

United States Department of Agriculture



**Summary Report of Stakeholder Responses to
USDA's Regional Biofuel Roadmap**

May 9, 2012

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Introduction

On June 23, 2010, the United States Department of Agriculture (USDA) published a strategic biofuels production report, "A USDA Regional Roadmap to Meeting the Biofuels Goals of the Renewable Fuels Standard (RFS) by 2022" (USDA's Roadmap). Subsequently, Secretary Vilsack directed the National Food and Agriculture Council (FAC) to obtain input from key bioenergy stakeholders throughout the country on USDA's Roadmap. During October and November 2010, the FAC conducted a series of workshops in 42 States and Puerto Rico and collected 57 reports of stakeholder answers to a common set of 16 questions. Stakeholder comments, as a whole, successfully broadened the view of the roadmap by providing additional information and insights. USDA stakeholders represented a wide variety of interests, including farmers, industry groups, industry executives, academia, and State FAC directors and staff. This report summarizes the results of the workshops, provides USDA responses to some but not all of the comments, and offers a perspective from a variety of USDA programs as a way for moving bioenergy forward.

Background and Methodology

USDA's Roadmap intended to (1) determine whether there was adequate capacity from agriculture and forestry to provide the feedstocks needed to achieve the next 21 billion gallons of advanced biofuel; (2) provide an estimate of the relative contributions and type of feedstocks different regions could provide; and (3) give an estimate of the financial investment required to stand up advanced biofuel refineries. The Roadmap provided one possible way to meet the RFS, assuming challenges such as capital, infrastructure, and blend wall issues would be resolved. USDA developed the roadmap using data from the 2007 NASS Census of Agriculture and assumptions developed by USDA experts from the Agricultural Research Service (ARS), U.S. Forest Service, Rural Development (RD), Farm Service Agency (FSA), and NRCS, and other industry and government experts. Energy crop yield estimates were based on eco-regional classifications and biophysical characteristics of feedstocks. USDA assumed current technology and yields and identified agricultural and forestry feedstocks to achieve RFS mandates. The USDA Roadmap addressed five classes of feedstocks: (1) energy cane (a high biomass form of sugar cane), (2) biomass sorghum (including sweet sorghum), oil crops (such as brassica seeds and soybeans), (3) perennial grass (such as switchgrass, miscanthus, Napier grass), (4) logging residues, and (5) crop residues (including corn stover and cereal straw).

USDA fits States into regions based on agronomic and forest management, and ecological landscape characteristics. States in regions used for USDA's Roadmap were based on the eco-geographic similarity that affects the kinds of feedstocks that can be grown there. This way Hawaii was counted among the Southeast States, Michigan and West Virginia were included in the Northeast region, and Minnesota, South Dakota, and Wisconsin were among the Central East region.

To collect a wide range of comments, the FAC developed a standard set of 16 questions to receive input, recommendations, and feedback to the Roadmap from local perspectives. The issues covered ranged from regional feedstock availability and production, sustainability, and public policies to address barriers and challenges to consumer expectations and regional consumer demand. USDA experts from the Forest Service (USFS), Rural Development (RD), Natural Resources Conservation Service (NRCS), Foreign Agricultural Service (FAS), National Agricultural Statistical Service (NASS), and Office of Energy Policy and New Uses (OEPNU), and Agricultural Marketing Service (AMS) analyzed over 200 pages of reports that compiled comments provided at the workshops. The task of the team was complicated by the diversity of the responses due to regional differences in the biofuel feedstocks. The intent of this

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summary is to provide an overview of the common themes across the Nation and those that were of specific concern for a State or a region. This report presents the summary of the analysis and describes a variety of USDA activities and programs that address stakeholder input. It consists of three main parts: (1) the executive summary of key stakeholder input, (2) the executive summaries of stakeholder responses to each of the questions from all the workshops, and (3) USDA renewable energy programs and activities. At the end of the report, the Appendix contains examples of USDA accomplishments that help accelerate the commercial establishment of advanced biofuel industries through USDA-supported programs and in-house expertise.

I. Executive Summary of Key Stakeholder Input

Key areas of common interest to all stakeholders included: (1) policy stability that can reduce investment risk, (2) market development through consumer education, (3) economic cost-benefit analysis economics, environment, and energy security of biofuels, (4) additional biomass resources for feedstock production, (5) the Conservation Reserve Program and marginal land, (6) additional work on cropping approaches, (7) diversification of biorefinery locations to reduce transportation and delivery costs, (8) greater recognition of woody biomass potential, and (9) competing uses for biomass from the combined heat and power sector.

- **Policy Stability.** Stakeholders encouraged a greater long-term commitment at the Congressional and Departmental levels to biofuel energy policy so that uncertainty and risks in steady private sector investment could be avoided. Stakeholders were also strongly in favor of complementary legislation and regulation policies, rather than apparent opposing policies. There is a need for clear policy direction, common definitions, and fewer conflicting programmatic and regulatory policies.
- **Market Development.** Increasing consumer awareness and understanding of the benefits from bioenergy can help create demand pull and new markets. Addressing some of the misinformation regarding food and biofuel conflicts would benefit market development.
- **Complete Economic Analysis.** A cost-benefit study for biofuels focusing on energy security, environment, and economic development should be conducted. This analysis would facilitate further development of bioenergy.
- **Additional Biomass Resources.** Biomass for feedstock production can include sugar beets, industrial sweet potato, agricultural and industrial waste, fish waste, algae, municipal solid waste, agricultural waste from Tribal Lands, and other dedicated energy crops not included in the roadmap (e.g., guayule, and jojoba).
- **Conservation Reserve Program (CRP).** Stakeholders expressed that not all CRP acreage is enrolled as non-productive or marginal lands. For productive lands: while there remains a strong commitment in preserving key conservation and wildlife goals of the CRP, there is room for allowing for penalty-free sustainable harvesting of energy biomass on a more than periodic basis.
- **Cropping Approaches.** Stakeholders urged more analysis on double cropping, intercropping, reserve cropping, and reclaimed land cropping opportunities.

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- Local Energy. Bioenergy policies should include a higher number of regionally-tailored approaches and receive federal attention that involves all of America and avoid energy markets dominated by single regions. Examples provided included smaller biorefinery facilities that could reduce the transportation distances of feedstocks and fuels to reduce transportation and delivery costs.
- Wood. Stakeholders from major forestry regions of the country believed that a greater recognition of the role of both existing and new woody resources is merited. Interest was strong in ensuring that wood residues are sustainably harvested, and that potential disruption of existing markets be considered. Purpose-grown wood could also be a major contributor in some regions, and significant potential exists for use of wood from forest health and fuel reduction treatments for energy purposes.
- Biomass for heat and power. Many stakeholders expressed support for a greater acknowledgement of solid biomass in replacing or displacing fossil fuels for heat and power. This creates additional and possibly competing demand for biomass.

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II. Summary of Stakeholder Responses, Questions 1-16, and Additional Comments.

Summary of Stakeholder Responses to Question 1:

Are there potential sources of feedstock that USDA did not identify in this report that locally could contribute to expanded biofuels production?

Most of the comments pointed to six major categories of additional feedstock resources: (1) woody biomass, (2) dedicated energy crops, (3) agricultural and industrial waste, (4) algae, (5) municipal solid waste, and (6) use of fallow and CRP lands for dedicated energy crops. Several additional comments addressed the need for a better renewable biomass definition.

1. Woody Biomass (33 comments) – Although the USDA Roadmap took woody biomass into consideration, the large number of comments emphasized this feedstock as a top priority.
 - Northwest, Western, and Southeast regions (26 comments) identified this feedstock as one of the top sources of biomass feedstock for their region.
 - The additional sources of woody biomass that USDA may not have considered included non-merchantable wood growing in western forests, pulp waste from paper mills, and orchard and vineyard woodstock.
 - Many of the same stakeholders also added the fact that there could be a demand for biomass for electric power generation depending on how markets and regulations develop.
2. Dedicated Energy Crops (26 comments) – Although the USDA Roadmap considered energy crops, other potential sources were suggested.
 - The Southeast region (12 comments) included dedicated energy crops such as sugar beets, industrial sweet potato, sweet sorghum, and energy cane.
 - In the Western region (seven comments) other dedicated crops were cited, including guayule and jojoba. This could include oilseed crops such as canola and camelina that can be grown on dry lands as a rotation crop or on land unsuitable for other crops.
3. Agricultural and Industrial Waste (21 comments)
 - Waste vegetable oil and used cooking oil for biodiesel production were supported in Southeast, Northwest, and Central East region (12 comments)
 - Cellulosic waste such as corn stover, rice straw, and switchgrass were supported in the Central East region (four comments)
 - Animal waste to energy received the remaining three comments from the Western and Southeast regions
4. Algae (16 comments) – Southeast and Western regions supported this feedstock.
5. Municipal Solid Waste (MSW) (14 comments) – the Western region cited this more frequently than other regions (six comments), but every region had at least one comment in support of MSW as a biofuel feedstock.
6. CRP and Fallow Land (10 comments) – Southeast and Central East regions equally supported rotating regular crops with or using fallow land for energy crops and ability to use CRP land. More research on cropping practices is needed – double cropping, intercropping, reserve cropping and reclaimed land cropping.

The remaining six comments included other feedstock sources such as fish waste, desert growth, and MSW and forest waste from Tribal Lands.

**Summary of Stakeholder Responses to Question 2:
Do you feel USDA's feedstock assumptions and/or limitations are accurate?
Is there information the report missed that could provide more accurate estimates?**

Stakeholders believed USDA Roadmap feedstock assumptions were too conservative. In addition, many chose to answer this question by stating that if there was long-term market potential and demand pull for renewable biomass, the supply would be more than adequate. Operational details such as the location and size of biorefineries was another important factor to consider in making feedstock projections. Some stakeholders also provided additional sources of information for feedstock opportunity assessment.

1. Feedstock Assumptions Too Conservative

- The majority of comments reflected the opinion that USDA was too conservative regarding the availability of feedstock potential, especially for the Western region.
 - Alaska is developing a model for managing interior Boreal forests for the sustainable production of woody biomass.
- Feedstocks excluded by the report included algae (especially Western and Southeast regions), logging residue and other woody biomass, and municipal waste. Some specific examples of different feedstock assumptions included:
 - Santa Cruz County, CA: about 28 million gallons of green-gasoline could be produced and consumed in the County from about 285,000 tons of woody biomass collected from this urban but heavily wooded county.
- Other potential feedstocks included: sugar cane, sweet sorghum, sugar beets, waste wood biomass, agricultural waste, manure, switchgrass, and local CA native plants such as guayule (pronounced *why-YOU-lee*).
- Marginal land can be used for feedstock production, but access to enough contiguous marginal and/or CRP land presents a logistical challenge.

