Symposium on Sustainable Feedstocks for Biofuels Production

The McKnight Foundation
Minneapolis, Minnesota
March 2-3, 2006

The McKnight Foundation
710 South Second Street, Suite 400
Minneapolis, MN 55401
T. 612-333-4220
F. 612-332-3833
www.mcknight.org

The Energy Foundation
1012 Torney Avenue #1
San Francisco, CA 94129
T. 415-561-6700
F. 415-561-6709
www.ef.org

Table of contents

Conference materials, and other information on biofuels and farm-based energy, are available online at www.ef.org/biofuels.

Meeting Summary

Symposium on Sustainable Feedstocks for Biofuels Production
The McKnight Foundation, Minneapolis, MN
March 2-3, 2006

Introduction

The Energy Foundation, in partnership with the McKnight Foundation, has launched a grants program to promote policies that encourage the move to advanced biofuels such as cellulosic ethanol. As part of this program, the Foundations worked with a steering committee of Minnesota sustainable agriculture advocates to host a symposium for the Upper Midwest on sustainable feedstocks for biofuels production, focusing on crop residues, prairie grasses and other crops, and woody crops.

The goal of the symposium was to explore attributes of a sustainable biofuels production system, and inform the development of sustainable cropping standards. It is timely to "set the bar" for raising crops in a manner that ensures long-term success by not depleting the landscape of its fertility and biodiversity, nor impacting rivers downstream. And lessons learned through conventional agriculture can be applied early-on in this new industry. Due to time constraints, the meeting did not address many related issues, such as conversion technologies, ownership and financing, and logistics. The symposium brought together about 35 researchers from universities, federal and state agriculture and natural resource agencies, along with advocates for wildlife, sustainable farming and forestry, and others.

This document is an abbreviated set of notes and observations that try to capture some of the highlights of the symposium. It is accompanied by a set of documents created by participants at the meeting. Together, we hope these serve as an abridged "proceedings" for the symposium. We encourage meeting participants (see attached list) and their colleagues to share this information broadly.

Symposium Structure

As shown in the attached agenda, the symposium started with presentations by regional experts on woody crops, agricultural residues, and herbaceous perennial crops. These presentations were followed by three breakout sessions, where participants discussed a series of topics related to the sustainability of the three feedstocks. (All materials are available at www.ef.org/biofuels.)

Later, the full group reassembled and compiled a set of "reflections" gleaned from their breakouts (and more ideas that emerged during this full-group discussion). Next, the group discussed policy ideas that could translate sustainable farming and forestry techniques into practice to supply biofuels production.

Symposium Highlights:

1. One feature of a sustainable biofuels supply system is that it helps **replicate a diverse landscape**. Diversity improves wildlife habitat, reduces the risk of crop disease and the consequent need for pesticides, and more closely mimics natural systems. A key question raised by this observation is the ability of biofuels refineries to handle a variety of biomass feedstocks at a single facility. It also has implications for feedstock supply and demand issues for both the biorefinery and the feedstock producers.

2. Another factor suggesting a diverse landscape is the need to **match crops to appropriate soil conditions and topography**. Native plants have adapted to specific types of landscapes, such as trees growing on riverside bottom lands and grasses growing in dryer uplands. Other biofuels crops may be suitable in some sites but not others – even on the same farm. Focusing on a single "best" plant for biofuels production may not be appropriate; instead, research on designed plantings, strip cropping, and other approaches that mimic natural systems needs to be done.

3. The **timing and frequency of harvest has the potential to either help or harm stands of perennial grasses and the quality of wildlife habitat**. Experts on the Conservation Reserve Program (CRP), for example, were concerned that if CRP land was used for biofuels production that the harvest should take place at times of the year that do not harm nesting birds or the ability to provide cover for over-wintering animals. In addition, issues with field access may limit possible harvest times, especially in Northern climates.

4. **Mixes of plants may provide better sustainability benefits than monocultures**. Research from South Dakota State University, presented at the symposium, suggested that grass polycultures were not only better for wildlife cover, soil retention, and resistance to disease, they also had higher and more stable yields than switchgrass-only plantings.

5. While corn stover is often identified as a near term cellulosic material that is available in large quantities, participants expressed concern that **aggressive removal of stover would risk damaging soil tilth and exacerbating erosion**. Questions were also raised about the economic and environmental considerations associated with one-pass or post-harvest collection of the stover. Winter cover crops such as annual rye grass were suggested as a way to ameliorate for the loss of cover provided by corn residues, though bird experts were concerned that such winter crops could be harvested at a sensitive time for nesting birds, causing a catastrophic loss of their reproductive efforts.

