it into a solid that can be used as fertilizer. Fritz Haber and Carl Bosch)
2. What was the growth in global population that resulted, in large part, due to industrial fertilizer? (answer: 1.6 billion to 6 billion in less than a century)
3. What are four ways that farmers fertilized their crops prior to synthetic fertilizer? (answer: 1. animal manure (dung), 2. silt from rivers, 3. nitrogen-fixing legumes in crop rotation, and 4. human feces ("night-soil").



### BUILD YOUR OWN GLOSSARY

- ▶ nitrogen fixation
- ▶ humus
- ▶ carbon footprint
- ▶ volatilization

4. List four ecological impacts of synthetic fertilizer use. (answers: loss of soil fertility, soil compaction, runoff creating hypoxic aquatic zones, use of natural gas, creation of nitrous oxide greenhouse gas which is 300x more powerful than CO<sub>2</sub>, mining operations.)
5. What are some ways that soil characteristics need to change in order to turn it into the humus desired by organic farmers? (answer: change the microbiology, return it from acidification and compaction, stabilize nutrient richness, enhance water retention.)
6. What is the humus “microherd” comprised of and what does it do? (answer: beneficial insects, worms, and microorganisms. They aerate soil and potentially reduce the need for chemical pesticides.)
7. List three drawbacks of all-organic farming. (answers: yield is much lower, rate of nutrient delivery isn’t timed to plant need, runoff can include excessive phosphorus, organic composting creates methane, and excessive application can cause even more nitrous oxide than conventional farming)
8. What are the “Four Rs” of fertilizer application? (answer: the right time, right place, right source, and right rate.)
9. What are three solutions proposed by the author to reduce the negative environmental impact of fertilizer? (answer: 1. controlled-release fertilizers could reduce nitrous oxide emissions by 30% and runoff by as much as 50%, 2. variable rate irrigation, 3. genetic breeding of plants for better nitrogen absorption)

### DISCUSSION QUESTIONS

[worksheet available online](#)

1. What do you think has been the larger consequence of synthetic fertilizer on the planet: the human population bomb, or the ecological impacts of production, use, and run-off? Which consequences should we work to remediate? Can they be addressed by technological innovation, by policy, or by ecological restoration?
2. What are the “long-held ideological barriers that divide organic farming and conventional agriculture”?
3. What is your reaction to the author’s statements regarding preindustrial nitrogen, “the common denominator was that they came from earthy processes considered to be natural” and “Haber and Bosch’s primary accomplishment was to empower agriculture to bypass nature”? How do you define “organic” and “synthetic”?



“ If organic methods are going to play a meaningful role in fertilizer’s future, organic standards will have to incorporate conventional methods and vice-versa. ”

4. Were you surprised by Ross Penhallegon’s statement that runoff rates from organic and conventional farming are the same? How about Steve Savage’s assertion, “When you combine [the rate of greenhouse gases created by composting] with the amount of manure needed to fertilize a crop, you end up with a ‘carbon footprint’ that is three to eight times as large as if you delivered the same amount of nitrogen with synthetic fertilizers like urea”? What led you to have preconceptions on this issue? (*Continue this discussion by reading “The Ecoverception Gap” by David Ropeik in the Fall 2012 issue.*)
5. What is your reaction to the argument from Ross Penhallegon, that we will dramatically reduce the amount of fertilizer lost to runoff or volatilization by becoming “extremely good at what we’re doing.” What motivation is there for farmers to become more judicious and follow the “Four Rs” of fertilizing? What was the historical precedent for NOT following the Four Rs? What leads Penhallegon to think that attitudes are changing?
6. What is the difference between the hybrid organic-conventional methods mentioned in studies 2-4 versus the author’s idea of using the *wisdom* of organic farming with modern farming technology?

### ADVANCED ACTIVITIES

- 1. History of Industrial Agriculture:** Research a specific aspect of how the Haber-Bosch process, synthetic fertilizer, or industrialization of agriculture impacted local, regional, or international communities. Which groups, companies, or services suffered? What new businesses arose? How did farm employment change? What were the accompanying cultural shifts (e.g. education, family planning, standards of living)?
- 2. Crafting Farm Policy:** If we consider a hybrid organic-synthetic model as a promising environmental solution, how will that translate to policy on rules and regulations for farming? What are the existing rules for food that is labeled as ‘organic’ or ‘natural’? Break into groups and have each one take the position of a different entity in the agriculture industry: pro-synthetic fertilizer (International Plant Nutrition Institute), pro-organic farming (the Rodale Institute, Organic Agriculture Centre of Canada). Have another group play the USDA’s National Organic Standards Board which is soliciting advice on their policies. The USDA Board group should research and report on the existing rules and regulations, as well as outlining the goals of a new policy, in advance of the in-class exercise. In class, groups debate and attempt to craft a new policy on Organic Standards. (*End the exercise by discussing the author’s statement, “In agriculture, nothing is as straightforward as we’d like it to be. Or, as Penhallegon says, ‘It’s never, us versus them.’”*)

- 3. Fact-Checking the Impacts of Human Diets:** The author cites data from a recent study (reference 1 in the article) showing that organic crop yields are much lower than 'conventional' farming (40% lower for winter wheat, for example). The author follows this data with the statement, "With 2 billion people expected to join the planet with the next 40 years, these numbers are, to say the least, problematic for the prospects of exclusive organic fertilization." What about the elephant in the? The author writes that "60 percent of the nitrogen that manages to make its way into the corn feed ends up having nothing to do with human caloric intake. Add to this perverse cycle that fact that it takes about 140 lbs of nitrogen to grow an acre of corn, but closer to 60 lbs to grow an acre of kale ... If commercial agriculture exploited the Haber-Bosch process to grow a diverse array of food for people to eat rather than a narrow array of food for livestock to eat, we would not have anything close to a fertilizer crisis." What percentage of the global population would need to be vegetarian or vegan to accommodate the drop in crop productivity of all-organic farming? Or is there already enough food on the planet, and the problem is transportation to food-poor areas of the globe and urban centers? Look into the facts of corn production for livestock.
- 4. The Science behind Hybrid Organic-Conventional Farming:** Check out the recent studies of hybrid farming techniques (references 2-4 from the article). After reading the science, do you agree with Seufert et.al. that, "By combining organic and conventional practices in a way that maximizes food production and social good while minimizing adverse environmental impact, we can create a truly sustainable food system." What hurdles exist for a hybrid system? What are the benefits of a hybrid system above and beyond either organic or conventional farming? What environmental impacts will still exist even with hybrid farming techniques? Do the authors suggest any way to ameliorate these impacts, or are they an insurmountable consequence of modern crop production? Chase down the author's source of data on nitrous oxide emission reduction and runoff reduction. (*Start hint: Alan Blaylock, Manager of Agronomy for Agrium Advanced Technologies.*)
- 5. Economic Analysis of Judicious Fertilization:** The author states that Polymer-coated "controlled-release" fertilizers are "finally becoming cost-effective." How cost effective? Are they still more expensive than traditional fertilizer? If so, what motivation is there for switching to this higher-tech, lower-environmental impact form of fertilizer? How expensive are the variable-rate irrigation systems? How much could be saved in water expenses by such a system? What companies are conducting the research of more nutrient-savvy plants? Do these plants constitute GMOs? What are the seed purchasing policies of those companies? What are the costs to the farmer?

**Further Reading:** *Just Food: Where Locavores Get It Wrong and How We Can Truly Eat Responsibly* by James McWilliams