2. Biomass Supply

- Biomass availability will grow as the end use market develops. Market potential exists for more growth in supply as the market demand develops.
- Market information such as relative prices, long-term commitment, land value impact as a result of biofuel production, and general market information is needed for farmers to switch growing traditional crops to energy dedicated crops.
- Several stakeholder recommendations included the development of a biomass market with information regarding prices and cost of production.
- Competing uses of biomass – power (including exports of wood pellets), fuels, and bioplastics and polymers may pose a challenge.

3. Suggested Operational Details

- The size of biorefineries will depend on the location because some feedstocks are more conducive to smaller operations—less than 7 million gallons per year (mgy) for some woody biomass feedstocks. Economies of scale, however, could be better realized for higher volume biorefineries (more than 40 mgy).

4. Other Sources of Information

- “Regional Strategy for Biobased Products in the Mississippi Delta”
<http://agbioworks.org/regional.cfm>
- Environmental Issues:
<http://www.chesbay.state.va.us/Publications/biofuels%20report%20v3.corrected.pdf>
<http://www.pinchot.org/news/297>
<http://www.pinchot.org/uploads/download?fileId=677>

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Summary of Stakeholder Responses to Question 3:

Are there ways to harness current local infrastructure not considered in the report?

Most of the comments on harnessing local infrastructure included recommendations and comments regarding region-specific market issues, distribution infrastructure, land availability, and opportunities for improvement.

Distribution Infrastructure:

- Encourage the use of existing local infrastructure for distribution of feedstocks and fuel by local communities
- Increase the use of trucks supplying rural fuel terminals to backhaul ethanol from biorefineries to blending terminals; can improve distribution efficiency and road capacity
- Use of shortline railroads role will be important for small biorefineries
- Take advantage of carbon dioxide (CO₂) pipelines that go from Southeast Colorado to West Texas, which could be used to move CO₂ captured from biorefineries
- Consider the feasibility of pipelines for some biorefineries (as in Tampa-Orlando, FL)
- Due to potential cost and equipment needs for transporting biomass feedstock, mobile refineries or a network of smaller scale facilities could be feasible depending on the scale of available resources.

Land:

- Many arable acres exist within the current agricultural land base for energy dedicated biomass feedstocks. (Comments did not specify whether the land is range or pasture.) Numerous industrial sites are available with potential for conversion facilities.

Recommendations for Market Development:

- Create incentives for regional energy companies to enter into discussions with biomass conversion operators, e.g. synthetic biofuels (converting coal with woody biomass into transportation fuel)
- Expand tribal community involvement
- Consider increasing production of biodiesel from waste vegetable oil, fish waste (Alaska)
- Educate farmers through central BCAP and biomass program specialists
- Clarify government programs for landowners and farmers and assist in reaching end use consumers
- Role of farmer cooperatives – build on existing relationships of a committed group of local producers who supply one feedstock and can mobilize additional suppliers and the use of infrastructure
- Encourage location near markets for co-products (e.g. distillers grains marketed to local dairy cattle operations)
- Analyze the impact of the competition for biomass use for heat and power generation

Opportunities for Improvement:

- Expand/improve water and sewage infrastructure
- In some locations, recycled water after industrial use can be used to produce non-food bioenergy crops.

Summary of Stakeholder Responses to Question 4:

What are your views of the estimated land use needed in your area for biofuels?

The comments responding to this question had a few main common themes and some region-specific differences. The majority of the viewpoints expressed that limiting disruptions in food channels, providing incentives that make economic sense for future biofuel producers and careful logistical planning of future plant and storage locations will all play critical roles in future agricultural lands meeting the advanced biofuel mandate in all regions of the country. Over half of the responses (34) came from two regions, the Southeast and Western regions. Specifically, seventeen came from the western region where demand for meeting the advanced biofuel mandate is minimal.

Common Findings:

- Conservation Reserve Program contracts must have more flexibility and can be part of the overall land use plan.
- Shifting land out of long-term agricultural enterprises will require demonstrated market profitability.
- Disruptions in the food chain if cropland that is normally used to produce food crops is perceived to transition into dedicated energy crops.
- Biorefinery and biomass storage locations should be convenient to any land dedicated to energy crops.
- Land use restrictions under the RFS guidelines potentially limit the quantity of land available for biofuel feedstock production.

Regional Differences:

- Southeast: Longer growing days and the number of non-food available acres give the region a competitive advantage in producing non-corn-starch advanced biofuels. This is especially true in Florida. Feedstock production locations being near future biorefineries and abandoned acreage in the Western rice belt of Texas were among items of discussion in the Southeast.
- Northeast: Cropland is available in States like New Hampshire; however, a lot of land is forested and already suitable for managed biomass production. Lakes and ponds in the region have great potential for producing algae feedstock and reclaimed strip mine land in West Virginia and other mining States could also be used for switch grass or reed grass production. Oilseed production in rotation with grains and grasses are land use goals in Vermont. New Hampshire respondents felt regional and federal policy should align so that the best use of available land resources is made.
- Central East and Northwest: Crop residue is a plentiful resource and would be a good source of cellulosic ethanol. These regions cited residue management as becoming more important. Technological advances in seed have increased agricultural land productivity and dual-purpose crops grown in Montana, Washington, Idaho and North Dakota like barley are examples where producers could harvest both straw and grain. Fallow ground is another consideration when determining land use plans in the Northwest region.
- Western region: The most abundant resource is timber and woody biomass and recommendations for land use planning should take these into account. Much of these resources are housed in public or Federal lands and are not eligible under the RFS guidelines, and stakeholders suggest this policy should be changed. A reintroduction of sugar beets in California (CA) was provided as a viable option to expand acreage and meet the 2022 goal. Generally, responses in CA discouraged the conversion of food producing agricultural land to biofuel feedstock production.

Policy Constraints: Many respondents who specifically mentioned whether they agreed or disagreed with USDA's estimated land use estimates did agree with those data provided in the USDA road map. For

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those in disagreement, a common thought was that available production area may be underestimated due to land use restrictions written into the RFS policy. For example, the possible exclusion of residues from existing tree plantations and intercropped, coppiced, short rotation woody biomass with saw logs was provided by Colorado.

Summary of Stakeholder Responses to Question 5:

How can the State or Federal government agencies partner with the private sector to expand the demand for biofuels?

Would such a plan push the private sector to meet the increased supply needs?

Three main ideas were echoed by the majority the stakeholders responding to this question: consistency in government policy and programs, reduction in feedstock and production costs, and educational advocacy.

Consistency in Government Policy and Programs: Stability and consistency in Federal and State policies will help create the environment for investments to develop new fuel products that need to be here for more than 10 years.

- Partnership between the public sector and private sector via mandates: require high volume fuel suppliers to comply with the mandates.
- Mandate auto manufacturers to produce a higher percentage of alternative fuel vehicles.
- Renew all State and federal tax credits for long-term stability and to encourage further investment.
- Government policy should continue to support the development of biofuels as a priority.
- Expanding the definition of eligible land would encourage private sector to make investments to meet the increased feedstock supply needs.
- Blender pump goal is important.

Lower Feedstock and Production Costs: Economic viability of the sector depends on lower costs.

- Increase percentage of loan guarantees for renewable energy projects;
- Provide funding for R&D and pilot projects
- More federal funding for research development infrastructure and deployment of conversion technology
- Develop infrastructure for easy access to biofuels.
- Need champions to set an example: commit to using biofuels in the government and other organizations' vehicle fleets.

Educational Advocacy: Evidence suggests the general public doesn't recognize the positive environmental economic and energy security advantages of biofuels.

- The importance of educating the consumer about the benefits of biofuels was stressed in almost every meeting.
- A nationwide program to educate the public about the availability and benefits of biofuels can assist with increasing demand for biofuels.
- Government agencies can develop biofuel checklists for consumer education

Summary of Stakeholder Responses to Question 6:

What can the government do to help expedite infrastructure improvement in the private sector?

The repeating themes in the majority of the responses to this question included the need for the government to help provide long-term stability by enforcing RFS levels, encourage growth in demand, and provide leadership in consumer education and biofuel consumption. The most recurring comments are summarized below by the main theme below.

1. Long-term Stability:

- Fund more pilot efforts to expand commercial production, conversion technology other than starch-based ethanol.
- Invest more funding in R&D.
- Provide investment tax credit and incentives for growing the feedstocks through programs such as BCAP.
- Long-term profitability is needed before large-scale investments in supply, logistics, and conversion technologies won't be made until there is an ability to demonstrate and predict a profitable return.
- Investment tax credits can give the industry long-term stability it needs to encourage investment.
- BCAP suspension is the opposite of what is needed.
- Participate in cost-share programs with fuel distributors.

2. Growth in Demand:

- Encourage growth in demand by providing incentive programs to every level of the biofuels industry from producer to consumer.
- Number of blender pumps is insufficient: increase distribution of higher blends and vehicle fleet.
- Provide a service by being a clearing house for all of the energy programs – there are many programs and the industry needs help in sorting out where all of these programs fit.
- Some parts of the country need improvements to the railroad lines for moving feedstocks and biofuels.

3. Leadership in Consumer Education and Biofuel Consumption:

- Awareness and understanding have a direct impact on the success of biofuels in the retail market.
- Need more regionally located buying stations for vehicle fleets of the state and federal agency fleets.

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Summary of Stakeholder Responses to Question 7:

Are there innovative state-based programs or incentives that have worked, and that the Federal government should consider copying nationwide?

There is no direct response to this question. The common viewpoints included various venues for increasing distribution of E85 (85% ethanol, 15% gasoline) and State mandate implementation, including increasing incentives for blender pump installation and tax incentives. Regional differences included the need for more rail infrastructure in some areas and more education programs in others.

Common Findings:

- Incentives for offsetting the cost of blender pumps is a common view expressed through comments received from Colorado, Iowa, Indiana, and South Dakota. Grants have been utilized for installing blender pumps (often extended to E85 as well).
- The Indiana Corn Marketing Council invested \$500,000 into a fund administered by the Indiana Department of Revenue which distributes rebates to E85 retailers. Potentially, in the future, this money could be shifted and used for blender pumps.
- There was a distinction made between voluntary program participation and mandatory participation. Massachusetts commented that at one time, all diesel motor vehicle fuel and home heating oil had to contain at least 2% renewable diesel fuel by July 1, 2010; 3% renewable diesel fuel by July 1, 2011; 4% renewable diesel fuel by July 1, 2012; and 5% renewable diesel fuel by July 1, 2013. This was later suspended by the State opting for a voluntary quota rather than a State mandate. The reasoning for the decision was that initiating the regulations would be too costly for businesses and consumers.
http://www.boston.com/business/articles/2010/07/02/mass_suspends_mandate_for_biofuel_us_e/
- Minnesota also commented on being the first State to have the E10 (10% ethanol) mandate and a biodiesel mandate. The commentator suggests that other States could adopt the use of mandates.

