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Guidelines for sustainable planting and harvest of nonforest biomass in Wisconsin

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PROSPECTS

In 2008, prospects for bioenergy and a bio-based economy were generating excitement in Wisconsin and around the country. The report from a state committee developing strategies to mitigate climate change (Governor's Task Force 2008) called for a state Energy Crop Reserve Program to accelerate Wisconsin production of biomass from perennial grasses and energy crops. Other proposed policies were intended to develop the necessary infrastructure and supply chains. Two major utilities were seeking permits to burn biomass, and the University of Wisconsin-Madison was designing a retrofit for a campus steam and power facility to use biomass.

Many factors have dampened progress toward these ambitious goals in the intervening years. The general downturn in the economy means investors are more risk-averse. The hoped for push and pull of regulation and incentives from the public sector have not occurred to any extent in Wisconsin. Natural gas and coal continue to remain abundant and cheap, and high corn prices continue to drive cropping choices.

However, high fuel prices are a fresh memory and an anticipated future. Impacts of climate change are increasingly evident (WICCI 2011), and the need for public response is more imperative. Even if viable commercial production of liquid transportation fuel (i.e., ethanol) from cellulosic conversion of biomass is still "just around the corner," we know that biomass can be combusted, fermented, pyrolysed, gasified, and in other ways be used to produce energy. For all of these reasons and more, we anticipate that Wisconsin will be using biomass for energy in increasing amounts in the future.

In anticipation of growth in bioenergy cropping, the Wisconsin Department of Natural Resources enlisted collaboration from the Wisconsin Department of Agriculture, Trade and Consumer Protection and the University of Wisconsin-Madison (UW) to develop guidelines for the sustainable production of nonforest biomass. The orientation to nonforest biomass occurred because a set of guidelines for woody biomass harvesting had already been completed by the Wisconsin Council on Forestry (Herrick et al. 2009).

Members of the newly formed workgroup on nonforest biomass agreed that Wisconsin growers, processors, investors, land and natural resource managers, and feedstock users would benefit from guidance on biomass production—to ensure that it is done with appropriate environmental safeguards while recognizing the need to be profitable and compatible with community and regional goals. This was particularly important with respect to marginal land—its environmental sensitivity, its prevalence in areas of Wisconsin, and the potential for change in land use and associated impacts to production and ecosystem services. A combination of satellite-derived land cover data with soils data (land capability classes) indicates that Wisconsin has 0.8 to 1.2 million ha (2 to 3 million ac) of open land not currently in crop production that could potentially be used for bioenergy crops (table 1). However, a substantial portion of these open lands are too steep, droughty, or wet for typical agronomic crops. These marginal lands have been touted for perennial biomass production by some as a way to obviate "food versus fuels" arguments (Tilman et al. 2009) and to provide income from land that has limited agronomic potential. (Although this statewide land cover analysis used a specific definition of marginal land, the guidelines use the term in a more generic sense).

PROCESS

By summer of 2009, Wisconsin Department of Natural Resources staff recognized the potential effects of land use changes associated with biomass production on wildlife habitat, water quality, and other resources within their purview. They linked with UW faculty and staff already researching sustainable biomass production practices and with Wisconsin Department of Agriculture, Trade and Consumer Protection, the agency with primary responsibility for agricultural activities in the state. A memorandum of understanding between the three organizations created an Executive Committee and a Technical Team:

> The development of science-based guidelines in advance of widespread biomass planting and harvesting in Wisconsin is intended to help ensure

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Table 1

Open land in Wisconsin not currently in agriculture potentially suitable for bioenergy crop production (Numbers are in thousands of hectares).

Crop	Productive land*	Marginal land†
Switch grass	311 ± 61	635 ± 29
Hybrid willow‡	1,246 ± 221	

* Land with soil capability classes I or II for switch grass; land capability classes I–VI for willow plus suitable slope and drainage conditions.

† Land with soil capability classes III or IV.

‡ Land areas for switch grass and willow are not mutually exclusive.

> sustainability of and, whenever possible, benefit the natural resources of the state. These voluntary guidelines may be used in making policy, land management, research and natural resources decisions… (WDNR 2010)

Preliminary but necessary work took nearly a year—developing the memorandum of understanding and scoping document, finding appropriate expertise and assigning staff, and working through key conceptual issues. Developing the scoping document was the means to hammer out core components of the final report, including what kinds of biomass production would be included, working definitions of nebulous terms such as marginal and sustainable, and a set of principles that would imbue the detailed guidelines.

This period also provided time to see what similar efforts might be available or underway. A few other states provided some ideas, particularly Minnesota, which had a draft proposal for best management practices (MBWSR 2008). The Council on Sustainable Biomass Production, a public-private consortium formed specifically to "develop comprehensive voluntary sustainability standards for the production of biomass and its conversion to bioenergy," released a draft standard in 2009 (CSBP 2009). Although this document lacked sufficient specificity for Wisconsin's needs, it contributed to the practices and principles included in our document.

