

Lessons Learned teaching a Massive Open Online Course on the Sustainability of Global Food Systems

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ABSTRACT

In the summer of 2013, we delivered a Massive Open Online Course (MOOC) exploring the *Sustainability of Food Systems: A Global Life Cycle Perspective*, which saw thousands of people from 138 countries enrolled in the course. We focused on increasing awareness of the complexity and global reach of modern agriculture and food production systems while enabling students (i.e., consumers) to understand the implications and impacts of their personal/household dietary decisions. The course included full cradle-to-grave consideration of food production; from the seeds that may have been genetically modified, through the choice of organic or synthetic fertilizer application, to the nutrient and calorie waste from poor handling or food spoilage. Through the interactive, discussion-based nature of the course, the students learned at least as much from stories and experiences shared by each other as from the video lectures and readings. As we hoped, many students left the course with an understanding of the substantial environmental impacts from activities throughout the life cycle of food production, and the importance of informed decision-making at the consumer level.

Keywords: teaching, Massive Open Online Course (MOOC), global food systems, sustainable food systems.

1. Introduction

Food systems represent a strong opportunity for those interested in life-cycle assessment (LCA) to affect positive change in reducing the environmental burden of human activities. Agricultural activities cover 38% of global land area (The World Bank), and are responsible for 10 to 12% of global anthropogenic greenhouse gas emissions (Smith et al. 2007) (2011 and 2005 figures, respectively). The supply chains that depend on agriculture are complex, but this complexity means there are many possible intervention points. In the spirit of the adage “an ounce of prevention is worth a pound of cure”, changing the behavior of the final consumer of food and agricultural products has a magnified impact on the agricultural practices at the start of the supply chain. The most effective way to achieve this change may be through education.

From June through August 2013, we helped thousands of students become better educated about global food systems through a Massive Open Online Course (MOOC) on the Coursera platform entitled *Sustainability of Food Systems: A Global Life Cycle Perspective*. A MOOC is free for everyone, anywhere so long as they have an Internet connection; there are no prerequisite courses or degrees, and the students are essentially free to interact with the course materials and each other as much or as little as they wish. Our course saw enrollment from 138 countries, and participation by more than 15,000 students.

Like many extension and outreach-focused efforts from the life-cycle assessment community, this course aimed to increase awareness of the complexity and global reach of modern agriculture and food production systems while enabling students (i.e., consumers) to understand the implications and impacts of their personal/household dietary decisions. Course content was organized around exploring the answers to 15 overarching questions. These included: How and where do we grow our food?; How do we choose what we eat?; and, How does what we eat affect our environment? As illustrated in Figure 1, we began at a personal level in discussing the nature of food and our individual relationships with it, then expanded our scope of investigation in order to illustrate the global nature of modern agricultural supply chains, then looked at the health and environmental impacts associated with this global supply chain, and finally returned focus to the individual in exploring how our personal or household choices could contribute to a more sustainable food system.

In this paper, we will discuss course organization, highlight some of the course topics most relevant to the food LCA community, and reflect on the key outcomes from this experience.

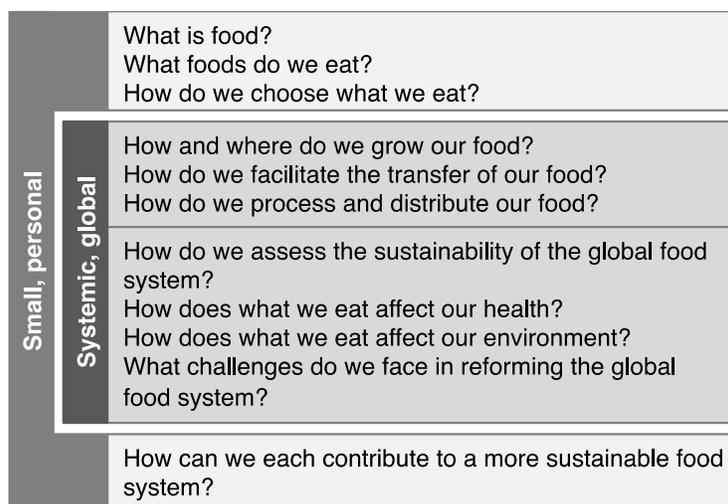


Figure 1. The complex global nature of agricultural supply chains and environmental impacts was the focus of our course, but we bookended the content with smaller scale, personal considerations so that students realized they could still affect change despite being a single actor in the system.

2. Materials and Methods

Course content was delivered in two ways: through readings, and through recorded conversations between Prof. Jason Hill and topic experts from the University of Minnesota. To keep the course ‘open’, readings were required to be accessible to anyone, anywhere, with zero cost. This ruled out using certain published journal articles, or requiring that students purchase any textbooks. It did not, however, rule out small extracts from books or articles as per fair use rules under copyright law. A complete list of readings is included in Table 1.

Table 1. Reading materials used in *Sustainability of Food Systems: A Global Life Cycle Perspective*.

