Outline for Energy Beet as P Remediation Presentation

Slide Number

1.

2.

Advanced Biofuels USA, a nonprofit educational organization advocates for the adoption of advanced biofuels as an energy security, military flexibility, economic development and climate change mitigation/pollution control solution. Our key tool for accomplishing this is our web site, www.AdvancedBiofuelsUSA.org, a resource for everyone from opinion-leaders, decision-makers and legislators to industry professionals, investors, feedstock growers and researchers; as well as journalists, teachers and students.

In addition, we prepare technology assessments, present briefing documents to Congressional staff, participate in international conferences on renewable fuels, provide both background and attributed interviews for a wide range of journalists and broadcast reporters, consult with international conference organizers, conduct presentations and lectures for civic and school groups, and provide general assistance to those interested in any facet of the world of advanced biofuels.

Reason here--did a feasibility study about energy beets on the Delmarva and encountered interesting questions about the value of possible P uptake.

But before we get into the details of that, I'd like to provide some context.

3.

What do you think of when you hear the word “biofuels/”

Many people think only of corn ethanol. When we are talking about advanced biofuels, we are thinking of these many fuels that can be “bio-ized” or made from renewable resources.

4.

Today I want to talk about a project that Advanced Biofuls USA was involved in with the University of Maryland Eastern Shore—a feasibility study, funded by a small USDA Rural Business Development Grant, to explore whether energy beets could be grown on the Eastern Shore for a jetfuel market.

For those not familiar with the Delmarva Peninsula or Maryland's Eastern Shore, a few things to note:

1. It is flat; all tidewater.
2. "Eastern Shore" references the land in Maryland that lies east of the Chesapeake Bay; Delmarva references the three states that make up this area.
3. Health of the Bay is crucial to the environmental, social and economic life of the area.
4. Poultry Industry is a leading business and politically active and powerful.
5. More characteristics later.

5.

Initial Goals: to understand the impetus for this project. Team brought together to apply for a large, multi-year USDA grant.

***Initial* goals of the project:**

- **Use a high yield (over twice yield of biofuel per acre of corn), low nutrient input crop that will reduce agricultural runoff into the Chesapeake Bay.**
- **Provide new opportunities for minority growers and entrepreneurs.**
- **Implement a decentralized processing system that will create good paying jobs in Delmarva.**
- **Address regional jetfuel markets not currently served by current biofuel production centers.**

- **Utilize Maryland developed crops, processing technology, and university agricultural expertise.**

6.

As the research progressed, these two additional goals were identified—and achieving these goals may be crucial to the success of achieving the original goals.

In reality—from a remediation perspective—it doesn't matter what the beets are eventually used for.

The important thing is that they grow, that they might take up legacy P; OR, in any case, they can be grown without adding P—and there may be markets for jetfuel—military or eventually commercial; or for ethanol for transportation fuel or as a precursor or biointermediate for renewable chemicals.

But I'd like to give you some background about this project, to give you some context.

7.

The crop chosen for this project was energy beets, derived from sugar beets.

A bit of background about sugar beets.

1. They grow in places like Minnesota, Northern Michigan, The Dakotas—cold and dry.
2. Because they are optimized for sucrose production to make table sugar, they have to be harvested in a short window where sucrose is at its best -- in the north about one month window;
3. Even if the sucrose optimization wasn't important, they have to be harvested before the fields freeze and making harvesting impossible.
4. And then they have to be stored and processed throughout the fall and winter. What they call "the campaign". Some storage is outside because

the mountains of beets can freeze through without spoiling. Some is in enormous storage facilities.

5. About 18% of the beet is sucrose; the rest is pulp that is used to feed cattle or sent to landfills.

8.

The difference between Sugar Beets and Energy Beets

1. They have been developed to be an energy feedstock, not to maximize sucrose for table sugar
2. They have been bred to use less nitrogen fertilizer (Plant Sensory Systems--ARPA-E grant)
3. To grow in moist, warm climates
4. They can be harvested from August to December on the Eastern Shore, negating the need for extensive storage facilities
5. When all the biomass of the pulp, in addition to the sucrose, is converted to ethanol, an acre of energy beets yields 2 ½ times as much ethanol as from the starch from an acre of corn—the kind of ethanol in gasoline today.
6. IMPORTANT: The beets grown in the UMES test plots had minimal nutrients applied when the field was being prepared. Otherwise no fertilizer was used, weeding was done manually, no pesticides applied. And these were the results.