6. Some participants argued that nutrients should be collected after processing at biorefineries and returned to the land to **avoid depletion of soils that produce energy crops**, thus making a closed loop for bio-nutrients and limiting chemical fertilizer inputs. Others were concerned that this would require greater energy expenditures in moving the nutrients, that more passes on a field could increase soil compaction, and that weather conditions may not always allow for nutrient spreading.

7. **The opportunity of producing cellulosic ethanol from sustainable crops is not limited to the Midwest**. Supportive policies and stable markets are essential to assuring that production is not limited to a few select crops, so that farmers are incentivized to produce feedstocks that are appropriate to local weather and temperature regimes, soils, and topography. Diversity within farms and across landscapes is possible.

8. **Local opportunities described above will be driven by national and international policies** related to issues such as carbon credits, volatility of oil prices, and world trade limits on commodity crop subsidies. In addition, local and regional policies around pollution reduction, water quality (TMDLs) and other specific environmental concerns may also support biomass production. These drivers could accelerate the development of advanced biofuels more rapidly than conventional wisdom would anticipate.

9. **More integration between farm policy and energy policy is required** to shape this industry that also affects rural economic development and national security. Environmental policy will also need to be informed and related to these broader landscape policies to optimize the ecological value of production.

Conference materials, and other information on biofuels and farm-based energy, are available online at www.ef.org/biofuels.

Agenda

SUSTAINABLE FEEDSTOCKS FOR BIOFUELS PRODUCTION
The Energy Foundation and The McKnight Foundation
Minneapolis, MN
March 2-3, 2006

NOON, March 2: WORKING LUNCH

1) Welcome: *Peg Birk, McKnight Foundation; Eric Heitz, Energy Foundation*

   a. Introductions
   b. New cellulosic ethanol focus in Upper Midwest (MN, WI, IL, IA, ND, SD, NE)
   c. Feedstock Certification: *Jim Kleinschmit, Institute for Agriculture Trade Policy*

1:00

2) Meeting Objectives, Format, and Expected Outcomes:

   a. Scope and Purpose: *Ben Paulos, Energy Foundation*
      i. Main focus is from seed to processing facility
      ii. Share current research and help set future agenda
      iii. Inform Energy Foundation grant making

   b. What are defining attributes of a sustainable biofuels production system? *Gretchen Bonfert, McKnight Foundation*
      i. How can energy crop production mimic natural ecological systems?
      ii. What are the criteria for ecological success?
      iii. What are indicators of environmental progress?
      iv. What are lessons learned from conventional approaches?

1:30

3) Feedstock Experts

   a. Crop Residues*: Dennis Keeney, Institute for Agriculture and Trade Policy*
   b. Herbaceous Perennials: *Vance Owens, South Dakota State University*
   c. Woody Crops: *Dean Current, University of Minnesota*, Center for Integrated Natural Resources & Agricultural Management (CINRAM)

2:15 Break

2:30

4) Break-Out Groups to Identify Principles & Principals; Moderators
   a. Crop Residues *Jim Kleinschmit, Institute for Agriculture and Trade Policy*
   b. Herbaceous Perennials and other systems that provide continuous living cover *Loni Kemp, Minnesota Project*
   c. Woody Crops *Steve Morse, Green Lands/Blue Waters*

4:00

5) Findings of Break-Out Groups
    a. Crop Residues *Jim Kleinschmit, Institute for Agriculture and Trade Policy*
    b. Herbaceous Perennials and other systems that provide continuous living cover *Loni Kemp, Minnesota Project*
    c. Woody Crops *Steve Morse, Green Lands/Blue Waters*

5:00 Social Hour

6:00 – 7:00 DINNER

--- March 3, 2006 ---

7:45 Continental Breakfast

8:30

6) Reflections, Q&A from Break-Out Group Results
    Gretchen Bonfert, McKnight Foundation, with Moderators

9:30

7) Policy Implications *Eric Heitz, Energy Foundation*
    a. How to we bring about optimum bioenergy cropping systems?
    b. What kinds of policies or incentives?
    c. How to avoid policies that have negative or unsustainable consequences?
    d. To what other policy priorities could this work contribute?

10:30

8) Next Steps *Ben Paulos, Energy Foundation*
    a. Gaps in subject matter or expertise
    b. Brainstorm most useful format for meeting's output
    c. Ongoing discussion: Annual symposium? Journal? Online communication?
    d. Evaluation?

