



The Northern Frontier of Forestry *and Fuel* Research

“If you’re going to do research on trees, it makes sense to do it where the trees are,” said Ray Miller, who oversees forestry research at MAES properties in the Upper Peninsula. Miller also serves as director of the U.P. Tree Improvement Center (UPTIC) in Escanaba and MAES forest biomass development coordinator. “About 80 percent of the land in the U.P. is forested. That’s why the forestry field research stations are here. It makes no sense to have a forest research center in the middle of Berrien County.”

Miller's ease at juggling various jobs and titles even extends to his unofficial "ambassador" duties that come with heading up one of Michigan State's northern-most outposts.

"We're the university's front door in the U.P.," he explained. "The field stations up here are the only thing some people know about MSU — they've never been down to campus. So to them we are Michigan State University. Other universities don't have this network. Combined with MSU Extension, which has offices in just about every county, the Michigan Agricultural Experiment Station network makes MSU unique in its ability to provide research and outreach to the state."

Trees cover 19.3 million acres in Michigan, which is a 5 percent increase since 1980, and more than half of Michigan's land, according to statistics from the Michigan Department of Natural Resources (MDNR). Most of the forested land is in the northern two-thirds

This is good for keeping plants healthy and helping them thrive, but it's a problem for making biofuels. Before the complex sugars can be converted into ethanol or other biofuels, they have to be broken down into simple sugars, such as glucose, by enzymes.

Doing that cost effectively has been the main issue slowing cellulosic biofuel production. Because the process is difficult to do efficiently, it can significantly raise production costs. This is why cellulosic biofuels aren't available commercially. Yet.

"In Michigan, our research and development emphasis is on making renewable fuels from cellulose," said Steve Pueppke, MAES director, who also serves as director of the MSU Office of Biobased Technologies. "Cellulosic biofuel allows the state to tap forestland to make fuel and sidesteps the 'food vs. fuel' issue that has been a subject of controversy."

With three forest research facilities in the heart of the region where forest biomass is produced, the

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of the state, and Michigan ranks fifth nationally in timberland acres (forestland classified as timberland must meet minimum timber production standards), behind Georgia, Oregon, Alabama and North Carolina.

Though the markets for forestry products have declined in some areas of the state, particularly in southeastern Michigan, the forest industry remains strong in the Upper Peninsula. About 150,000 jobs and approximately \$12 billion of the state's economy are credited to the forest industry, according to the MDNR.

As Michigan moves to shift its economy from one based on nonrenewable resources such as petroleum and coal to one based on renewable resources such as plant material, the state's vast forest resources make it a leader in this new bioeconomy.

Trees and other plants are a huge potential source of energy — each year, the biomass in the Earth's plants captures about eight times the total amount of energy used by people from oil, coal, natural gas, wind, water, etc. But about 90 percent of this energy in fibrous plant biomass isn't readily available because it's locked up in cellulose and hemicellulose, the complex sugars that make tree trunks, grasses, plant stems and stalks, and leaves rigid. Unlike the simple sugars in the grains of plants, such as corn kernels, cellulose and hemicellulose don't dissolve in water.

MAES is poised to help Michigan become a leader in commercial-scale production of cellulosic biofuels.

"We really don't know how much cellulosic ethanol will cost when it comes on the market, but there is a suspicion that it will cost more than ethanol made from corn grain," Miller said. "That said, we also know that the cellulosic ethanol industry will get more efficient, which will bring the price down. And we also may find that there are other biofuels, such as dimethyl ether, that may be better biofuel choices. There's a lot of research work to be done, and we're working to make Michigan a hub for it.

"There isn't one thing that's going to make us energy-independent," he continued. "It's not as simple as substituting one fuel for another. We have to use less and be more thoughtful about how we use it. People are worried about using forests for energy, but we're not talking about turning forests into farms. By working together, we can do this intelligently in a way that benefits both the economy and the environment."

From Forests to Fuels

Michigan State has been conducting research in the Upper Peninsula for more than 100 years. The two oldest off-campus properties are located in the U.P.: the Upper Peninsula Experiment Station (UPES), in Chatham, was established in 1899, and the Dunbar

Forest Experiment Station, near Sault Ste. Marie, was established in 1925. Though most of the research at the UPES focuses on carbon sequestration, forage, and beef and dairy cattle research, the Jim Wells Forest, MSU land near Au Train used for forestry research, is about 20 minutes away. Established in 1986, the U.P. Tree Improvement Center is located in the center of the state's forest industry. Miller manages the three forest research facilities from his base at UPTIC in Escanaba. *(See box on page 38 for more detailed descriptions of each forest research facility.)*

"Dunbar and UPTIC are the two biggest MSU forestry research properties," Miller said. "And the

data. But it makes sense to start that work there because it's so close to the site Mascoma has chosen for its plant."