9.

Some photos showing the planting of the 25 varieties, the size of the test plot

10.

What energy beets look like when growing.

Fields look very similar to the greens (collards, kale, etc.) that are traditionally grown in the region.

11.

Beets were planted in mid-April. First harvest was in mid-August where testing of sugar content, size, weight, etc. were made; and samples taken for continued testing in labs of conversion processes of beets to sugars with high protein residues; of sugars to ethanol or oil; and of the ethanol to jetfuel

Students at UMES played an important role in the harvesting.

Beets were developed by Plant Sensory Systems—directing the harvest and testing.

Testing was also done by Atlantic Biomass.

Samples were taken and Penn State was contacted to do testing related to P uptake.

12.

Examples of beets at harvest

One characteristic of beets is that they take up lots of phosphorus. They have very deep taproots.

Because the grew so well without any fertilizer, we wondered about the possibility that they were taking up legacy P from deep soils.

UMES has done extensive research on strategies to prevent P from draining into the Chesapeake Bay.

The theory is that from decades of use of poultry manure as fertilizer thoughout the Delmarva, that which is not used by the corn and soybeans that are the main crops grown, sinks into the ground. And the deep roots of the energy beets are able to access and use that Phosphorus

Details in a few minutes.

13.

One other advantage energy beets have over other advanced biofuels feedstock--and the reason the yield per acre compared to corn is so great: no lignin.

Lignin is what makes trees, grasses, corn stand up.

It is very hard to break down—think buildings and furniture.

Hard to commercialize what termites do to use the energy stored in that lignin for other purposes; so it is usually burned (think campfires; or power for refineries, paper mills, etc.).

Root crops have negligible lignin, so more of the biomass can be converted to sugars—more efficient use of land if the purpose is “cellulosic” or advanced biofuels.

14.

The key participants in the project:

Plant Sensory Systems: developed the beets

UMES: hosted the test plots; led team that applied for a large multi-year USDA CAP grant --did not get it; and could not fund further planting

Atlantic Biomass: developed the enzymatic biomass conversion technology (hemicellulose, cellulose, pectin to constituent sugars)

Purdue: has microbes that convert those sugars to ethanol

USDA: has microbes that convert those sugars to oils which could then be converted to jetfuel

Vertimass: Has process originally developed at Oak Ridge National Laboratory to convert alcohols to jetfuel and BTX

15.

The military is interested in renewable fuels so that they are not reliant for oil/fuel on people we might be fighting against or who could be in conflicts that hamper production. And for energy security reasons. They have conducted extensive tests over the past few years.

16.

Specifics about tests, actual use of biofuels by military.

2014 marked the first time the U.S. Navy is including biofuels in its annual procurement for bulk fuels.

Aviation and Marine fuel purchased beginning in 2015

17.

There's not just one way to make jetfuel. Many processes. All being extensively tested.

The one this project mainly looked at was alcohol to jet. But the sugars could also be converted to oils which might follow the other pathways to jetfuel. Drop-in necessary.

18-9.

Illustration of the testing process to get to ASTM approval needed to put renewable fuels into commercial market.

Continued pathway of testing to get to ASTM approval

Renewable fuels are currently blended into fuels for plants at LAX, Oslo airports; Luftansa, Alaska Air, Singapore Air, others have used them for demos; but fuel is too expensive, not competitive with low oil prices.

20.

Navy is closely watching the ASTM approval process for commercial aviation; but also has its own testing. Because it has different fuel—specially designed for Navy use on aircraft. AND they have their own solicitation which includes a price that they will pay for fuel which tries to anticipate future oil prices.

21.

Just a reminder of the original goals of the project

22.

Again, the key goals—of most importance to the nutrient management and trading.

Again: In reality—from a remediation perspective—it doesn't matter what the beets are eventually used for.