Regional Difference: Noticeable variability based on geographical differences reaffirms that one size does not fit all:

- Southeast: support tax credits and incentives, funding for research and development, collaboration, and the agricultural production aspect. Comments also pointed to the need for education.
- Northeast: mandates and use of proceeds from energy bills to fund research and project implementation. Numerous references were given to websites to learn of program details.
- Central East: more blender pumps require state-owned vehicles to use biofuels, more biomass studies in the United States and abroad, and the importance of government funding.
- Northwest: infrastructure improvement for railroads, current and past programs that produced a network of experts, and farm to end-product usage models.
- Western: more interest in solar and wind power while excluding other renewable energy generators, less than expected use of funds for State Energy Programs, the need for state government to be “on the same page” with Federal government agencies, include biofuels in the Investment Tax Credit (ITC) like solar and wind projects, underfunding of some programs like BCAP, worried about competing uses of agricultural resources, the need for incentives, and preparing for the future through educational programs, prepared workforce, and a competitive environment.

Comments from Montana encouraged a holistic approach as “farm to end product usage”. Comments from Tennessee, Massachusetts, and New Hampshire stressed the importance of joint partnerships,

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including nonprofit organizations in some instances. Use of lands enrolled in conservation programs could also be considered for biomass production which would give the producer opportunity to periodically enter the marketplace.

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Summary of Stakeholder Responses to Question 8:

Are there further opportunities for expanding production capacity that should be added to the report?

Responses to this question were grouped by specific suggestions made for USDA, local communities, and creative opportunities.

Suggestions for USDA:

- Adjust USDA programs to support energy innovation on farms and provide more incentives for farmers. Develop an incentivized program for all land owners to grow small acres of perennial warm season grass (Switchgrass, Miscanthus, etc.) to control erosion, runoff and provide biomass.
- Focus more on current crop residues rather than introducing new crops to producers for production of cellulosic biofuels.
- The South Dakota State University Research Department has actively pursued the development of biofuels via the Pyrolysis process, stating that pyrolysis results in biomass oil (bio crude) that can be easily transported via railway, pipeline, etc.
- One State suggested USDA use land in the Conservation Reserve Program (CRP) for production of perennial grasses that require long-term land leases.
- Long-term profitable contracts are needed. There needs to be a long-term market plan—considering all consequences.
- Cellulosic producer credit (of equal to or greater than 60%) should not be held to just cellulosic sources. It should apply to ANY advanced biofuel. Additionally, there need to be more grants and incentives specifically targeted to assist farmers with investing in producing biofuel crops.
- Government should create incentives for the use of biofuels by consumers.

Suggestions affecting local communities:

- Small communities in Alaska have the potential to reduce their use of fuel oil for heat and power and replace it with woody biomass facilities. Although this would not result in additional biofuel production, it could make an impact by significantly reducing existing fossil fuel consumption.
- Utilize land that is not currently used for food production so there is no conflict.
- An efficient example is an ethanol facility that is co-located with a dairy or feedlot and an anaerobic digester. The milk or meat goes to market and the waste goes to the anaerobic digester. The anaerobic digester produces energy and a concentrated fertilizer and or compost. The energy goes to power the ethanol facility and the fertilizer and compost go on the fields or to market. Research by the Vermont Sustainable Jobs Fund (VSJF) indicates 1 or 2 facilities with 1-2 million gallons per year (MGPY) of biodiesel production capacity from local oilseeds are feasible and sustainable. These small-scale models need to be included in the DOE and USDA analysis of opportunities.
- Expansion of the biofuels industry should focus on advanced biofuels and direct substitute fuels that can leverage the existing American multitrillion dollar liquid fuels infrastructure.
- In some areas it would likely be more economical to utilize mobile processing plants. This was discussed for use in Wyoming because the area is so large.
- Develop a tax credit for local power generators that create more energy than used in the community.

Suggestions not to overlook creative opportunities:

- Waste products within the forests have huge potential. Government must encourage the application of emerging technologies, no matter the source. Short-Rotation Woody Crops (SRWC) such as willow should be included under planted crops and crop residues.
- Algae potential in the Southwest should not be ignored.

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- Fallow field crops like camelina and kenaf are high yield, non-food and commercially grown on over 8,000 acres in Florida and with emerging markets like bio jet fuel.
- Europe is using grapeseed oil which produces more biofuel oil.

Summary of Stakeholder Responses to Question 9:

What are the top issues that you need to be assured exist before you'd grow biomass for biofuels (especially if it's not a conventional standard crop, like switchgrass or fast growing willow)?

The range of comments for this question was fairly narrow. The issues of concern that rose to the top of most of the stakeholders included long-term economic viability of the industry in the face of limited demand, stability of laws and regulations, and the availability of natural resources. Some of the specific comments are summarized by theme below:

1. Economic viability - profitability:
 - Producers want to be assured of a market return for their crop and that its value is comparable to other crops; need long-term contracts or a futures contract to manage risk and cash flow.
 - Producers need consistency in the market for long-term commitment.
 - Reliable production estimates will help producers with economic analysis and marketing decisions.
2. Stability of Laws and Regulations:
 - BCAP program was good for producers.
 - Infrastructure planning – transportation, labor supply, social impact.
3. Natural Resource Availability:
 - Need to be assured of soil quality and water availability.

Another interesting comment addressed producer education, stating that landowners may need more training before growing a new crop such as short-rotation woody crops.

Summary of Stakeholder Responses to Question 10:

What are the top issues you'd want to avoid, or be protected against; what might deter you from considering growing biofuels crops?

Many of the same issues were raised by stakeholders that they wanted to avoid, be protected against, or that may deter them from growing biofuel crops, including:

- Market Risk: lack of a marketing system for alternative crops; demand will drive supply; need guaranteed markets to boost producer confidence.
- Avoid food vs. fuel issues and environmental protection issues.
- Managing available resources such as water, labor, soil, weeds.
- No incentives for oil refineries to do biofuel.
- Assurance that ethanol fuel industry of the future will be there for the long term.
- Backlash from established energy monopolies, market fluctuations, lack of long-term purchase contracts, not cost-effective or profitable proposals, political and environmental opposition.

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Summary of Stakeholder Responses to Question 11:

Who has experiences with flexible fuel vehicles (FFVs)? Why did you purchase an FFV?

Do you use biofuels higher than E10? Why, or why not?

Very few participants had experience with FFV's across the Nation. Most frequently cited reasons included:

- Lack of E-85 stations
- Lack of FFV availability; one comment indicated that auto dealers are not familiar with what an FFV is.
- Issues with underground storage tanks.
- Negative impressions about ethanol due to lack of knowledge.

Summary of Stakeholder Responses to Question 12:

What are your views of the accomplishments of corn-starch ethanol in achieving 10 billion, and soon 15 billion gallons, of our roughly 140 billion gallon fuel supply?

The comments had a somewhat uneven split between the positive and negative impressions about corn-starch ethanol. The less positive viewpoints slightly outnumbered the positive ones and some expressed mixed feelings.

Positive Viewpoints of Corn-Starch Ethanol:

- Revitalized American agriculture.
- Filled a niche in the market place when no other technologies were available to provide these resources.
- Beneficial to reducing greenhouse gases (GHG) and is not hurting the supply of food.
- American fuel supporting a clean and renewable energy supply.
- The 15-billion gallon cap should be market driven.

Less Positive Viewpoints of Corn-Starch Ethanol:

- While realistic, it is not very popular with the public, as the argument that it's diverting corn away from food quickly became a factor in public acceptance of biofuels; more should be done to educate consumers.
- Difficult to move beyond corn-starch.
- Fewer miles driven per tank, reduces consumer confidence.
- Participants were more interested in using biomass for combined heat and power than biofuels.
- Increased corn yield helped, economics will drive the future.
- No E-85 infrastructure – even if more ethanol is produced, there is no way to get it to the end user.

Summary of Stakeholder Responses to Question 13:

What does your locality offer in meeting biofuels goals?

What are the barriers or challenges faced by your locality in meeting biofuels goals?

Some of the stakeholders supported the fundamental goals of growing domestic biofuels and supporting domestic investment into the industry. One specific goal mentioned by several was to focus on agricultural waste and waste vegetable oil as viable feedstocks. However, most of the comments addressed the barriers and challenges facing their area, including:

- Competing uses of biomass
- Federal forest land cannot be used for biomass under RFS
- Lack of availability to access “slash” product in natural forest
- New technology to convert biomass into biofuel needs to be developed
- Transportation infrastructure and costs
- Scale of operations
- State and local permitting and air quality regulations
- People are used to high fuel costs
- Few E-85 stations
- Want to keep biofuels local
- No tax incentives

Summary of Stakeholder Responses to Question 14:

Do you think biofuels should be sustainable? What is your definition of sustainable?

1) Do you think biofuels should be sustainable?

Survey responses revealed a broad range in attitudes toward biofuel sustainability. When directly asked if biofuels should be sustainable half of the survey participants (27/54) responded with an unequivocal yes, a third (18/54) did not directly answer this question or answer question 14 at all, and one-sixth (9/54) responded by saying that it depends on the definition of sustainability.

2) What is your definition of sustainable?

The answers to this open-ended question exhibited a few strong themes that are categorized below. Note that several of the longer answers could be placed in more than one category. Because 6 of the survey responses did not answer question 14, the fraction of responses is per the 48 responses to the question.

- Sustainability can be defined as being able to maintain or increase levels of production/harvest for perpetuity. (22 comments)
- Sustainability predominantly can be defined in terms of economic viability of the industry. Respondents accepted that the government could initiate the production of bioenergy, but the biofuels sector will be sustainable only when producers earn stable profits over an extended period of time. (19 comments)
- Maintaining environmental quality is an important part of sustainability. Several of these responses referred to life-cycle analysis (LCA) and the need to insure that biofuels reduce greenhouse gas (GHG) emissions. (15 comments)
- It may be difficult to define sustainability and several asked USDA for guidance on how to define sustainable bioenergy production. (8 comments)
- Local production and consumption of the bioenergy can define sustainability (6 comments).
- Forest products as examples of ways to sustainably produce bioenergy. (6 comments)

Summary of Stakeholder Responses to Question 15:

As a consumer, what are your expectations of biofuels as a fuel? (i.e. performance, access, price). Are their differences in biofuels that you'd be willing to accept in order to switch from standard fuels?

Most of the comments addressed the cost-effectiveness of biofuels as a top priority. Other comments pointed other expectations:

- Easily accessible
- Less expensive and not result in lower vehicle performance
- Compatible with existing fuels
- If locally produced, biofuels should be less expensive than fossil fuels due to lower conversion, processing, transportation and delivery costs, at some economies-of-scale point.
- Geopolitical issues impact prices; locally produced fuel can reduce the cost of these geopolitically driven prices.