12:00

Boxed lunches available

Remarks by Gretchen Bonfert, McKnight Foundation

March 2, 2006

Those questions on the agenda are meant to underpin what I say, and be a point of reference for the break-out groups when they are underway later this afternoon.

What are defining attributes of a sustainable biofuels production system?

1) How can energy crop production mimic natural ecological systems?
2) What are the criteria for ecological success?
3) What are indicators of environmental progress?
4) What are lessons learned from conventional approaches?

By raising these questions, we are speculating that certain things are possible:

- We CAN design methods that mimics ecosystem processes,
- That doing so would yield benefit to the environment,
- And that we could quantify that benefit.
- And exploring this possibility of ecological success involves harnessing what we've learned through conventional ag to set some standards that would be influential when the industry is at a formative stage of development.

Depending on your point of view, that might seem exciting or impossible, or something in between. I offer that is very possible to envision such a biofuels feedstock production system.

What are defining attributes of an "environmentally beneficial biofuels supply system"?

i. That maximizes productivity. Crop productivity, soil productivity (implies soil retention), productivity of the receiving streams…

ii. Define productivity in volume and dollars, but also in benefiting environmental conditions, wildlife habitat and avoiding remediation costs.

iii. We have a responsibility and an opportunity, if we want to maximize success, to design a way that farmers can embrace viable changes in their practices that will be lucrative for them and beneficial to the environment.

iv. In order to do that, consider what have we learned from conventional ag production? What are implications of monocultures vs polycultures? For example, take one of our 3 focuses, that being perennials. Will we have to apply what we've learned from handling corn and soybean smuts, rusts, blights, and borers? I believe we're learning that mixed plantings of prairie grasses yield more biomass per unit acre than a single species planting. THAT is significant and likely offers other ecological benefits. And prairie restorationists know how to handle seeds with different properties and how harvesting methods address different plant heights.

Before you listen to our three panelists and go into the break-out groups, please pause for a moment to think about a time you've dissected a vexing problem, figured out what the pivotal factors were in its formation, then bemoaned "if only someone would have known how destructive that choice was going to be... or known how beneficial choosing the other path at the early pioneering stages would have been, everything would have turned out so differently." That's the kind of back-to-the-future opportunity we have today, to tap into your wisdom and create a better situation for farmers and the environment in 2015, 2025, and beyond.

I'll conclude that the defining attributes of a future system, that will address the questions on the agenda, are two:

1) Maximizes productivity: economics and ecosystem

2) Minimizing costs: on the farm and downstream, later.

That is our ideal, and with your help today and tomorrow, it will become a well-informed ideal to shape the advanced biofuels industry.

Policy Discussion

(This was a full group brainstorm on policy ideas to advance cellulosic ethanol.)

- National and international policies drive what happens locally
- Identify opportunities to influence state and federal policy priorities and expenditures
- Stark reality that this could accelerate much sooner than anticipated.
- Need to connect energy and farm benefits in policy

<u>Policies that Can Drive Research: State and Federal</u>

a. Homeland Security Funds as a source
b. How patenting and licensing of crops interplays with future plans
c. Single authoritative voice of NAS/NRC needed for this field
d. Benefit of aligning multiple states' R&D interests for more clout. Possible 2-day workshop in August with 8 states participating and Great Lakes Water Quality Initiative.
e. Research into policy formulation
f. Desire ability to document % increase in water quality
g. Three federal programs that includes economists and gauging results: Renewable Energy Assessment Program, 8 years with DOE effort of removing stover for biofuel with guidelines pending; ARS' Greenhouse Gas Reduction through agricultural Carbon enhancement (Gracenet); Conservation Effects Assessment Program parallels REAP.
h. Cooperative demonstrations involve fed, state, NGOs, private corporations.

1. Production Incentives:
   a. Regulation and mandates
   b. Incentives and guidelines; tax credits, renewable standards

2. Policies that would drive stable markets and risk mitigation
   a. Drive from consumer side – product labeling, marketing
   b. Besides $30b Farm Bill, DOE, Corps, Energy Policy Act
   c. WTO cotton decision-driven opportunities in research and conservation