The important thing is that they grow, that they might take up legacy P; OR, in any case, they can be grown without adding P—and there may be markets for

jetfuel—military or eventually commercial; or for ethanol for transportation fuel or as a precursor or biointermediate for renewable chemicals.

23.

What they found out when they did the field and follow-up lab testing was that, looking at the 10 varieties that are most likely to be chosen to be grown in this area (throwing out the results from the "control" varieties and the ones that proved to be dead ends for these purposes), they can expect to get about 40 wet tons of energy beet per acre.

Converting those 40 tons of beets to ethanol yields over 1000 gallons of ethanol per acre;

Taking that ethanol and converting it to jetfuel (which means taking out the oxygen, so results in fewer gallons), you get 702 gallons per acre.

That same acre (40 tons of beets) takes up 3.46 lbs of P per ton or 139 lbs of P per acre.

When we communicated this to the team members and to stakeholders in informal settings, there was as much interest in the possibility of growing the beets as part a nutrient management best practice as there was in growing them for renewable fuel—maybe more.

I was interested because I thought it enhanced the sustainability reasons for growing them.

So, we decided that we needed to include this in the feasibility study as it seemed there should be a way to put a value on this.

I called many people and got in touch with Patricia Gleason who also put me in touch with Jeff Corbin.

24.

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25.

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27.

But figuring out a value is still hard, so I'm hoping that you will be able to help not only with figuring out a value (the study is published, but the work will go on) with this process; but also with a myriad of other questions that have arisen as we've thought about this. And to think about energy beets as an example of other crops to which this analysis might apply

One possible way to calculate some of the value would be avoided cost of fertilizer with about $24/acre a typical expense. The avoided cost of expensive infrastructure to mitigate runoff, such as building gypsum curtains or tile drainage management structures, might also factor into calculations of value. Another way to calculate value might be to multiply the 83 lbs/acre uptake by the value of P removed.

1. How to ***value*** potential Nutrient Management/Phosphorus Trading Credits—initial question raised during feasibility study.
    A. Certainly there was a P uptake benefit over other field crops (no fertilizer was added in test plots)
    B. How to measure that benefit?
    C. How to calculate that benefit?
    D. What are the markets?
    E. Is there "legacy" P in deep soil that energy beets take up? Does it matter?
2. Can annual agricultural crops participate in existing and developing nutrient management programs as non point sources?
3. For Delmarva project, since all fields in tidewater areas, would deliver ratio be 1:1?
4. Who would get the credits? Farmer? Landowner? Biofuel Producer? Shared?

28.

5. Could value of credits be calculated by comparing the cost of removing the same amount of P by making changes to wastewater treatment facilities or building new wastewater treatment infrastructure to manage runoff from new residential or business/industrial development?
6. In addition to illustrating this as income/acre, the table on next slide illustrates potential net margins in terms of pounds of P removed using the Virginia concept of perpetual credits. How realistic is the value of the potential credit?

29.

The data used to consider using a comparison to the cost to take P out at a water treatment facility.

Tetra Tech, "Cost Estimate of Phosphorus Removal at Wastewater Treatment Plants: A Technical Support Document prepared for Ohio Environmental Protection Agency," May 2013 Accessed 7/6/2017 https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwih5If97vLUAhWJbz4KHePkCXcQFggnMAA&url=http%3A%2F%2Fepa.ohio.gov%2FPortals%2F35%2Fwqs%2Fnutrient_tag%2FOhioTSDNutrientRemovalCostEstimate_05_06_13.pdf&usg=AFQjCNESR_welh3ECPfmPTPyGs_ytnVYmw

30.

***Policy-Issues and Nutrient Management Questions*:**

7. What policies exist regarding this type of valuation? Do any anticipate this type of annual crop nutrient remediation strategy?

8. Does the P have to leave the watershed? What if the P taken up by the beets locates in the co-product animal feed (poultry feed) that is used on the Delmarva?
9. What about crops like beets, grasses or coppiced poplar/willow that might be grown in landscapes to take up nutrients from runoff? How would they participate in a nutrient management credit trading program?

31.

Thanks for the opportunity.

Please contact me to continue the discussion or if you want to know more about advanced biofuels.