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Summary of Stakeholder Responses to Question 16:

In addition to Biofuels, USDA is very interested in Bioenergy. Please list below any key points that were made during the meeting in regards to Bioenergy production:

Thirty individuals from twenty states plus Puerto Rico responded to the open-ended question. They represented all five of the USDA roadmap regions: Southeast (11), Northeast (2), Central East (5), Northwest (3) and Western region (9). Among the major findings:

- Opportunities to utilize woody biomass for heat and power if current laws were changed to include Federal land materials. Also, woody biomass is a great source for electricity throughout the nation because of its availability. This was noted as a concern more in the Northwest and Western region because of the amount of forest lands in these regions.
- Cost effectiveness to produce bioenergy from biomass would be better if transportation, local utilization and fire prevention were effective and sustainable activities. The infrastructure barriers of rail and trucking for transportation modes need to be assessed along with barge transportation as a viable mode because it is more efficient. A cost-benefit study for biofuels on economics, environment and energy security should be conducted. This was a concern throughout all regions for bioenergy to be considered it would have to have a complete economic analysis.
- Education of the benefits of a healthy forest, improved public safety, and renewable source of feedstock material. Utilizing biomass from thinning forests and clear cutting would be part of the education.
- Government incentives to produce bioenergy needs to be in place to encourage energy conservation and alternatives for production of energy. This was more of a concern with people in the Southeastern region.
- Bioenergy production like geothermal, solar and wind resources potential needs to be researched as possible alternatives. In the Central East region, wind energy is an expanding market while in other regions it was not mentioned as an alternative.
- Waste material was mentioned in several regions as a tremendous opportunity for biofuels if conversion becomes economical and technologically viable.

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Summary of Stakeholder Responses to: *Additional Notes*

The content of the Additional Notes section spanned a spectrum of topics from feedstock estimates to policy. The majority of the comments were from the Western United States, with some comments from the South and Midwest, and few comments from the Northeast. The following summarizes the major points gleaned from the information provided on public comments:

- Domestic production, energy security, and rural economic development are very important.
- Many comments, including from the Midwest, noted that the Roadmap report placed too heavy an emphasis on corn ethanol, and not enough emphasis on other transportation fuels, specifically drop-in fuels, and other feedstocks. However corn grower groups wanted the RFS (EISA 2007) corn ethanol limit lifted, more emphasis on corn ethanol, and various legal requirements to force higher corn ethanol use in transportation fuels.
- The feedstocks and alternative energy crops, both woody and non-woody, suggested varied somewhat by region reflecting regional growing conditions and land suitability.
- Essentially each region commented that the Roadmap report significantly underestimated available feedstocks in their region.
- Feedstocks repeatedly called out as having high potential were algae, particularly in the sunny, but arid West; woody biomass across the West and South; and municipal solid waste (MSW).
- There were multiple requests for long-term, dependable, consistent policies across Federal agencies related to biomass and biofuels. Policy inconsistencies were seen to dampen or curtail investment and reduce feedstock options.
- The definition of renewable biomass in RFS was cited multiple times as an example of inconsistent policy. Of significant concern was the RFS definition of renewable biomass which excludes woody biomass from federal lands and limits the use of wood from forest plantations for credits under the RFS.
- It was noted that complementary DOE programs and the impact of EPA regulations were not acknowledged in the Roadmap.

III. USDA Renewable Energy Programs and Activities – A Way to Move Forward

USDA has a long history of supporting the research and development of renewable energy resources and is deeply involved in and committed to the Nation's quest for energy security.

USDA recognizes that renewable energy, energy efficiency, and conservation programs provide opportunities for economic growth and prosperity in rural America. USDA further recognizes that energy conservation in the production of food and other consumable products is important to producer and market costs, reduction of greenhouse gas emissions, and resource conservation.

The Food, Conservation, and Energy Act of 2008 Act (Farm Bill) provides over \$1 billion of mandatory budget authority during a 5-year period to support a comprehensive approach to energy efficiency and renewable energy development in rural America. This level of support has provided a program level of nearly \$2 billion in support for the renewable energy and biobased product development. The Farm Bill programs were designed to increase America's energy security, improve the environment, and strengthen rural economies through development and production of renewable energy and the creation of sustainable green jobs.

Since the enactment of the 2008 Farm Bill, USDA has accomplished numerous goals in the realm of renewable energy, energy efficiency, and conservation. By working with other Federal agencies, State governments, private industries, and local communities, USDA has supported the increased research, development, and commercialization of renewable energy throughout rural America. We continue to work to accomplish President Obama's goal of promoting the domestic development of renewable energy sources, improving our environment, reducing energy consumption, and ensuring energy security for future generations.

USDA Programs and Key Stakeholder Issues

USDA has many programs to assist farmers, forest landowners, rural businesses, rural residents, and the Nation to respond to energy-related issues and opportunities. These programs address many of the stakeholder issues and range from basic scientific research to the development and commercialization of new technologies. They include outreach and education, technical assistance programs, financial support for infrastructure, and the adoption of biobased and energy-saving products by USDA itself. We support efficient farming and sustainable feedstock production and management techniques; geothermal facilities; solar and wind farms; current and advanced bioenergy production supply chains; and biochemical and genomics research. USDA also supports modernization of the rural electric grid to support renewable energy development to move renewable electricity to markets, as well as the deployment of smart grid technologies.

Policy Stability: The stakeholders raised this as a broad issue, mostly as it relates to the RFS. As part of the Executive Branch, USDA is working in strong partnership with other agencies in facilitating the policy goals. USDA works closely with DOE and the Environmental Protection Agency (EPA), through the Biomass Research and Development Initiative Board (BRDi) and other mechanisms to help ensure that programs complement each other across agencies and that policy and regulatory impacts are clearly understood.¹ USDA and DOE co-chair the BRDi Board and EPA plays a major role in Board activities.

¹ On August 10, 2011, Department of Energy (DOE) released a detailed analysis: *2011 U.S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry* that provided county-level supply curves for many, but not all biomass feedstocks. This Study is the most

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Some of the USDA programs and activities that address this issue include:

- USDA's National Institute of Food and Agriculture (NIFA) has funding programs in place that support extramural research addressing the needs pointed out by the workshop participants. NIFA's Agriculture and Food Research Initiative (AFRI) 2012 Sustainable Bioenergy Challenge Request for Applications (RFA) has solicited Sustainable Bioenergy Research proposals specifically to address: *Policy Options for and Impacts on Regional Biofuels Production Systems* (Program Code A6122) and anticipates making up to six awards of \$350,00 for two to four years. In addition, the NIFA has funded a growing number (currently five) of Coordinated Agricultural Projects (CAP) throughout the United States supporting robust industry, academic, government and non-government organization partnerships to facilitate the development of regional systems for the sustainable production of biofuels, biopower, and biobased products.
- On June 24, 2011, in keeping with President Obama's strategy to expand domestic oil and gas production safely and responsibly, the U.S. Department of the Interior (DOI), USDA, and the EPA released an interagency approach to address air quality issues associated with onshore oil and gas development on public lands. A new Memorandum of Understanding (MOU) establishes a common process for the agencies to follow in analyzing the potential air quality impacts of proposed oil and gas activities on federally managed public lands. The collaborative approach established in the MOU will increase efficiency, certainty and transparency in the process - benefitting industry, federal agencies, States, and Tribes.
- On October 21, 2010, USDA and the Federal Aviation Administration (FAA) established a partnership with the signing of a Memorandum of Understanding. The FAA and commercial airline industry see the potential of biofuel as jet fuel. Under the MOU, the USDA and FAA will work together with the airline industry over the next five years to develop appropriate feed stocks that can be most efficiently processed into jet fuel. Doing so will decrease the industry's current dependence on foreign oil and help stabilize fuel costs in the long run.

Market Development: USDA agencies are involved in educating and providing information and technical assistance to USDA customers, stakeholders and members of the general public. Programs are designed to facilitate the transfer of new technology and products to primary users and to disseminate information among scientists, farmers, ranchers, foresters, and the general public. This includes programs to encourage the use of new research results and technologies, manage risks, and expand awareness, acceptance and use of products, processes and technologies. USDA's Rural Development mission area and NIFA have programs that address this issue.

- The Rural Energy for America Program (REAP) provides loan guarantees and grants to agricultural producers and rural small businesses to purchase and install renewable energy systems and make energy-efficiency improvements. Renewable energy systems include those that generate energy from wind, the sun, biomass, geothermal sources, or that produce hydrogen from biomass or water using renewable energy, and ocean and hydroelectric source technologies. Energy-efficiency projects typically involve installing or upgrading equipment to significantly reduce energy use. Energy audits and feasibility studies are also eligible for assistance. Eligible applicants for energy audits include State, tribe, or local governments; land-grant colleges and universities; rural electric cooperatives; and public power entities. Eligible applicants for feasibility studies include rural small businesses and agricultural producers. Through its network of State offices, USDA has on-going conversations with

recent example of collaborative work between DOE, USDA, industry, and other experts on potential feedstock yields, considering soil and environmental characteristics, and land and feedstock demands for other vital U.S. farm and forest products.

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producers, small businesses, and other renewable energy stakeholders about the importance of their role in the future of the Nation's renewable energy programs.

- The Business and Industry (B&I) Guaranteed Loan Program provides financial backing for rural businesses through guarantees up to 80 percent of a loan made by a commercial lender. Loans may be used for working capital, machinery and equipment, buildings and real estate, and certain types of debt refinancing. Biobased, bioenergy, and other qualified energy projects may be financed through the program for technologies that convert biomass into affordable, commercially proven electricity, fuel chemicals, pharmaceuticals, and other materials in cost competitive ways for large national and international markets.
- The Biorefinery Assistance Program provides loan guarantees to viable commercial-scale facilities and grants to demonstration-scale facilities to develop new and emerging technologies for advanced biofuels. Eligible entities include Indian tribes, State or local governments, corporations, farmer co-ops, agricultural producer associations, higher education institutions, rural electric co-ops, public power entities, or consortiums of any of the above.
- The Repowering Assistance Program provides payments to biorefineries that use fossil fuels to produce heat and power to replace the fossil fuels with renewable biomass. To be eligible, the biorefineries must have been in existence as of June 18, 2008, and applicants must demonstrate the economic, technical, and environmental feasibility of the proposed biomass system.
- The Advanced Biofuels Payment Program provides payments to producers to support and expand production of advanced biofuels refined from sources other than cornstarch. To be eligible, producers must enter into a contract with USDA Rural Development for advanced biofuels production and submit records to document such production.
- The NIFA AFRI Sustainable Bioenergy Challenge, *Regional Approaches to Sustainable Bioenergy Systems Program* (A6101) has funded five Regional Bioenergy CAP projects for a total of \$136 M over five years. One of the critical aspects that each of these projects must address is increasing consumer awareness through education and outreach programs. Additionally, required robust sustainability analysis within the CAPs will contribute to informing the Food vs. Fuel debate. Similarly, the 2012 AFRI Sustainable Bioenergy Research *Environmental Implications of Direct and Indirect Land Use Change Program* (A6125) will be funding up to 5 awards for \$500,000 over two to four years. Out puts from these projects could help inform the Food vs. Fuel debate. The 2012 AFRI Sustainable Bioenergy Research *Socioeconomic Impacts of Biofuels on Rural Communities* (A6124) will be funding up to six awards for \$350,000 over two to four years. Market development may be among issue areas addressed by this program.