FEDERAL

a) Federal Corporate Research Tax Credit (change to a subsidy?)
b) New incentives for managing woodlots for biofuel feedstocks
c) Mandate flex-fuel vehicles and increased efficiency from US manufacturers
   1) Provide more federal tax incentives for consumer's purchase
   2) Convert government fleets to flex-fueled vehicles (Sen. Obama's bill)
d) Commodity Credit Corp. payments for cellulosic ethanol plants (Wisc. doing)
e) Whether tradeable renewable energy credit as means of bundling env services (CSP a starting point)

f) Add $.05/bu for corn from no-till fields farmed sustainably.
g) Create CSP Tier structure in a renewable fuels standard w/ cellulosic as Tier III.
    1) Appropriate dollars within CSP for monitoring and research
    2) However, watershed scale of CSP too limiting because intended as nationwide entitlement
    3) Noteworthy: 11M acres, 280 watersheds to-date and NRCS' adapted to new operating methods and metrics for rewarding performance with enhanced payments
    4) CSP includes section as means toward achieving energy goals, unused to-date
    5) Biomass production incentives could readily be part of CSP; $50/acre credit for continuous cover
    6) Concern about REAL monitoring to gauge sustainability
    7) Contrasting suggestion to pay for biofuels as a commodity, with enhanced payments possible for better performance.
h) Incentive for floodplain revegation with woody crops. Esp. Lower Miss.
i) Need a trade group or a seat in the Renewable Fuels Assoc. to be a player every day in DC
j) Weigh in on harvesting CRP acres for biofuels. Thinning during contracts possible now. Annual rental rate increased in LA and MS. Improve existing programs.
k) 15% biofuels by 2015 as a Renewable Energy Standard with continuous living cover
l) National Research Initiative, CSREES, National Association of State and Land Grant Universities and Colleges.

STATE:

a) Minnesota bill pending: new incentives for biomass feedstocks due to pressure for coal conversion
b) NE states capping carbon on power (electricity) sector
c) Some interest in a carbon content in fuels standard in CA, first cutting out tar sands from Canada
d) Reinvest in Minnesota (RIM, like CRP, funded for 20 years) could tweak as laboratory for harvesting and related approaches;
e) Flood Reduction Grants in Minnesota – opening for revegating floodplains with trees.
f) Supplemental Environmental Projects funded by fines on corporate violations. Add pioneering biomass efforts to list of eligible projects.
g) Seed a revolving loan fund with public resources to foster industry. Example from Minnesota Dept. of Agriculture
h) Statewide voluntary guidelines/bmp's for sustainable removal and production of biomass from all sources – linked to payments? Some binding to quality for favorable purchasing rates and incentives.
i) Property Tax Credits and rebate could be directed toward units of local government for expenditure in support of renewable fuels standard.
j) Automotive policies with a higher bar for flex-fuel & plug-in incentives
k) State adoption of federal bio-based product procurement rules (tested at Iowa State)
l) State cost-share as a conditional basis of eligibility of federal cost-share (Wisc. doing)

m) U of M Ag Exp. Station past role in establishing corn, wheat, barley, etc., could occur in coordination with plant breeders et. al. (pre-dates statehood first as education, then research).
n) National Academy of Sciences panel study contrasting demand with lack of development capacity (case made by Green Lands, Blue Waters to the American Association for the Advancement of Science)
o) General revenue for Sustainable Biomass Development fund @ $50K per year to support cross-sector learning groups would address local diversity
p) Iowa 1990 $3m per year from utility consumers.
q) Increase state gas tax on imported petroleum and shift payments to advanced biofuels (CA 25% petroleum reduction goal raising $4b on severance fee on oil and gas extraction);
r) Ag Exp Station small scale demonstration and prototypes.

Reflections on the Breakout Sessions

(This was a full group brainstorm reflecting on the breakout sessions.)

- There is no silver bullet; supportive policies & stable markets are essential.

- Local variability of solutions (opposite of commodity model; responding to microclimate, soils, markets, yields ultimate sustainability).

- The key to cellulosic ethanol is that its feedstocks are non-corn-kernels and available nationwide, not just in "corn country."

- Research gaps in all categories: residue, perennials, woody. (some potential institutional challenges re: academic)

Ecologic Factors:

1. Multi-functional: btu's, volume, env services (water quality improvement, evapotranspiration of water, more pervious landscape, temporary flood storage, carbon sequestration, other greenhouse gases, wildlife habitat).
2. Rotation/Diversity
3. Placement on Landscape, matching plantings to contours and hydrologic conditions instead of all-over. Match plants to soils to maximize productivity
4. Minimizing Tillage frequency and intensity.
5. Long-term Soil Quality, especially carbon (Ca, Mg could be limiting)
6. Nutrient Balance – sustainability of levels under different crops (not mining).

