GLBRC BCSE Tour – Sarah Roley notes, 2017

1. Why biofuels?

* Current fuel for our cars comes from fossil fuels
* Release CO2 and this is NEW CO2; without cars, it would be buried underground
* Can also get fuel from plants – currently, this is corn grain fermented to ethanol
  + 45% of our corn crop is converted to ethanol
  + Ethanol is mixed with all gasoline
* Cars burn biofuels and release CO2, but that CO2 came from the atmosphere, which means it’s carbon-neutral. Essentially we’re recycling CO2 in the atmosphere, rather than producing new CO2 that would otherwise remain sequestered
* (depending on group): growing corn does require CO2 release from manufacturing fertilizer, fuel in tractors, etc, but still much less NEW CO2 released than if use fossil fuels

2. Why cellulosic biofuels?

* Cellulose can also be converted to ethanol, with an additional processing step
* This gives us flexibility, because all plants have cellulose; it is the most abundant plant material on Earth
* Corn is a resource-intensive crop, requires lots of fertilizer & herbicide, and often pesticides
  + Impacts on freshwater bodies, drinking water
  + Impacts on biodiversity
* Corn is a food crop!
  + Effects on food supply, food prices
* What is a good alternative to resource-intensive corn?

3. The ideal biofuels plant… (depending on group, can get them to brainstorm about what the ideal characteristics would be)

* Small amounts of fertilizer, chemical inputs
* Does not compete with food crops = can be grown on “marginal” land
* Produces lots of biomass so can meet our fuel needs
* Supports biodiversity (birds, insects…)
* Perennial – prevents loss of nutrients, soil erosion, provides year-round wildlife habitat, potential C sequestration
* Supports rural communities (economic sustainability)

4. Here at the BCSE, we have several candidate cellulosic crops (show the map of the site)

* Experimental design (depends on group; good for REUs, college students, less useful for public groups or HS students)
  + Randomized block (5 blocks, location of each treatment random within a block)
  + 10 treatments, 5 reps each
  + Gradient from low-high input (high = corn/soy; low = prairie, with no inputs)
  + low-high biodiversity (low = corn/soy, monoculture perennials
* To evaluate each crop’s potential we measure:
  + Yield (total and ethanol yield)
  + Soil nutrients
  + Species composition
  + Greenhouse gas emissions (more on this later)

5. Walk around and look at each of the candidate crops

* Switchgrass: native to N. America, dominant species of prairies and savannas, huge genetic diversity, so potential for adaptation to marginal lands where corn & soy don’t grow, also potential for breeding ideal traits. Requires very little N inputs – mention lack of yield response at N gradient. Also comparable to prairie on many biodiversity metrics
* Prairie: 18 species sown, including grasses, forbs and legumes, great for biodiversity, challenge to convert because the chemistry of the different species makes for an uneven product
* Early successional: nothing planted – species composition from seedbank. Fertilized annually. This mimics abandoned ag land – many people have a few acres of unmanaged land that looks like this.
* Corn: grown in 3 ways – continuous, continuous with cover crop, and in a corn/soy rotation with cover crop. Cover crop is another source of biomass for conversion, also reduces loss of nutrients and prevents soil erosion. Also note that we harvest the grain and the stover. Stover considered cellulosic. Advantage: already growing corn – farmers can produce biofuels without changing their farming practices. Stover-ethanol plant in Iowa.
* Mixed grasses: “prairie lite”, more biodiversity than switchgrass, but only one kind of plant so easier to convert than the prairie
* Poplar: fastest growing tree in N America, requires very little fertilizer (fertilized just once), harvested every 6 years. Current poplars are regrowth from the 2014 harvest. No need to replant – they regrow from the stems. Much research on poplars from the forest products industry – grown for pulp wood and sometimes for furniture.
* Miscanthus: triploid hybrid, found in a botanical garden in Germany. Parents are of SE Asian origin. Tremendous biomass, but not native, so doesn’t provide much habitat. Also concerns about invasibility – it is sterile, but were it to develop viable propoagules, could wreak havoc on natives.

6. Yield (use poster)

* Have students note which crops yield the most at KBS and at Arlington
* When evaluating sustainability, must consider a wide range of ecosystem services
* Yield is really important – the more yield, the less land must be used for biofuels
* But Miscanthus best yield but performs poorly on biodiversity.
* So it’s complicated, but we hope our data will inform decisions on what species to recommend

7. Greenhouse gas emissions. Point this out whenever convenient – when you walk by one of the greenhouse gas chambers.

* Greenhouse gases come from cars, factories, etc, but also from the soil
  + Microbes (naturally occurring) produce GHG as part of their metabolism
  + N2O especially concerning in ag soils. N fertilizer – NO3 – N2O
* Must consider ALL the sources of greenhouse gases, including the soil
* Show poster

8. So which crop is the best candidate? Depends on which ecosystem services you value. Switchgrass looking really promising, but another consideration is where the crops are grown.

9. Mention marginal lands experiment – all perennial treatments, in abandoned ag land (the most likely location for these biofuels). Preliminary findings: sg survives everywhere, other crops more variable