Complete Economic Analysis: Office of Energy Policy and New Uses in the Office of the Chief Economist and the Economic Research Service conduct a broad range of research on how agricultural markets and natural resources might be affected by the increased demand for bioenergy. ERS research on bioenergy encompasses all aspects of the ERS research mission, including economic and policy issues involving food, farming, natural resources, and rural development. Ongoing bioenergy research focuses on domestic and global agricultural markets; economy wide, regional, and household effects; natural resource, environmental, and rural community impacts; and implications for food prices. In addition, the

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AFRI Regional Bioenergy CAP projects are required to perform economic analyses. These analyses will inform a broader complete economic analysis of biofuels.

Additional Resources: The NIFA/DOE *Biomass Research and Development Initiative (BRDI) Competitive Grant Program* supports research and development on alternative feedstock resources. The listed feedstock sources from the stakeholder input would be eligible to compete for this funding (\$40 M NIFA contribution in 2012). The USDA SBIR Program has a long history as one of the very few programs supporting the development of new industrial crops. SBIR also supports development of conversion of municipal solid waste and animal manure and carcass waste to value-added products.

ARS is USDA's in-house research agency for agriculture. ARS leads America towards a better future through agricultural research and information. The Program's mission is to enhance the economic viability and competitiveness of U.S. agriculture by maintaining the quality of harvested agricultural commodities or otherwise enhancing their marketability, meeting consumer needs, developing environmentally friendly and efficient processing concepts, and expanding domestic and global market opportunities through the development of value-added food and nonfood products and processes.

Conservation Reserve Program: The NIFA AFRI Sustainable Bioenergy Challenge has funded approximately 12 projects over five years addressing feedstock crop protection. CRP lands may be part of some of these studies. For 2012, the AFRI Sustainable Bioenergy Challenge will be funding up to five awards of \$500,000 for two to four years as part of the *Impacts of Regional Bioenergy Feedstock Production Systems on Wildlife and Pollinators Program (A6123)*. Some of these projects may address impacts on CRP lands. Similarly, the 2012 AFRI Sustainable Bioenergy Research *Environmental Implications of Direct and Indirect Land Use Change Program (A6125)* will be funding up to 5 awards for \$500,000 over two to four years. Changes in CRP lands are among targeted issue areas addressed by this program.

The Farm Service Agency (FSA) implemented a conservation loan program in FY 2010 that could be used for the implementation of qualified conservation practices as outlined in an approved Conservation Plan developed by NRCS. Conservation activities that are being addressed with loan funds provided under the Conservation Loan Program include purposes consistent with the plan, including the adoption of any other emerging or existing conservation practices, techniques, or technologies approved by the U.S. Secretary of Agriculture. FSA has made 229 direct conservation loans for \$16,078,000 and 3 guaranteed loans made by commercial lenders for \$703,000 since the inception of the program. FSA conservation loans can be made in conjunction with grants and other commercial financing.

CRP for Energy Crops: It has been suggested that land under Conservation Reserve Program (CRP) contracts can be used productively for growing perennial grasses as energy crops. ARS scientists showed that Old World bluestem grown on CRP land in central Oklahoma produced an average of only 1.7 DryTons/acre and that a native mix produced 0.9 DT/acre. Maximum yields were obtained at the October harvest for both Old World bluestem (1.86 DT/acre) and the native mixed species (1.0 DT/acre). Although soil characteristics were not altered by three years of annual harvest, biomass production consistently declined at all sites over the three harvest years. This study shows that some CRP land may not be attractive for biomass feedstock production.

Cropping Approaches: The AFRI Regional Bioenergy CAPs will be addressing a wide-array of cropping options, including intercropping, and reserve cropping. The 2012 AFRI Development and Sustainable Production of Regionally-appropriate Biomass Feedstocks Program (A6101) will be

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evaluating proposals that target this issue area. NIFA anticipates making one award for \$10 M over five years.

Local Energy: The NIFA Institute of Bioenergy, Climate, and Environment, Division of Sustainable Bioenergy manages a portfolio of competitive and non-competitive programs that support regional system-based approaches for development of sustainable supply chains for the production of biofuels, biopower, and bioproducts. The annual investment exceeds \$100 million (M), including approximately \$90 M of competitively award projects supported by the Agriculture and Food Research Initiative (AFRI), the Biomass Research and Development (BRDI), and the Small Business Innovation Research (SBIR) program.

The AFRI Regional Bioenergy CAPS are addressing several new systems for a more distributed (local) production of fuel and products. Similarly, the BRDI program is funding and is currently evaluating new proposals targeting smaller-scale biorefinery models. The USDA SBIR Program also supports pre-commercialization industry research in this area. The 2012 AFRI Sustainable Bioenergy Research *Socioeconomic Impacts of Biofuels on Rural Communities* (A6124) will be funding up to 6 awards for \$350,000 over two to four years. Local energy is among targeted issue areas addressed by this program.

Wood: Woody biomass is currently one of the most important sources of feedstock for biofuels, biopower, and biobased products. The AFRI Regional Bioenergy CAP Program is providing approximately \$90 M over five years to support research, development, demonstration, and commercialization of fuel and products from wood-based regional systems, including purpose-grown agroforestry systems. Both the BRDI Program and the USDA SBIR Program have supported and continue to support projects involving woody biomass production, utilization, and product commercialization.

Forest Service Research and Development (FS R&D): FS R&D leads research in wood-based bioenergy and biobased products. FS researchers work with other Federal agencies, State and local agencies, universities, Tribes, NGOs, and industry in both basic and applied research in this important area of science. This research helps provide the science and technology to sustainably produce, manage, harvest, and convert woody biomass to liquid transportation fuels, chemicals, and other high-value products. Taken together, these can reduce investor risk and significantly contribute to U.S. energy security, environmental, and economic goals. The FS R&D Bioenergy and Biobased Products Strategic Direction can be accessed at:

http://www.fs.fed.us/research/pdf/RD_Bioenergy_Strategy_March_2010.pdf

Biomass for Heat and Power: The BRDI and USDA SBIR Program accept proposals for biomass to heat and power.

APPENDIX – Examples of USDA Accomplishments

1. Agricultural Research Service (ARS):

a. Feedstock Development

- Plants with less lignin may be more disease resistant: Incorporating lignin biosynthesis mutants (bmr6 or bmr12 – aka brown midrib) into sorghum grain lines reduces lignin content and increases cell wall digestibility. Although lower lignin content can increase biofuel yield, it is commonly believed that low-lignin varieties are more susceptible to disease. In both field and greenhouse studies, however, ARS researchers found that brown midrib lines were actually more *resistant* to infection by the fungus *Fusarium*. In fact, one *Fusarium* species commonly found in wild-type grain was not detected in bmr12 grain. This research shows that crops modified for increased cellulosic biofuel yield are not necessarily more susceptible to pathogens and could even be more resistant.
- Breeding corn stover for higher biofuel yields: Corn stover, the most abundant biomass resource today, can be an attractive feedstock for biofuel production. However, research is needed to enable breeding of corn with higher yields of ethanol. ARS and University of Minnesota researchers showed that genetic traits of corn that affect cellulosic ethanol yield (percent/amount? cellulose, percent/amount? lignin, and facility of glucose release) had moderate to high heritability and did not show an accompanying decrease in grain yield. Further, they identified genetic markers for cell wall traits important for cellulosic ethanol production. Their work enables the use of marker-assisted selection to breed corn that exhibits both higher yields of cellulosic ethanol from stover, and higher yields of grain. In addition, University of Minnesota scientists discovered a corn mutant with reduced ferulate cross-linking in stover; and ARS scientists showed that stover from the mutant variety was more easily digested into fermentable sugars. Research is continuing to isolate the mutated gene in order to breed a superior feedstock for both biofuels production and corn silage production.
- ARS develops switchgrass genetic map: ARS scientists working together with the Noble Foundation produced the first published genetic map for switchgrass. This key achievement enables scientists to genetically dissect, identify and assemble genes responsible for many high value traits and enables breeders to better recombine, evaluate and enhance switchgrass germplasm that exhibits desired traits.
- New, improved variety of energy cane: ARS researchers developed and released a new high-fiber, low-sucrose energy cane cultivar that is more resistant to smut infection than L 79-1002, another high-fiber variety which ARS developed in the early 1970's. Sugarcane smut appeared in the U.S. in the 1980's and became a major disease which reduced yields of sugarcane, including L 79-1002, by as much as 50% or more over the crop cycle. The primary method of controlling smut is through the development of resistant varieties of sugarcane.
- New genetic tools for grass breeding: Collaborating ARS and Australian scientists used a high-throughput phenotyping platform (phenomics) to characterize over 100 natural accessions of *Brachypodium*, a wild grass. Extensive natural variation was found in several traits relevant to biofuels, including cell wall composition, stem density, and fermentability. ARS researchers also

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created over 4,000 insertional mutants this year and released over 4,000 mutant lines made in the prior year to the public through a newly established website. These tools will identify and manipulate target genes that affect biofuel production from dedicated energy crops.

- High oleic acid soybeans: Biodiesel fuel produced from soybean oil with high levels of oleic acid has significantly better cold-flow properties and higher oxidative and temperature stability. ARS scientists identified and combined mutant alleles of two soybean fatty acid-modifying genes, resulting in beans with high oleic acid content. The researchers also developed molecular markers for these genes, thereby facilitating the breeding of soybean varieties containing this valuable trait.
- Grass genome sequenced: The Nation's scientific community chose *Brachypodium* as a simple model for studying grass cell walls and enabling rapid improvements in plant traits for biofuels production. ARS scientists, in collaboration with DOE and other researchers, have annotated the entire *Brachypodium* genome. A paper describing the results was published in *Nature*, and the genomic information is now publically available on several databases. In addition, a project to resequence additional accessions of *Brachypodium* was initiated. To date, four lines have been resequenced and the analysis of the sequences has begun. Knowledge of the genome sequence of *Brachypodium* and the linear order of genes in the genome relative to other grasses will help researchers improve traits in energy crops and grain species.
- Hi-Yield Switchgrass Strain: ARS scientists developed a strain of switchgrass that, when grown in Nebraska, produced a potential ethanol yield of 355 gallons per acre – 20 gallons per acre greater than that of the previous best cultivar. This is the first publicized example of a switchgrass strain specifically bred for improved conversion to ethanol.
- Cell Wall Genomics: The plant cell wall is a complex composite of polysaccharide polymers, phenolic compounds and proteins; and the genes controlling cell wall composition are poorly understood. In collaboration with DOE, ARS scientists sequenced the entire genome of the grass *Brachypodium*; and a complete draft of the genome was released through the website www.brachypodium.org. In addition, ARS researchers developed over 200 inbred *Brachypodium* varieties which are freely available to researchers, and have created over 4,000 T-DNA lines which will soon be released to the public. Using near infrared spectroscopy (NIR), ARS scientists have identified 27 mutants of *Brachypodium* with altered cell wall composition. This work will enable research to improve cell wall properties for biofuel production.
- Rapid Predictive Method for Ethanol Yield from Biomass Feedstocks: Conventional wet chemistry analyses of biomass composition and tests for biomass conversion to ethanol are time-consuming and expensive. ARS scientists developed Near-infrared Reflectance Spectrometry (NIRS) calibrations for predicting biomass ethanol yield (per ton) for switchgrass. The NIRS measurements provide data on cell wall composition, cell wall sugars, soluble sugars, lignin, released and fermented glucose from cell wall cellulose, released cell wall pentoses, and other biomass quality attributes. The calibrations enable rapid and accurate estimation of theoretical ethanol yield from hexose sugars, theoretical ethanol yield from pentose sugars, total ethanol yield per ton, total ethanol yield per acre, total theoretical ethanol yield per ton, and total theoretical ethanol yield per acre. These calibrations will be useful for feedstock breeding, genetics, and management research, and can also be used by biorefiners to determine ethanol yield from a particular biomass feedstock.