As the bioproduct industry comes into its own, Miller expects to be able to provide private forestland owners with management guidelines should they be interesting in selectively harvesting some trees to sell to biofuel or bioenergy producers.

"Research on the management of natural forest systems has been ongoing at Dunbar for a while," he explained. "We have data on how best to manage stands in that area."

Biofuel research at UPTIC is a bit further along,



Ray Miller oversees forestry research at MAES properties in the Upper Peninsula. He also serves as director of the U.P. Tree Improvement Center and MAES forest biomass development coordinator. Miller's foresight in planting a poplar plantation in 1997 that was harvested last year has provided the first and only hard data on yields of trees grown specifically for biofuel production in Michigan.

bulk of the research occurs at those two sites."

Much of the ongoing research based at Dunbar is long-term genetics and silvicultural work started in the 1900s, but Miller explained that plans are in place to position Dunbar to tackle some of the issues that the Mascoma Corporation will face as it works to open a commercial cellulosic ethanol production plant in Kinross in Chippewa County, about 5 miles away from the Dunbar site.

"We're going to refocus parts of Dunbar to study forest biomass crops," he said. "We're working to clear the land and establish new plantations of willows and poplars, but it will take about 5 to 10 years until we have our first harvest and can gather any meaningful

mainly because Miller had the foresight to plant clonal trials of poplars and willows soon after being named director in 1988. He also put in a poplar plantation in 1997 that was harvested last fall, providing the first and only hard data on yields of trees grown specifically for biofuel production in Michigan.

"We're using the data to build computer models to simulate production so we can manipulate the variables," Miller said. "Our test plots were small and the productivity wasn't anywhere near what a commercial-size plantation would do. Once the models are done, we can see what happens if we use different equipment."

Miller said scientists also are building a computer



MAES Upper Peninsula Forest Research Properties

✦ Dunbar Forest Experiment Station

A 5,700-acre parcel of land near Sault Ste. Marie, the Dunbar Forest has been part of the MSU Department of Forestry's research, education and demonstration program since 1925. From 1940 through the mid-1970s, the forest hosted planting, cultivation and harvesting research programs, as well as a forest seedling nursery and a field program for forestry and civil engineering students from the main MSU campus in East Lansing. Much of the current research at Dunbar is based on the long-term genetics and silvicultural experiments that were started at the site many years ago. New research is being focused on forest biomass crops that can be used to produce bioenergy, which will help address any issues faced by the Mascoma Corporation as it works to develop a cellulosic ethanol facility in Chippewa County.



✦ Jim Wells Forest

Located near Au Train, between Munising and Marquette, the 440-acre Jim Wells Forest is about 20 minutes northeast of the U.P. Experiment Station in Chatham. The Wells Forest has been part of MSU since 1943, when tax-delinquent land was given to MSU by the state so the profitability of sound forest management could be demonstrated. The property is undeveloped, and researchers use a network of unpaved truck roads to navigate to sites in the forest. The management plan drafted by then-manager Maurice Day in 1946 is still being followed today.

✦ Upper Peninsula Tree Improvement Center

Established in 1986 when MSU bought an 840-acre beef farm in Escanaba, UPTIC expanded to its current size in 1987 when the Mead Corporation donated an adjacent 880-acre tract of cedar swamp. In the mid-1800s, the vast hardwood forests around Escanaba supplied charcoal to the region's pig iron furnaces. The land that would become UPTIC was cleared around 1890 and was incorporated into one of the first dairy farms in Delta County. Unlike other MSU forest research properties that were established on abandoned farms, UPTIC became part of the MAES field station network because it was so far away from agricultural markets. Forest genetics and tree improvement research has been a staple at UPTIC, but a new biofuel research center, operated in collaboration with Michigan Tech and housed at UPTIC, will allow scientists from both universities to work together to find solutions to the most complex problems facing the forest-based cellulosic biofuels industry.

model of the entire forest biofuel feedstock supply chain, which will help forest owners and bioproduct manufacturers get a better idea of how to ensure the supply chain is stable and sustainable. The model also will help answer specific engineering questions, such as the effects of bringing in new systems that have been successful in other areas but are untested in Michigan, such as harvesting techniques used in Sweden that Miller has studied during exchange programs with Swedish scientists. Wood-fired power plants are common in Sweden, a country that lacks natural gas and coal reserves but does have 69 million acres of forestland.