- McGee, H. (2004) The Four Basic Food Molecules. In *On Food and Cooking: The Science and Lore of the Kitchen*. Scribner: New York, NY. pp. 792-809.
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- Gustavsson, J., et al. (2011) *Global Food Losses and Food Waste*. FAO: Rome, Italy. pp. v–vi; 1–9.
- Lipinski, B., et al. (2013) *Reducing Food Loss and Waste*. WRI and UNEP: Washington, DC. pp. 1–10.
- D'Souza, A. (2011) Rising food prices and declining food security: Evidence from Afghanistan. *Amber Waves* 9: 26–33.
- Dahl, R. (2010) Greenwashing: Do you know what you're buying? *Environmental Health Perspectives* 6: A247–A252.
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- Foley, J. (2011) Can we feed the world and sustain the planet? *Scientific American* 305(5): 60–65.
- Pearce, F. (2011) The Borlaug paradox. *New Scientist* 209(2798): 26–27.
- Bartholet, J. (2011) Inside the meat lab. *Scientific American* 304(6): 64–69.

One of the key challenges of teaching in a MOOC environment is how to assess students' comprehension of the materials and concepts presented. Due to the sheer number of participants, it is not possible for student responses to an essay prompt to be assessed by a professor or teaching assistants. Multiple choice or filling the blank type questions are implementable, but only go so far in assessing student understanding of content. This latter assessment is problematic in a course such as this that requires students to incorporate new knowledge into what they already know about food systems. Our approach, then, was to get the students to engage with each other and discuss topics through the discussion forum on the course website (see Figure 2 for a screenshot). Through these interactions, the students learned at least as much from shared stories and experiences as they did from the video lectures and readings. As instructors, we also learned from these exchanges; stories from students in developing countries about ingenious local production practices, or from students directly involved in food aid assessment add color and context to more academic publications on which we base our understanding of the topics we teach.

The screenshot shows the Coursera interface for the course 'Sustainability of Food Systems: A Global Life Cycle Perspective' by Dr. Jason Hill. On the left, there is a navigation menu with sections for 'INFORMATION' (Start Here, Syllabus, Grading, Staff, Announcements) and 'COURSE' (Week 1 through Week 5). The main content area is titled 'Forums' and includes a search bar, a welcome message, and a table of sub-forums. The table lists various topics like 'Introductions', 'Questions', 'Readings', 'Activities', 'Guests', 'General', 'Recipes', and 'Study Groups', each with a brief description and a 'Latest Activity' entry with a timestamp (e.g., '8 months ago').

Sub-forum	Latest Activity
Introductions Please share a bit about yourself and say hello to someone else! (See the Week 1 page for instructions.)	Amy From Central New Jersey (8 months ago)
Questions Discuss any of the course's fifteen questions.	Food game (8 months ago)
Readings Discuss the current week's readings.	Self-Sustainability and Advocacy (8 months ago)
Activities Post your activities here.	What to do now... (8 months ago)
Guests Post questions here for the guests. We will try to answer the top two or three.	Question on waste reduction and... (8 months ago)
General General discussion about food, the course, life, and everything under the sun.	Statement of Accomplishment (8 months ago)
Recipes Post your favorite recipes here for others to try!	Eggplant with cheese and turkey in oven (8 months ago)
Study Groups Find friends and arrange meet ups.	HELLO TO THE WORLD.STUDY GROUP FROM... (8 months ago)

Figure 2. A screenshot of the Forums section of the course on the Coursera platform. Sub-forum headings directed the students towards the appropriate places to post questions, respond to assignment prompts, etc.

To introduce students to the beginning of the food supply chain, we discussed where our food originated historically. This issue is important in considering the sustainability of the global food system, as the plants and animals we consume now depend on the domestication decisions that were made many years ago. One assigned reading highlighted the fact that the domestication process is, in fact, ongoing in Africa (Pye-Smith 2009). We asked the students to pick a recent meal they had eaten, and determine to which regions in the world the basic ingredients of their meal were native. For example, if one had eaten spaghetti and meat sauce (wheat, cow, tomato and basil), the list would include the Eastern Mediterranean, the Andes, and India. The course materials and the exercise encouraged the students to reflect on how the availability of food has changed over time, and to consider the idea of “eating locally”, popular among those wishing to reduce the environmental impacts of their diets, in a new context.

The question of where our food originated was followed by a discussion of how our food is grown today. Prof. Paul Porter of the Department of Agronomy and Plant Genetics at the University of Minnesota discussed the myriad of agricultural practices currently undertaken around the world, highlighting that many practices in the world do not resemble the large-scale agriculture practiced in the midwestern United States. Of course, different practices characterized by labor and chemical input are associated with different yields. We had the students explore which countries produced which crops, and with what yields, using an online database from the UN’s Food and Agricultural Organization called FAOSTAT. This database is free and easy to query, important characteristics for a diverse student population.