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- Lignin Gene Mutation Increases Cellulosic Ethanol Yield: ARS scientists found that a low lignin sorghum mutant can produce significantly more ethanol (gal/ton) than wild-type sorghum. Incorporating this gene mutation into energy crops should enable the development of new varieties with superior traits for 2nd generation (cellulosic ethanol) biorefining.
- New Tools for Sorghum Breeding: The genes which enable a plant to sense the length of daylight must be incorporated into tropical sorghum lines so that they will flower and produce seed in temperate locations, such as the U.S., where the day-length is longer during the growing season. ARS researchers developed molecular markers and new genomic methods to efficiently breed varieties having these photoperiod-response genes. In addition, ARS scientists developed a quick and low-cost fluorescent screening assay to identify drought-tolerant sorghum germplasm. The fluorescent method is as effective as conventional selection techniques which required multi-year field trials at multiple locations. These new sorghum breeding tools will accelerate the development of new sorghum varieties with superior traits for bioenergy feedstock production.

b. Sustainable Feedstock Production Systems

- Herbicides to improve switchgrass establishment: Weeds limit switchgrass establishment from seed, but few herbicides are labeled for switchgrass establishment. By applying quinclorac, which provides effective control of grassy weeds, plus atrazine, which provides good broadleaf weed control, ARS scientists generated good switchgrass stands for a variety of ecotypes throughout the Great Plains. With good management, including herbicides, switchgrass yields were already half of full in the first year following planting and were at full production by the second year. This research has enabled the labeling of quinclorac for switchgrass establishment in the Great Plains.
- Response of napiergrass to fertilizer: Napiergrass, a high-yield perennial, is a promising feedstock for the emerging cellulosic biofuels industry in the Southeast U.S. ARS scientists studied the rain-fed growth of napiergrass under three fertilizer treatments – no fertilizer, poultry litter, and inorganic fertilizer. Relative to the unfertilized control, napiergrass grown with either poultry litter or inorganic fertilizers exhibited yields that were 17% and 48% greater in the second and third year of growth, respectively. These results will contribute to the development of best management practices for viable biomass feedstock production systems in the Southeast.
- Not all biochars make good soil amendments: There is a widespread public perception that any type of biochar, produced from pyrolyzing biomass, will improve soil fertility. However, ARS researchers showed that biochar derived from poultry litter was toxic to earthworms, whereas earthworms were unaffected by biochar made from pine chips. Since a healthy earthworm population is a key indicator of productive soils, these results demonstrate that biochars produced from some materials can have detrimental impacts on soil quality, at least in the short-term.
- Northeast CRP lands for biofuel production: Growing feedstocks for biofuel production on marginal croplands, such as those often enrolled in the Conservation Reserve Program (CRP), would minimize food-vs-fuel concerns. ARS scientists determined the effects of plant species composition, diversity, above ground biomass, and chemical composition on potential biofuel yield across major Northeastern ecoregions. Whereas converting CRP land to corn production is unlikely to yield more than 400 gallons of ethanol per acre, this study showed that CRP lands

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with a high proportion of native warm-season prairie grasses have the potential to produce more than 600 gal-ethanol/ac, while still maintaining the ecological benefits of the perennial grasses.

- On-farm pretreatment of biomass: Pretreatment of cellulosic biomass is necessary in order to obtain reasonable yields of ethanol, but it requires expensive equipment and so is a major cost component in cellulosic ethanol production. In addition, the narrow window for crop harvesting requires long-term storage of biomass feedstocks, which can lead to significant losses from spoilage. ARS scientists developed simple, yet novel methods to combine these two steps -- storage and pretreatment -- on-farm. They found that biomass can be stored with sulfuric acid or lime for one to six months in sealed plastic bags typically used for silage production. On-farm pretreatment/storage resulted in ethanol yields comparable to those obtained when pretreatment methods were done at a biorefinery, while avoiding spoilage losses, reducing overall costs, and providing farmers with opportunities to capture more return from their biomass crop.
- Simple Method for Estimating Switchgrass Biomass Volumes: Efficient and accurate methods to estimate the amount of switchgrass biomass feedstock within a production area will help decision makers, and biorefiners in particular, plan their operations. ARS scientists evaluated the effectiveness of various indirect methods for on-field estimation of switchgrass yields in a multi-year study. Visual obstruction (as measured horizontally through a stand of switchgrass) was the best method for estimating yield on switchgrass fields with low to variable stand densities, while elongated leaf height measurements should be used on switchgrass fields with high, uniform stand densities. Twenty to 30 elongated leaf height measurements in a field could predict switchgrass biomass yield within 10% with 95% confidence. These procedures can be used by biorefiners to estimate feedstock supply in a production area, and also by the USDA National Agricultural Statistics Service (NASS) to estimate national bioenergy supplies from switchgrass.
- Incorporating Perennials in Corn-Soybean Cropping Systems: Combining annual and perennial crop species in rotational cropping systems – termed “living mulch” cropping systems – could enable the production of both food and bioenergy on the same land and thereby minimize the displacement of food crops by cellulosic energy crop production. Concurrent management of food/feed crops such as corn or soybeans with perennial crops (forages) requires that the forages be suppressed during row-crop production. ARS scientists investigated combinations of reed canarygrass or orchardgrass with leguminous forages such as alfalfa, kura clover, and birdsfoot trefoil in a corn-soybean-forage rotation. The cover crops were managed by harvesting four times during the forage year and by suppressing with a 10 inch glyphosate band over the row during the corn and soybean years. They found that a combination of alfalfa, kura clover, and reed canarygrass resulted in the highest forage yields and lowest weed densities. They also found that seeding an unadapted alfalfa in the spring of the forage year supplemented yield and suppressed weeds in the former crop row. Use of the cover crops also allows producers to remove more corn stover (for bioenergy) and still maintain long-term productivity of the soil. In short, this study showed that producers can produce both food and bioenergy crops on the same land, diversify their cropping systems, obtain high yields of forages for livestock or bioenergy, eliminate the lower yields usually encountered in the first (establishment) year for perennials, and improve ecosystem function of corn production systems.
- Optimal Peanut Varieties for Biodiesel Production: Peanut oil could be an excellent feedstock for biodiesel production, but no data currently exist about which cultivars might be best suited for this market. ARS scientists evaluated the economic and agronomic performance (under both low and high input management strategies) and biodiesel engine performance of over 40 different

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cultivars. The research identified five peanut cultivars which exhibit superior production performance and oil characteristics and will help to enable on-farm biodiesel production.

c. Biorefining

- New process for producing hydrocarbon fuels from biomass: A commercially viable process for converting cellulosic biomass into drop-in replacements for petroleum-derived fuels would be a significant advancement for the biofuels industry. ARS scientists have combined the fermentative production of volatile fatty acids (VFAs) from biomass by ruminal bacteria with subsequent electrolysis of the VFAs to produce propane and other alkanes, which could be subsequently reformed into liquid fuels. The fermentation can be performed on ground biomass without additional pretreatment and without sterilization of the biomass or the culture medium. The electrolysis can be conducted at low voltages with inexpensive graphite electrodes. A U.S. patent application has been filed.
- Increasing energy efficiency of bioethanol production: A major concern associated with corn ethanol fuel is the relatively low energy efficiency of its life-cycle production, a situation resulting in large part from the high energy input required to distill ethanol from fermentation broth. In addition, the fermentative conversion of biomass to ethanol involves especially low concentrations of ethanol, so the distillation step requires even larger amounts of energy. ARS scientists invented a new membrane-based ethanol recovery process that exhibits twice the flux of conventional membrane systems. The novel fabrication process lays an ultra-thin, low-permeability layer of an active adsorbent on a very permeable, large-pore rubber support. A patent application has been filed on the technique, which enables an energy-efficient alternative for ethanol production.
- Increasing yield of ethanol from corn stover: One reason cellulosic ethanol is more expensive than corn-based ethanol is that biomass contains both six-carbon sugars (hexoses, such as glucose), and five-carbon sugars (pentoses). Corn-based ethanol is produced with brewer's yeast, which converts only glucose. Although new recombinant microorganisms have been developed to convert both hexoses and pentoses to ethanol, these organisms ferment glucose preferentially and do not begin to metabolize any pentoses until low glucose concentrations have been reached. As a result, fermentations times are long, and the pentoses are not fully converted. To overcome these hurdles, researchers at ARS and Iowa State University co-developed a two-stage simultaneous saccharification and fermentation process. In the first stage, pentoses are released and fermented to ethanol using an organism capable of highly efficient pentose metabolism; in addition, glucose is released and simultaneously converted to ethanol with brewer's yeast. Using this process, an ethanol yield of 85 gal/ton was achieved from corn stover. If the traditional process that ferments only glucose had been used, the yield would have been only 65 gal/ton. This process will enable more efficient and cost-effective production of ethanol from cellulosic biomass.
- New, highly-efficient hemicellulase enzyme: Beta-D-xylosidase from the bacterium *Selenomonas ruminantium* is the most efficient enzyme for releasing the sugar xylose from biomass, but high concentrations of xylose inhibit this enzyme. ARS scientists developed a mutated enzyme that tolerates 3 -fold higher sugar concentrations, thereby lowering the production costs for cellulosic ethanol.