Learning from Sweden

On one fact-finding mission, Miller visited Skelleftea Kraft, a heat and power plant in Hedensbyn, Sweden, that also produces wood pellets (about the size and shape of guinea pig food), which can be burned in stoves to provide heat. The plant provides heat, power and cooling to residents and businesses in about a 4-mile radius around the plant through what's called district heating. In district heating, the plant sends heated water through pipes to each building in the town. The hot water circulates through radiators in each room, so different parts of a house or office building can be warmer or cooler as desired. Homes or businesses that are outside the district heat-

ing area receive bags of wood pellets that are burned for heat. In the summer, when demand for heat and power is low, the plant puts much of its energy into making pellets, which are then stored. In the winter, when heating demands are higher, the plant makes more steam heat.

Miller is intrigued by the concept of a coordinated heat/power/pelletizing plant for the smaller communities across the Upper Peninsula and northern lower Michigan.

"Even if district heating weren't implemented for homes because of concern about hook-up costs or replacing gas forced-air furnaces with radiators, it could be pilot tested in businesses and municipal buildings," he said. "As communities have to replace aging, inefficient power plants, we could test or demonstrate this concept. In some cases, consultants have recommended huge replacement power plants with huge price tags, which small communities don't need and can't afford. I think these smaller, efficient plants have real possibilities for Michigan."

But any sort of wood-burning power plant must have a steady supply of wood to burn. This is why the computer models will be invaluable as the industry emerges.

"We're consulting with a company that makes briquettes from wood waste, as well as a company that wants to open several wood-fired power plants in



the U.P.," Miller said. "But in some cases, they're having trouble getting enough fuel. The models can help us look at the situation holistically and make sure that all users' needs are met."

Because the forest industry is still strong in the U.P., any company using trees to produce fuel or energy is in competition with existing paper mills and other forest product businesses. Still, the state

Martin Dober, MEDC vice president of new markets, said the research at the center will build on work funded through the state's Forest Feedstock Supply Chain Center of Energy Excellence. MSU and MTU received \$2 million through this program to support Mascoma's proposed plant.

The center further strengthens the forest-based biofuel relationship between Michigan State and

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grows more trees than it uses and has the potential to grow even more in energy plantations, so meeting the increased demand is possible.

"The infrastructure to harvest and handle trees for cellulosic biofuel production won't be fully developed until there is a market," Miller said. "Policymakers need to look at what will entice biorefineries to locate here, as well as what will entice landowners to cultivate the types of trees needed for biofuel production. Policy could have a huge effect on the future of Michigan's bioeconomy, perhaps even more than technology. That's why we're working so hard to provide sound, science-based information."

Federal Support for Michigan Biofuel Research

Biofuel research at UPTIC got a boost with a \$1.4 million allocation in the federal omnibus spending bill passed in March. The funding created the Forestry Biofuel Statewide Collaboration Center, to be based at UPTIC, and will allow MSU and Michigan Technological University scientists to work together to find solutions to the most complex problems facing the forest biomass cellulosic biofuels industry. The center's funding is from the U.S. Department of Energy and is being distributed by the Michigan Economic Development Corporation (MEDC).

"The center will be a place where new and existing research, development and outreach projects at Michigan State and Michigan Tech can be focused," Miller explained. "We'll be investigating and demonstrating the best ways to use the state's forest resources to expand the state's rural economies in environmentally, economically and socially sustainable ways."

Michigan Tech, about 140 miles northwest of Escanaba in Houghton, which Miller coordinates wearing his forest biomass development coordinator hat. The collaborative research, outreach and economic development programs are overseen by an eight-member Renewable Fuels Working Group made up of four scientists from each university. According to Miller, UPTIC's location made it the logical site for the new center.

"Escanaba is somewhat of a midpoint between Houghton and Sault Ste. Marie, so we can serve as an operations base and an equipment storage facility," Miller said. "We're much closer to Michigan Tech and the proposed Mascoma plant than the main MSU campus, and we have technicians on site that are available to work on projects. Having the field stations up here makes the research more efficient."

The U.P. forestry field stations also provide visibility and accessibility to local forest owners and managers. The fact that the research is done on the same soil types and under the same weather, disease and insect conditions resonates powerfully with local growers.

"When we're making recommendations about what to do with land, we need to have experience with land and trees in that area," Miller added. "We have to have local experience to be credible. People up here are faced with the choice of driving an hour to visit UPTIC and see the results of research that has been done in the U.P. or taking a day to fly down to Lansing and visit campus to see research results that have been done under conditions that are different from what they have. There's really no comparison."

... Jamie DePolo