**The Future of Food: Module 10 Summative Assessment Worksheet:**

**Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**First, put your name on this worksheet. Then, based on your completion of the life-cycle analysis in the summative assessement and your learning about food systems and environmental impact in modules 10.1 and 10.2, answer the following questions. Type your answers into the worksheet (they will require more room than what has been left here, for some answers) and submit to the online course management software.**

**(note that if you type your responses into this worksheet, its length may well increase somewhat from the short answer questions)**

1. Imagine you are at a large meeting on improving sustainability of human society and its impact on the environment, as an advocate for food system sustainability. An advisor to a United States Senator approaches you and asks you “Why should I care about how food is produced, distributed, and consumed? Aren’t there much more important aspects of environmental sustainability to pay attention to, like mining, oil, and gas, how much energy factories use, whether people leave their lights on during the day, and how many miles I commute to work in my car? Seems like food is a small consideration compared to that.” Explain in a 2-4 sentences why human activities related to food systems are a big deal for environmental sustainability.
2. What estimated impact on energy use of food production would the following have? Each example is based on a potential or real situation with the food system types in the LCA. Please answer by stating first, “increase” or “decrease”, followed by 1-2 sentences explaining why:
	1. The potato farm in the industrialized system LCA example above starts applying less nitrogen fertilizer by growing a winter cover crop that recycles nitrogen from the soil: (increase/decrease, why?)
3. The water table in the valley that is pumped for irrigation falls, and water must now be pumped from twice the depth to irrigate crops. (increase/decrease, why?)
4. An integrated pest management approach to potato pests and better forecasting of fungal disease outbreaks allows the farmer to apply fewer/less quantity of insecticides and fungicides, so that fewer of these agrochemicals are produced and transported to the farm. (increase/decrease, why?)
5. Because of technical assistance and subsidized fertilizer and agrichemicals, smallholder potato farmers gain new access to urban markets and start planting the marketed varieties with fertilizers instead of manure, and greater use of pesticides, because they want to produce the largest yields of blemish-free potatoes. (increase/decrease, why?)

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1. Why is fossil fuel energy use a convenient measure of human impact on the natural earth system that is often evaluated in LCAs? (i.e. to what other impact or impacts on the earth system does it relate?). Note that this is similar to the first group and class discussion question from the online instructions for step 3 of the assessment on the website.
2. For the measure or metric of fossil fuel energy, the smallholder system had less of an impact per kg of food produced. However, it also yielded less potatoes.
	1. Based on this lower yield and assuming there is only limited amount of land to grow food on, what is a potential criticism of this seemingly superior system? (1-2 sentences)
	2. Can you think of other measures of food system sustainability where the smallholder system might fall short of the industrial system? You may want to refer to the issues of poverty traps in module 10.1, and note some of the possible issues of environmental sustainability there. (1-2 sentences)
	3. (answer in one word) We may want to think about what the goals of each food producer are in these systems, in order to understand the two dramatically different outcomes occur in the different systems. Which food producer likely desires a moderate yield for home consumption, and very low costs and external inputs? (choose smallholder or industrial) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_; Which food producer likely desires to maximize earnings in a relatively low-value national and global marketplace, and has ready access to fuel and agricultural inputs at relatively advantageous prices? (smallholder or industrial) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	4. (no answer required, for reflection).Note that these are extreme cases, and it is probably best to not think of these two cases as the only alternatives, but a mix of alternatives that create the best solutions for sustainability.
3. In the early 1990s of the last century, Chinese food production systems existed in an environment where farm sizes were small and new farmland was limited, so that it was difficult to simply increase the number of acres (or hectares) farmed in order to increase food production. The overall demand for food in China was large and growing. Although rising, the price of fossil fuel energy was relatively cheap in global markets. Also, in comparative world terms, the yields on these small farms were low so that there was much room for improvement that could be gained by increasing nutrient inputs to these farms. Based on your LCA and other materials on food production impacts on earth surface processes in this course, what effect do you think this situation had on each of the following: (answer in 1-2 sentences, include briefly WHY)
	1. Fertilizer use by Chinese farmers
	2. The overall energy use of Chinese farm crop production per kg food produced
	3. Water quality in rivers and estuaries connected to Chinese agricultural regions.