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- Increasing the profitability of manure digestion by adding dewatered food waste or switchgrass: Methane, the main component of biogas, is currently used as a “clean,” energy-dense transportation fuel. Livestock farmers with anaerobic digesters can increase their income by adding food waste to the digesters and charging fees for accepting the food waste from restaurants and other sources. But how much food waste should a farmer accept? ARS scientists showed that anaerobically digesting mixtures of swine (or dairy) manure and 5% pulped food waste produced about 20% more biogas than mixtures containing only 1% food waste. However, it was found that the ability to achieve higher biogas production required good control of digester pH. ARS scientists also showed that adding switchgrass to a high-solids anaerobic digester increased the biogas yield from dairy manure about four-fold. They also found that the increased yield is the same for green switchgrass (harvested in July) or senescent/brown switchgrass (harvested in January) although the point of harvest changes the timing of optimal biogas production.
- Lowering butanol production costs: Butanol is an advanced biofuel more compatible with the Nation's transportation fuels infrastructure than ethanol. ARS scientists have discovered that furfural and hydroxymethylfurfural, which are produced when biomass is pretreated with dilute acids, stimulate the rate of butanol fermentation by a factor of two or more. This discovery lowers the cost of producing butanol from any plant-derived feedstock.
- Cost-effective ethanol from citrus processing waste: Converting pectin- and cellulose-dense citrus processing wastes (such as peels) to ethanol is technically feasible, but the enzyme cocktail typically used to hydrolyze the various polysaccharide fibers is expensive. Using both a new commercially-available, multifunctional cellulase enzyme and a Simultaneous Saccharification and Fermentation (SSF) bioreactor, ARS researchers reduced the number of enzymes required to convert these wastes to ethanol and have thereby made such biorefineries more commercially viable.
- Pyrolysis economics: Unlike other biomass conversion technologies, pyrolysis may enable biorefining processes on or near the farm at a relatively small scale, thereby minimizing the costs associated with transporting large quantities of low-density biomass. By developing and using a process cost and simulation model for biomass fast-pyrolysis, ARS researchers found that a 200 tons-per-day plant is the smallest size that would be competitive with \$85/bbl petroleum. This information provides a valuable guideline for designing small-scale biorefining operations.
- Distillers dried grains with solubles (DDGS) as a high-protein, high-fiber food: ARS researchers, in collaboration with South Dakota State University, conducted studies using various blends of DDGS (a co-product of corn ethanol production) in Asian flat breads (naan and barbari). DDGS, which cost only \$0.05/lb, could replace corn-based food ingredients, which cost ~\$3/lb, at levels up to 20% with only minimal reductions in bread performance and consumer acceptability.
- Using ethanol to lower energy costs for food refining processors: ARS researchers determined that ethanol can be used to dehydrate food processing or refining products such as wheat gluten, resulting in up to 60% lower capital cost and up to 60% lower energy consumption relative to standard industry practices such as fluidized bed, flash or rotary drying. The study considered total system costs, including capital costs for ethanol recovery (via distillation), and also showed that dehydrating with ethanol can improve product quality. Ethanol could thus be a cost-saving

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addition to the food refining process.

- Increased energy efficiency of corn biorefining: A major criticism of corn-based ethanol is its relatively low life-cycle energy efficiency, and that the bulk of the energy used in bioethanol production is consumed by the corn biorefinery. In turn, almost half of the total energy usage in a corn biorefinery goes into drying of the distillers grain co-product. ARS scientists discovered that cell wall degrading enzymes dramatically decrease the water binding capacity of the by-product grains and so make them much easier to dry. A plant trial of the new technology reduced natural gas usage in the distillers grains dryer by almost 15%, and increased the amount of water recycle in the biorefinery. The technology can easily be adopted by existing ethanol plants to reduce their energy usage and operating costs.
- High-productivity bioreactor for cellulosic ethanol: Biorefining cellulosic biomass to ethanol is relatively expensive for a number of reasons. For instance, cellulosic biomass contains significant amounts of 5-carbon sugar, but yeast ferment only 6-carbon sugars. In addition, most ethanol-producing microorganisms are significantly inhibited by sugar degradation byproducts formed by acid pretreatment. Also, cellulosic biorefining as traditionally envisioned requires multiple steps and so more pieces of equipment. By using a combination of...
 - a recombinant ethanol-producing microbe capable of fermenting both 5-carbon and 6-carbon sugars,
 - an aerobic fermentation step to remove inhibitors typically produced by pretreatment, and
 - a fed-batch, simultaneous saccharification and fermentation (SSF) process to consolidate equipment.ARS scientists were able to convert wheat straw into ethanol in a manner that increased the final ethanol concentration by 75% (to 4.5%), decreased the total processing time by 20%, and decreased the amount of hydrolysis enzymes by 50%. These advances significantly increase the commercial viability of producing ethanol from cellulosic biomass.
- Corn oil from ethanol biorefineries: Most corn oil is extracted from corn in wet mill refineries because they are large enough to justify the use of expensive solvent extraction. In contrast, most bioethanol plants use dry grind process and do not produce edible corn oil as a co-product. ARS scientists developed a process called “aqueous enzymatic oil extraction” (AEOE) to separate corn oil from the germ produced at a dry-grind biorefinery, but the AEOE process needed a pretreatment step to increase oil yields. Consequently, ARS scientists developed an enzyme-based pretreatment step that increased oil yields to 90%. Preliminary cost estimates indicate that with the pretreatment step, the AEOE process will allow ethanol biorefineries to produce edible corn oil economically. The process may even replace hexane extraction in wet mill refineries. This advancement will help corn ethanol refineries produce a valuable co-product (corn oil), and be more economically resilient to volatile corn and ethanol prices.
- Corn Ethanol Co-products as Fish Feed: A major feed component in fish farming is fishmeal, which is produced from marine stocks. Because of the rising cost and declining availability of marine stocks (and fishmeal), ARS scientists investigated the use of distillers dried grains (DDGS) as an alternative to fishmeal in aquaculture feeds. ARS researchers, in collaboration with South Dakota State University, determined that a feed combination of 40% DDGS (a co-product of corn ethanol production), 9.5% soybean meal and 24% fishmeal resulted in the highest weight gain in yellow perch. Replacing the current diet in yellow perch aquaculture (40% fishmeal) with the DDGS-based diet could save the industry nearly \$9 million annually.

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- Bioplastics from cellulotics: Today's major commercial bioplastic is polylactic acid (PLA), and the lactic acid bacteria which produce the L-lactic acid monomer for PLA can only ferment 6-carbon sugars such as those in sugar cane and corn starch. ARS scientists discovered a heat-tolerant, 5-carbon-fermenting lactic acid bacterium in dairy manure compost. This new strain uses all the sugars in biomass feedstocks such as corn fiber, switchgrass and wood; and it tolerates inhibitors typically produced by biomass pretreatment. This discovery may enable the commercial production of PLA plastics from cellulosic biomass.
- Improving Cold-Flow Performance of Biodiesel: Biodiesel typically thickens in cold temperatures, a phenomenon that can lower engine performance and may even clog engine fuel filters. ARS scientists determined that adding low levels (2.5%) of ethyl levulinate, a biobased material, improves cold flow performance of the resulting biodiesel fuel. ARS scientists also determined that enriching the vegetable oil feedstock in certain types of fatty acids (e.g., decanoic acid) results in biodiesel fuels with better cold flow properties. This knowledge can be used by crop breeders to produce vegetable oils better suited for biodiesel production.

2. The ARS Research Centers:

- Rapidly assessing feedstock quality: ARS and the *Near Infrared Spectrophotometry Consortium* (NIRSC) of Hillsboro, Wisconsin recently established a cooperative agreement for the purpose of transferring the NIRS calibrations for switchgrass composition to other public and private laboratories that conduct research on developing switchgrass into a biomass energy crop, and to industries which are using or will use switchgrass for biofuels. NIRSC is an association of commercial laboratories, universities, government groups, plant research companies, and instrument companies whose members collaborate to development standard methods and unify knowledge, accuracy, and application of NIRS technologies. ARS scientists at Lincoln, Nebraska, Madison, Wisconsin and Peoria, Illinois, led this effort that provides a rapid method industry and researchers to do mass screen the quality of switchgrass genetic lines and biorefiners to accurately assess the expected ethanol yields from biomass production fields. This effort is a product of the Central-East USDA Biomass Research Center.
- Clear Invasive Eastern Red Cedar to Produce Jet Fuel: Eastern red cedar trees are native to the eastern half of the U.S., but they've become an invasive species of formerly productive rangeland in the eastern Great Plains. ARS scientists in El Reno, Oklahoma have been working with the NRCS High Plains Resource Conservation and Development Council to turn invasive Eastern Red Cedar trees into a bioenergy opportunity. The team developed a remote sensing technique to accurately estimate the amount of biomass that can be harvested and used to produce electricity or biofuels from the red cedar. More than 12 million tons of red cedar growing in only the 17 highest impacted counties in Oklahoma, there is enough biomass to produce more than 800 million gallons of biofuel, or more than 9-million megawatt hours of electricity. Clearing the red cedar will also restore the rangeland productivity for native wildlife habitat and cattle grazing. Commercial business developers are proposing to use this feedstock resource and are pursuing capital to build a first-of-a-kind jet fuel biorefinery in Oklahoma. This effort is a product of the Southeastern Regional USDA Biomass Research Center.

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- Future Navy Fuels from Hawaii: A public and private partnership in Hawaii led by USDA-ARS has been designed to establish commercial production of advanced biofuels for use by the Navy. The USDA-ARS, Department of the Navy's Office of Naval Research, and the University of Hawaii have formed a research and development partnership with Hawaiian Commercial & Sugar (HC&S) Company on Maui, along with involvement from the Department of Energy, to develop the most sustainable opportunities for producing advanced biofuels and renewable electricity from sugarcane and other biomass crops. HC&S is Hawaii's largest agricultural operation and its last sugar plantation, so is an ideal partner to immediately test and apply the results from the partnership. This research is developing the tools needed to find ways to sustainably integrate renewable energy production into existing agricultural operations in ways that minimize disruption to existing markets while preserving the quality of natural resources. This effort is a product of the Southeastern Regional USDA Biomass Research Center.
- Biofuel from winter barley – where there was none: The ARS laboratory in Wyndmoor, Pennsylvania, partnered with scientists at Genencor/Danisco to develop a new chemical cocktail and process that will increase ethanol yield from barley – a crop that has not been used in U.S. ethanol production. Farmers from southern Pennsylvania to South Carolina could profit from using a new two-year rotation of corn followed by winter barley and then soybean that protects soils, prevents fertilizers from washing into the Chesapeake Bay, and produces grain on land that otherwise would be fallow over the winter. Osage Bio Energy will use this technology when its new ethanol plant in Hopewell, Virginia opens in April 2011. Plant construction has provided over 500 jobs, leveraged over \$150 million in procurement and labor, and will create 50 new permanent jobs for operating the plant. The new ethanol plant is expected to generate \$2 million in tax revenue every year for the city of Hopewell. This effort is a product of the Central-East USDA Biomass Research Center.
- USDA and FAA Develop the Feedstock Readiness Level Tool: Air industry experts had recognized disconnects between the level of development for fuel conversion processes and the actual availability of plant-based feedstocks that were to be used in the production of aviation biofuels. The commercial air transportation industry requested that a *Feedstock Readiness Level (FSRL) Tool* be developed to complement the internationally recognized Commercial Air Alternative Fuel Initiative (CAAFI) *Fuel Readiness Tool*. A USDA and FAA team created the FSRL to track progress on the development of agricultural and forest-based feedstocks needed to produce alternative jet fuels. The FSRL tool was the basis for the USDA-FAA MOU announced by Secretary Vilsack on October 21, 2010, and fulfills the industry request to USDA. This effort is a contribution of the USDA Biomass Research Centers.
- Large-scale gene sequencing effort leads to switchgrass linkage map: The Agricultural Research Service and Department of Energy's Joint Genome Institute released the results of a large-scale switchgrass sequencing effort that also led to the creation of genetic linkage maps for switchgrass in collaboration with the Samuel Roberts Nobel Foundation. The more than 435,000 sequence tags identified have made this the largest collection of publically available gene sequences for switchgrass and is helping accelerate efficient selection in switchgrass to produce new varieties with enhanced biomass yield and increased efficiency when converted to biofuels. This research can help accelerate the development of the next generation of high performing feedstocks that are needed to meet U.S. biofuel production goals. This effort is a product of the Central-East USDA Biomass Research Center.