Economic Issues

1. Ownership Models (holding land, plant materials, field equipment, processing facility, waste streams in a closed loop?)
    a. Demonstration of feasibility of facility, how build toward it.
2. Risk Mitigation for Producers:
    a. competition for feedstocks in multiple markets, plus food vs. fuel; forest products industry demand vs. fuel (WI, MN, MI). Fueling forest products industry with biofuels logical, given aging infrastructure.
    b. choice of materials to produce
    c. No "safety net" for new crops; long time horizon of risk and for generating a return, with woody and perennials. Contract for env services could be lucrative in the interim period. Interplant faster (cottonwood) and slower growing (oak) trees for phased harvesting.
    d. Access to capital and demographic changes.
    e. Rental of absentee-owned land on annual basis, not multi-year.
    f. Incentives for adoption of new methods and crops
    g. NOTE: technology risk and market-risk a double whammy.
3. Infrastructure (machinery, transportation, storage)
4. Rewarding outputs of enviro services (#5 above)

5. Issues of scale influential in economics, technology, radius of suppliers.
    a. Road infrastructure and traffic, axle loads of large facilities vs. current scale of ethanol plants in MN.
    b. Community-level biofuel facilities possible.

Technology Issues That Influence Refinery Viability and Landscape Diversity

1. Flexibility of the materials handling/sorting/processing into various streams and enzymatic conversion process to enable diverse feedstocks.
2. State of knowledge of breadth of enzymatic action, choices
3. Local processors with flexibility of choice (e.g., change waste streams)
4. Scaling of storage capacity of facility vs. seasonal harvest or phased year-long
5. Diversity of raw feedstocks yields the same ethanol.
6. Water volume used in refining could be limiting in Great Plains, at a minimum.
7. Economics driving ethanol plants to biomass as fuel instead of natural gas in fluidized-bed boilers. May be pre-cursor to cellulosic ethanol.
8. Research on comprehensive green technologies that address life cycle from cultivation to emissions.
9. Needs on production and harvesting equipment and know-how. Large custom operators for planting and harvesting could cover a lot of ground.
10. Embrace cross-expertise dialogue “from seed to speed,” from producers through the technology experts. At national/regional scale and at local scale.
11. Need metrics and methods for better quantifying enviro services.

Notes from Break-out Group Sessions: Herbaceous Perennials

Factors For Herbaceous Perennials	Lessons learned from conventional production	Mono vs Polyculture	Seed Sources	Planting & Harvesting Methods
Landscape Considerations • Diversity tolerance(low-lying to steep) • Soil quality requirement (marginal to prime) • Placement, design and cropping system	There are many different planting designs that should be considered. "Think outside the box" when considering farmscape design. - The energy production system must be localized so that nutrients, such as ash from biomass production, can be brought back to the farm to replenish N,P and K. Otherwise not sustainable. - Livestock must also be considered when designing the farmscape – for grazing, forage production, and consumption of ethanol byproducts.	Diversity at the landscape level might be in field rotations, intercropping, or mixed plantings. Diversity at a landscape level may be expressed over a number of years. Even annuals, planted in sequence to maximize soil cover, should be considered. Monoculture switchgrass –or anything else - is probably not sustainable.	Choices will be locally specific. Some biomass feedstocks are widely available now, others will need to gear up seed production, creating new economic opportunities.	Crops should be planted in a way that maximizes soil cover throughout the year. Choices for planting and harvesting will be locally specific. May need farmer coops to manage the region. Grasses may be able to wait for spring harvest – leaving soil covered most of year.
Productivity • Maximizing biomass production • Soil tilth and retention	- There are no silver bullet options for biomass, switchgrass is not the only option. Dozens of biomass crops are possible. - Optimize multiple benefits (energy and environment). - Optimize multiple revenue streams (energy, other products, and green payments.) - Highest yields are not necessarily the ultimate goal in farm systems, if they are to include multiple products. It is important to integrate multiple end-products and ecosystem services on the farm. Productivity does not equal profit.	In the long run we want a lot of diversity in biomass products to maximize productivity without compromising sustainability.	Seeds can also be harvested as an extra source of income for farmers.	When is the best time to harvest? This will be locally specific. <u>Shared equipment (co-op model) or a contractor working numerous tracts in a region are possible alternatives.</u>
Input Considerations Water/irrigation Nutrients	<u>Water</u> – select crops appropriate to natural rainfall. <u>Nutrients</u> - There is a great need for nutrient cycling to maintain	Annual crops should be rotated.		The less tillage the better, this will help maintain soil tilth. A