A key step in the food supply chain is the conversion of these raw, basic ingredients into what is termed ‘processed food’. This can include anything from pasta to a ready-made frozen meal. This step has become an increasingly important one in developed countries, though the term ‘processed food’ is often used with negative connotations. Students read an article discussing the social and dietary impacts of major multinational food companies moving into Brazil (Monteiro and Cannon 2012). The students then heard Prof. Gary Reineccius of

the Department of Food Science and Nutrition at the University of Minnesota describe food scientists' innovative work in food processing to improve the sustainability of the global food system. For example, food scientists can make whole grains more palatable to the general public through the calculated use of polyphenols, a natural plant extract that stops a chemical reaction during baking that produces an undesirable bitter flavor. The unsophisticated response is simply to add sugar to mask the bitter taste. The result of this food science development is that more whole grain low-calorie foods are consumed.

Environmental impacts lie at the heart of assessing the sustainability of the global food system. Prof. Stephen Polasky of the Departments of Applied Economics and Ecology, Evolution, and Behavior presented the concept of ecosystem services to the students. We felt it important to acknowledge that sustainability depends on more than reducing greenhouse gas emissions, but rather the natural systems upon which our food supply depend also influence biodiversity, water quality, air quality, and nutrient flows. A key point made by Prof. Polasky is that the food services we want from our natural systems, namely the profitable yield of food, can be at odds with the services we agree are beneficial but are not easily bought or sold, such as water remediation.

Some students were aware of these types of impacts or benefits because of the various food-labeling standards in place around the world. A discussion of supply chain impacts from Prof. Tim Smith, Director of the Northstar Initiative for Sustainable Enterprise, and a reading on "greenwashing" (Dahl 2010) forced the students to more carefully consider the claims made by labeling organizations and their eco-labels. His central point was that there is an important tradeoff between how rigorous and scientific the labeling requirements are and how many companies will actually engage in the process to receive the label. To reinforce this discussion, we asked the students to investigate two products that bore some claim to sustainability, with the expectation that students would find the requirements to earn the label, or the research and testing done to support an in-house claim of sustainability, vary widely among companies and labeling organizations. A handful of students were able to deliver what amounted to impressive investigative reporting to the rest of the class.

We wanted to make sure the students left the course feeling empowered to affect positive change and hopeful that change is possible, which can seem challenging in the face of a complex global system full of problems. To do so, we discussed broadly how we can provide food more sustainably, and how the individual consumer can contribute to a more sustainable global food system. The students read and heard the strategy of Prof. Jon Foley, Director of the Institute on the Environment, to feed a growing population more sustainably by increasing yields in low-yielding areas of the globe, increasing the use of modest technology options to improve the ratio of calories output to units of water or fertilizer input to an agricultural system, to reduce global meat consumption, and the reduce food lost to waste (Foley 2011).

3. Learning Outcomes

At the end of the course, we asked the students to reflect on what they had learned, and how they could apply their new knowledge in their own lives to improve the sustainability of the global food system. Some key themes emerged in reviewing student responses to the prompt. One of the most common responses given by students was their plan to reduce meat consumption, or at least reduce beef consumption, in light of the negative impacts of a global food system that relies heavily on the production and processing of animal protein.

Many students also left the course feeling better able to find further information on the topic we studied, or new topics we were not able to cover given the introductory nature of our curriculum. This result came from the introduction of tools, such as the FAOSTAT database, resources, of reputable organizations or scholars in the field of food systems and life-cycle assessment, and, simply, from a newfound vocabulary the students could leverage to find reliable information online more quickly.

From a pedagogical standpoint, we learned that emphasizing student interaction in the forums had many advantages, but it was not without drawbacks. Like tends to attract like, and in many cases this lead to a small community within the class that could share resources on specific interests such as vermiculture, managing dietary restrictions related to illness, or the challenges of food aid policy. Unfortunately, on some occasions these communities simply propagated misinformation. Perhaps the strongest such case was a completely erroneous discussion that arose about how using microwaves to heat food causes cancer because radiation affects DNA. We interjected with a post carefully crafted to explain the important differences between ionizing and non-ionizing radiation, and how microwaves employ only the latter, but it went completely unheeded by the

discussion participants. Unfortunately, some deeply held convictions and prejudices were not shaken, and the nature of MOOCs made this task all the more difficult.

4. Conclusions

Agriculture, a global system expanding by necessity to feed an increasing population, is associated with many substantial environmental and health issues and changes in human behaviour are needed. This MOOC presented us with an opportunity to increase the awareness of the individual decision maker with regards to the complex and global nature of the modern agricultural system, and the challenges present, along with the resulting opportunities to improve sustainability. Based on participation and the ensuing robust discussions, we believe our efforts were successful.

In addition to being more aware, many students left the course believing that their individual efforts could have an impact on upstream activities in the supply chain. Some declared that they would change their behaviors; others argued that they could not, citing lifestyle pressures and other challenges. Some gained a confirmation of their current choices. The fact that such attitudes were expressed indicated successful engagement.

It was beyond the scope of this (or any) MOOC to assess the true impact on behavior; that is, will students actually behave differently? That said, we feel confident that our efforts have captured their attention and given them cause to consider the course of action they might take.

5. References

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