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- ARS taps into sugarcane diversity to create new biofuel feedstocks: ARS has begun a public-private consortium for improving both sugarcane and energy cane that will provide important new sources of genetic diversity to help keep up with the demands of the emerging biomass industry in the southeastern U.S. and around the world. Sugarcane contains valuable genes that can be used to increase biomass and impart traits that will increase production efficiencies and geographic range of sugarcane for use as a biofuel feedstock. This new research builds on efforts already underway by ARS and university partners at the University of Florida, Louisiana State University, and Claflin University (1890 institution), and industry cooperators who have identified three high-yielding energy cane varieties that show promise as bioenergy feedstocks. This three year project, funded jointly by DOE and USDA, will also use next-generation sequencing and association analysis to identify genes and alleles associated with biomass and bioenergy traits for use in the emerging energy cane breeding program in Florida. This effort is a product of the Southeastern Regional USDA Biomass Research Center.
- Helping the Colville Federated Tribes produce biofuels: ARS agronomists have done research that has allowed the planting time for winter canola to be moved earlier so young canola shoots can become established and survive the winter, and help fend off weeds in wheat fields. The Colville Confederated Tribes are working with ARS and the Washington State University Extension to find ways to produce winter canola on tribal lands. They plan to extract the seed oil to make biodiesel for their fleet of school buses, and then sell the crushed seeds to local farmers as a livestock feed supplement. And USDA's Risk Management Agency has already used Young's work as *the basis for extending* crop insurance for canola in two Washington State counties. This research is timely – EPA has reviewed the use of canola oil for biodiesel production to see if it meets requirements for greenhouse gas reductions under the *Renewable Fuel Standard*. This is a contribution of the USDA Northwest Regional Biomass Research Center. This effort is a product of the Northwestern Regional USDA Biomass Research Center.
- First real-costs estimated for switchgrass biomass: Until completion of a recent study, the actual farm costs for producing the perennial grasses on commercial-scale fields for advanced biofuels were not known. By contracting ten farmers from northern North Dakota to southern Nebraska, ARS and University of Nebraska researchers estimated cost of biomass for a 10-year rotation to be a little more than \$46 per metric ton. These results show that substantial quantities of feedstock could be produced at a cost of \$0.13 per liter of ethanol, a cost that should help make ethanol production from biomass an economic alternative to petroleum fuels. This research is a contribution of the USDA Central-East Region Biomass Research Center.

3. Forest Service Research and Development:

- Patented vegetation control system for use in short rotation woody cropping systems.
- Contributed to the successful sequencing of the poplar genome and continue to contribute to tree genome science through cooperation in the Pine Genome Initiative.
- Fuel Reduction Cost Simulator, a tool that simulates the cost of forest operations that are undertaken to reduce fuel loads by cutting and removing trees for solid wood products or chips (http://www.fs.fed.us/pnw/data/frcs/frcs_home.htm).
- Quantified costs of innovative in-woods chipping equipment for use in electricity generation.
- Evaluation and successful deployment of forest biomass bundling technology; biomass harvesting synthesis; Fuel Treatment Evaluator; trucking simulator
- Genome sequencing of the brown rot fungus and the xylose-fermenting yeast, *Pichia stipitus* – advances for bioconversion technology.

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- Completed Value Prior to Pulping project with academic and industry partners to develop liquid fuel and utilization of residual wood fiber.
- Completed techno-economic analysis of wood-to-ethanol conversion processes.
- Participates in, and funds work of, a successful multi-partner consortium conducting life cycle analysis of wood products and forest biomass-based fuel products. (<http://www.corrim.org/>)
- Forest Service Research & Development actively represents the U.S. in IEA Task 43 (Biomass Feedstocks for Energy Markets).
- Sustained an internal competitive research grants program targeting sustainable practices, improved tech transfer and biofuels conversion technologies, Between FY 2007 and FY 2011, 30 projects were funded for approximately \$3.878 million, leveraging an additional \$2.85 million in external partner support, resulting in over 30 peer-reviewed publications, numerous presentations and technology transfer opportunities, and several theses and dissertations.
- Catchlight Energy LLC signed a technology transfer agreement with the FS in biofuels conversion technology.
- Provided significant scientific expertise to the forest components of U.S. DOE's FY 2011 Billion Ton Report Update-- an in-depth analysis of the technical feasibility of a billion ton annual supply of biomass capable of displacing 30% or more of the US petroleum consumption. (http://www1.eere.energy.gov/biomass/pdfs/billion_ton_update.pdf)

4. Foreign Agricultural Service (FAS):

- Initiation of Bilateral Negotiations on the Renewable Energy Directive: FAS staff is actively engaged with the European Union's (EU) Directorate General for Energy to negotiate an agreement whereby current U.S. agricultural conservation programs are deemed equivalent to the sustainability criteria contained in the EU Renewable Energy Directive. These sustainability criteria threaten to hinder U.S. exports to the EU of biofuel, and biofuel feedstock (particularly soybeans) worth over \$1.5 billion. FAS is leading the interagency process while working closely with U.S. industry to conclude a permanent bilateral agreement, and a temporary interim agreement that ensures trade continues until the bilateral agreement can be finalized. A bilateral agreement is the most economical and least burdensome method for U.S. agriculture to comply with the EU sustainability criteria. This approach also highlights the decades of conservation successes in the United States for all agriculture, not just agricultural commodities destined for biofuel.
- Global Bioenergy Partnership Reaches Agreement on Sustainability Indicators: In May 2011, FAA played an integral role in the deliberations of the Global Bioenergy Partnership (GBEP) Sustainability Indicators discussion. In May of this year, GBEP agreed on a set of 24 voluntary, science-based indicators for assessing the sustainable production and use of all forms of bioenergy. The agreement represents the first global and government-level consensus on such indicators. The sustainability indicators for bioenergy aim to assist countries in assessing and developing national sustainable production and use of bioenergy that is consistent with multilateral trade obligations. The indicators cover all three sustainability pillars, economic, environmental and social, and specifically include provisions on: greenhouse gas (GHG) emissions; biological diversity; the price and supply of a national food basket; access to energy; economic development; land tenure; female and child labor; and energy security. The indicators represent factors by which the sustainability of biofuels production and use can be measured and are not prescriptive in terms of policy, nor are they legally binding.

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- International Bioenergy Capacity Building: GBEP has agreed to launch a capacity building initiative that seeks to promote the optimum use of modern bioenergy for sustainable development. The Global Bioenergy Partnership was launched in January 2007 as part of the G8 +5 (Brazil, China, India, Mexico and South Africa), which called for "a Global Bioenergy Partnership to support wider, cost effective, biomass and biofuels deployment, particularly in developing countries where biomass use is prevalent." Its partners currently consist of 23 national governments and 13 international organizations, with an additional 22 governments and nine international organizations acting as observers. FAS, with collaboration from other USDA Agencies, will support State Department's efforts to provide capacity building aimed at increasing modern bioenergy production in developing countries with the goal of increasing food and energy security while contributing to economic development. FAS also supports international capacity building of bioenergy through a series of MOUs which include scientific exchanges and joint research efforts primarily with China, Germany and Brazil.
- Annual Biofuels Reports and Analysis: Utilizing FAS' global network of Attachés and locally engaged staff, FAS produced 22 Biofuel Annual Reports on the status of bioenergy production in all of the major producing and consuming regions of the world. These reports provide qualitative and quantitative data on production, consumption and trade of biofuels, gives projections for future years, highlights new policy developments, discusses the state of research and advanced biofuels, and serves as a major input into USDA's global feedstock use projections.
- Energy and Climate Partnership of the Americas (ECPA): ECPA is an initiative of President Obama's which strives to expand the production and use of low carbon clean energy throughout the western hemisphere. FAS, with financial support from State Department, is carrying out a capacity building project with four Latin American countries entitled "Increasing Sustainable Production of Biomass for Energy." With technical expertise from ARS and several land-grant universities FAS is building the capacity of Uruguay, Honduras, Guatemala and Ecuador to carry out lifecycle analysis of alternative bioenergy pathways; converting coffee waste into biofuels; and developing viable co-products from jatropha oil.
- (Borlaug Fellows) Program: In October 2010, Agriculture Secretary Tom Vilsack announced that USDA had selected 10 researchers from seven developing countries to work side-by-side with U.S. scientists on climate change mitigation research. These fellows were selected under the Global Research Alliance Norman E. Borlaug International Agricultural Science and Technology Fellowship (Borlaug Fellows) Program. The 10 researchers, two each from Chile, India, and Malaysia and one each from Ghana, Mexico, the Philippines, and Vietnam, have chosen the following areas in which to conduct their research: developing tools for greenhouse gas and carbon sequestration assessments; mitigating greenhouse gas emissions in crop, grazing, or confined animal production systems; and developing databases and strategies for synthesis, integration, and decision support to manage greenhouse gas emissions and carbon sequestration in agricultural systems.

5. Risk Management Agency:

- Beginning with the 2012 crop year, the Risk Management Agency (RMA) will implement a crop insurance pilot program for camelina in Montana and North Dakota as part of a private section submission utilizing Section 508(h) of the Federal Crop Insurance Act. A non-reinsured supplemental product for corn stover has also been approved recently for Iowa and Minnesota. It too is in the first year pilot stage.

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- RMA has also contracted with external researchers to conduct three studies affecting dedicated energy crops, corn stover /crop residue, and woody biomass to determine the feasibility of creating insurance programs for biofuel crops. The studies have indicated that few of the biofuel crops are being grown at a commercial capacity sufficient to sustain a crop insurance program at this time; however, RMA continues to maintain contacts with and is monitoring the growth of the biofuel industry in anticipation of developing more crop insurance products as the industry matures.