Energy Crop protection Machinery Labor	sustainability; we cannot deplete P, K and N from the soil. Fortunately, the process of biomass energy production does not destroy the nutrients; could be done locally so that nutrients can return to the land in the form of the ash products from biomass production. The system must be closed or it will not be sustainable. Animals will play an important role in perennial systems, by helping to maintain the soil nutrient balance. Energy – Carbon is sequestered in soil at new levels with perennials and rotations. Question: does even slight tillage take it back to original carbon level? Biomass crops will take less input energy – less tillage, fertilizer, chemicals, etc. Crop protection – diversity decrease pests and diseases. Labor – not sure. Use of perennials implies there is nothing to do but harvest. Others say establishment and plant diversity require complex farm management.			dormant cover is ok and will help reduce soil erosion during the dormant season.
Biodiversity Wildlife habitat population and diversity Plant communities population and diversity	Biodiversity will create more wildlife and more sustainability. Diversity may not be at one time in one field, but result over the landscape and over time with rotations. Having more choices of crops may facilitate more farmers changing to energy crops. -The dream to mimic a natural prairie is not the only option because native plants are not always the best option. The solution will be site specific.	Biodiversity may reduce disease and pest problems in a perennial system.	More research needed on native and non-native species.	Harvest timing should be designed to maximize wildlife diversity.

Other issues for **Herbaceous Perennials**				
Transitions for farmers	Are farmers going to have the time and knowledge to manage complex prairie-like systems?			Let's identify the easier transition options first – what farmers already have skills, equipment, and enthusiasm for. Due to the similarity in equipment, changing to prairie grasses would be easier for those currently farming small grains than for those growing hay.
Economics	The biomass system could mimic the successful petroleum industry by creating multiple revenue streams from biomass produced on the farm.		Seeds, especially for mixed prairie grasses may be expensive. This may also create new economic opportunities for farmers to produce this seed.	

Notes from Break-out Group Sessions: Woody Crops

Factors For **WOODY CROPS**	**Lessons learned from conventional production**	**Mono vs Polyculture**	**Seed Sources**	**Planting & Harvesting Methods**
Landscape Considerations • Diversity tolerance(low-lying to steep) • Soil quality requirement (marginal to prime) • Placement, design and cropping system	Appropriate soil characteristics for crops (i.e. willows traditionally in low lands/low areas); Hardwood species; Flood tolerance and land drainage (restoring natural hydrology); Temporal perspective (31 million acres forest prior to settlement by people of Euro descent – lost 15 million to ag) what is role of biofuels production in landscape restoration – woody crops can play role in landscape restoration; Invasiveness/true hybrids (i.e. hybrids don't produce viable seed); Soil quality requirements – productivity considerations; very difficult to get enough landowners within limited area to make it economically viable, combining multiple sources of biomass will maximize returns; look at where's it has been done already; not just one place or product in biomass production; ecological credits to increase economic benefits to woody crop producers - make sure we identify potential revenue streams and build those; 20,000 acres supports a plant; regulatory licensing; certain crops best suited for specific areas (place switchgrass in cattle country)	Global climate change is key consideration to what gets done;	Genetic diversity and seed source location very important; woody biomass isn't as restricted to weather conditions; do we have capacity available – nurseries for seeds, etc.; open source – ensure open source intellectual property on seeds, needs to be certified and market standards	Hybrid poplar planting/cottonwood plantings have bare ground 3 years, special consideration during establishment i.e. timothy to reduce erosion, plant on level ground
Productivity Maximizing biomass production	Optimize for multiple benefits instead of maximize productivity; multiple markets to maximize	Hybrid poplar is being planted because we know most about it – we need	Seed source	Soils – not al soils are equal, focus on appropriate soils to

Soil tilth and retention	economic benefits – if there is good pulp and biofuel markets, best of both worlds	more information and research; different species grow at different rates – multiple age stands; risk versus return over long period of time – diversity is more important in long-term crops such as woody crops; not a consensus on total production; to get meaningful production per ton, there are limited species that provide this		reduce negative effects; public policy perspective – identify which soil types should be targeted first and prioritized
Input Considerations Water/irrigation Nutrients Energy Crop protection Machinery Labor	Many woody crops require much less chemical inputs; Consider long-term impacts – full cost accounting; 1 cord of cottonwood will produce 95 gallons of ethanol; multiple uses from products	Mixing – diversity on landscape or diversity on plots? Site issue – mix of natural diverse systems have very little input; planting poplars still have diversity in monoculture planting; Establishment and harvesting have low inputs as monoculture – multiple species require greater inputs; but the reason why we're here is because traditional practices such as monocultures have ecological costs		Do we have reliable equipment for harvesting woody crops? Small willow, grass willow, woody shrub harvesting equipment available, timber jack harvester – but expensive not farmer but co-op? Yes, equipment may be available but very costly, shearing operations, chipping on-site; do we have reliable labor for harvesting?
Biodiversity • Wildlife habitat population and diversity • Plant communities population and diversity	Native wildlife mixes – potentially less biomass, but other benefits, some care needed to not increase just deer habitat; because poplar and other crops don't have market returns for 10 years, look t increasing wildlife benefits, which may provide payments for these benefits in the short term;	some care needed with mixing - harvesting and competition concern; Focus on places that you will enhance biodiversity rather than adversely impacting it (i.e. don't put poplar on brushland for Laurentian Energy issue in northern MN); More research needed; different		

Other issues for **WOODY CROPS**	
	What are the markets and policy considerations that will help drive adoption of woody crop adoption?
OUTPUTS	recreation, water quality, aesthetics, increases value of land, flood reduction or flood management benefits, soil conservation, site planning important in maximizes environmental benefits; need to quantify environmental benefits – most haven't been accounted for; carbon sequestration; bioremediation; regulatory restrictions on discharging to impaired waters – mitigation; neotropical birds
	It's economic – must pay producers fair price for Need to look at joint production – better forest management on existing forest land with energy as secondary market Too few species we're working with, we haven't done enough research on other species

Notes from Break-out Group Sessions: Crop Residues

Factors For **CROP RESIDUES** *[Focus on corn stover]*	Lessons learned from conventional production	Mono vs Polyculture	Seed source / Genetics	Planting, Harvesting and Tilling Methods
Landscape Considerations • Diversity tolerance(low-lying to steep) • Soil quality requirement (marginal to prime) • Placement, design and cropping system	Site selection is critical. Don't harvest stover on steep slopes! (Highly erodible land (HEL)) Don't encourage using CRP land for corn production. Do we reinforce corn-bean supply system by using stover?	Rotation of corn results in polyculture over time. Does rotation facilitate more corn stover removal? Does stover removal require nutrient replacement with other materials? 3.3 tons per acre of biomass has to be returned to protect soil health (Larson, '70s research) Rotation with winter crops provides seasonal cover, reduce erosion, retain nutrients. Works better in warmer climates.	Do we want more lignin-rich or cellulose-rich crops to maximize energy production, depending on processing and end product? How does this affect soil health?	Does removal of stover encourage no-till? Does no-till encourage removal of stover (stover can build up over time with no-till.) More lignin reduces cellulosic breakdown but increases BTU content for burning.
Productivity Maximizing biomass production Soil tilth and retention	Silage cutting could reduce impacts compared to conventional crop production		Applying genetics to increase volume and usefulness of crop residues. (Also being applied for conventional biofuels production.)	Harvesting methods will affect sustainability (compaction, frequency, timing, fuel use – one pass harvest has lower impacts)
Input Considerations Water/irrigation Nutrients Energy Crop protection Machinery & Capital Labor & management	Use of crop residue for heat input to ethanol production (e.g. corn stover at Chippewa Valley Ethanol)	Continuous corn would be highly input intensive (fertilizers, chemicals) but reduces machinery and labor needs. Polyculture reduces chemical inputs but increases labor and machinery needs.	Genetics could affect most input considerations, e.g. increase carbon retention in roots?	Well managed manure as a nutrient source improves sustainability. Removal of stover requires replacement of nutrients somehow. Harvesting stover may

				affect need for irrigation.
Biodiversity Wildlife habitat population and diversity Plant communities population and diversity	No-till leaves more cover for wildlife.	Will rotation result in more habitat?	Genetic modification could create more diversity of corn varieties? Or would GM corn add to 'genetic pollution' of native varieties?	Is there much bird nesting in stover? How will stover removal affect biota in soil?

Other issues for **CROP RESIDUES**	
Transition issues	Is use of corn stover transitional? Corn stover may always be part of mix, since there will always be demand for corn, even after move to cellulosic ethanol
Influence of markets on crop choice	Stable market for cellulosic ethanol could create market for greater variety of crops. (Depends on process: gasification more flexible than enzymatic.)
Policy issues	Policy drives the economics, which drives crop decisions. Need guidelines to control stover harvest practices. Verification is very difficult. Would rotational system requirement make up for nutrient loss from stover removal?

Breakout group participants:

Jim Kleinschmit
Jane Johnson
Susan Heathecoate
Ray Kirsch
Dennis Keeney

Mark Lindquist
Dick Hemmingsen
Ben Paulos
Ron Kroese
John Baker

Participants List

Name	Affiliation	Email	Breakout Session
Don Arnosti	Institute for Agriculture and Trade Policy	darnosti@iatp.org	Woody crops
Michael Russelle	USDA - Agricultural Research Service, U of MN	russelle@soils.umn.edu	Crop residues
John Baker	USDA - Agricultural Research Service St. Paul, MN	jbaker@umn.edu	Crop residues
Gretchen Bonfert	McKnight Foundation	gbonfert@mcknight.org	Perennial herbaceous crops
George Boody	Land Stewardship Project	gboody@landstewardshipproject.org	Perennial herbaceous crops
Dean Current	U of MN, Program Manager, Center for Integrated Natural Resources & Agricultural Management	curre002@umn.edu	Woody crops
Robert Elde	U of MN, College of Biological Sciences, Initiative for Renewable Energy and the Environment	elde@umn.edu	
John Hall	Michael Fields Agricultural Institute	jhall@MichaelFieldsAgInst.org	Perennial herbaceous crops
Kurt Haroldson	MN Department of Natural Resources	Kurt.haroldson@dnr.state.mn.us	Perennial herbaceous crops
Susan Heathecoate	Iowa Environmental Council	Heathcote@earthweshare.org	Crop residues
Eric Heitz	Energy Foundation	eric@ef.org	
Dick Hemmingsen	Initiative for Renewable Energy and the Environment	hemmings@umn.edu	
Bridget Holcomb	Michael Fields Agricultural Institute	mkrome@inxpress.net	
Jack Huggins	The Nature Conservancy, Illinois	jhuggins@tnc.org	Woody Crops
Jane Johnson	USDA- Agricultural Research Service, Northern Plains Soil Conservation Research Lab	jjohnson@morris.ars.usda.gov	Crop residues
Brendan Jordan	Great Plains Institute	BJordan@gpisd.net	Perennial herbaceous crops
Dennis Keeney	U of MN and Institute for Agriculture and Trade Policy	drkeeney@iastate.edu	Crop residues
Loni Kemp	Minnesota Project	lkemp@acegroup.cc	Perennial herbaceous crops
Ray Kirsch	Food Alliance	ray@foodalliance.org	Crop residues
Jim Kleinschmit	Institute for Agriculture and Trade Policy	JKleinschmit@iatp.org	Crop residues
Ron Kroese	The McKnight Foundation	rkroese@mcknight.org	
DoKyoung Lee	South Dakota State University	DoKyoung.Lee@sdstate.edu	Perennial herbaceous crops
Matthew Liebman	Iowa State University	mliebman@iastate.edu	
Mark Lindquist	Minnesota Project	mlindquist@mnproject.org	Perennial herbaceous crops
Linda Meschke	Blue Earth River Initiative	meschkel@berbi.org	Perennial herbaceous crops

Steve Morse	Green Lands, Blue Waters	morse033@umn.edu	Woody Crops
Michael Noble	Minnesotans for an Energy Efficient Economy	noble@me3.org	
Norman K. Olson	Biomass Energy Conversion Labs (BECON), Iowa Energy Center	nolson@iastate.edu	Crop residues
Vance Owens	South Dakota State University	Vance.Owens@sdstate.edu	Perennial herbaceous crops
Ben Paulos	Energy Foundation	ben@ef.org	Perennial herbaceous crops
Greg Russell	MN Department of Natural Resources, Resource Conservation and Development	greg.Russell@rcdnet.net	Woody crops
Philip Rutter	Badgersett Research Farm	woodyag@aol.com	Woody crops
Dean Schmidt	Minnesota Resource Conservation and Development Program	dean.schmidt@mn.usda.gov	Woody crops
Preston Schutt	Wisconsin Biorefining Development Initiative	preston.schutt@doa.state.wi.us	
Doug Van Thorre	Biorefining, Inc.	dvthorre@biorefining.com	
Pat Weber	Business Council for Sustainable Development	Creatfrsty@aol.com	Woody crops
Don Wyse	U of MN, Center for Integrated Natural Resources & Agricultural Management	wysex001@umn.edu	Perennial Herbaceous Crops
Dave Zumeta	U of MN, and Minnesota Forest Resources Council	dzumeta@tc.umn.edu	Woody Crops