In May 2010, the Wisconsin legislature passed Act 401 that created the Wisconsin Bioenergy Council. The Council was asked to

> …identify voluntary best management practices for sustainable biomass and biofuels production, which may include consideration of practices related to choosing biomass species, where to plant, crop management, harvest, and processing and transport, and factors such as soil management, chemical inputs, carbon sequestration in soil and root mass, plant and animal biodiversity, and other factors… (Wisconsin Statutes 2009)

The Bioenergy Council, appointed by the state legislature and comprising agricultural, energy, timber product, and conservation organizations convened for the first time in November 2010. The Council recognized that a sensible option for producing the first version of the required biennial report was to work with the already formed nonforest biomass Technical Team and potentially adopt their guidelines under development. Throughout the first half of 2011, the Council reviewed drafts and provided feedback to the Technical Team. In addition, a stakeholder review was completed through the Bioenergy Council. A formal scientific peer-review process was conducted in June 2011 by which nine science reviewers responded with additional suggestions. In July 2011, the Council approved the penultimate draft with minor revisions and released it to state agencies and the public for use in land management and planning activities.

PRODUCT

In overview, *Wisconsin Sustainable Planting and Harvest Guidelines for Nonforest Biomass* (Guidelines) "provide[s] general guidance for site and crop selection and more specific management guidelines for biomass projects within the categories: perennial grasslands, nonforest trees and shrubs, crop residue, and wetlands" (Hull et al. 2011). The guidelines are based on the best available science, though it is recognized that many biomass schemes are emergent systems without complete information about either production or potential consequences of associated land use changes and other impacts. Therefore, the Guidelines embody a precautionary approach. In the absence of scientific consensus or where scientific evidence is insufficient regarding any particular action, and where there is some risk of negative impact associated with an action, the recommendations are written to minimize negative consequences in the face of uncertainty. With greater scientific certainty in the future, the Guidelines may be revised to reflect evidence-based knowledge.

The Guidelines are voluntary. They are intended to help farmers, land owners and managers, crop consultants, natural resource managers, and others make good choices based on what is currently known. Some of the Guideline's suggestions are based on the experience of experts, some come from recent or extant research, and some are based on existing rules and regulations such as the state's nutrient management planning requirements and similar federal laws.

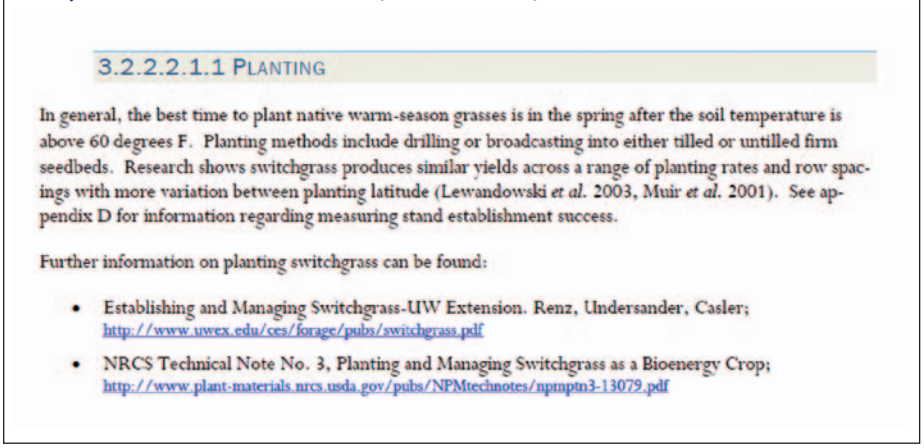
Sustainability principles are reflected in the Guidelines as both a broad discussion of planting and harvesting of nonforest biomass (e.g., benefits and costs, landscape-scale impacts, ecosystem services, and tradeoffs between cropping alternatives) and in management guidelines for specific crop types. These principles are primarily oriented to the imperatives of public agencies mandated to protect agricultural and natural resources and support endeavors based on these. However, a broader definition of sustainability is recognized, including the need for growers and entrepreneurs to be economically successful and for practices to be compatible with community and societal goals.

Chapter 2 of the Guidelines contains an overview of the potential impacts of nonforest biomass production in Wisconsin, sensitive resources and areas within Wisconsin, and other fundamental concepts that build the framework for sustainable biomass production within the state. In the Guidelines, production refers to growth and harvest of annual and perennial bioenergy crops as well as periodic harvest of vegetation from lands not in crop production (e.g., harvest of restored prairies for management of woody encroachment). The information in Chapter 2 should be useful for addressing the following questions: What biomass crop should I grow or harvest? Where should I grow or harvest this biomass? What information do I need to make sustainable and ecologically sound decisions?

Specific guidelines in chapter 3 include discussion of site selection, crop selection, wildlife considerations, crop management practices, and harvest regimes that apply to any type of biomass production. This chapter specifically covers four categories of nonforest biomass: perennial grasses, nonforest trees and shrubs (including short-rotation woody species such as hybrid willow and poplar plantations), crop residues, and wetland harvest. This chapter contains more specific information for crops and plants typical of, or

Figure 1

Example of Guidelines instructions (Hull et al. 2011).



3.2.2.2.1.1 PLANTING

In general, the best time to plant native warm-season grasses is in the spring after the soil temperature is above 60 degrees F. Planting methods include drilling or broadcasting into either tilled or untilled firm seedbeds. Research shows switchgrass produces similar yields across a range of planting rates and row spacings with more variation between planting latitude (Lewandowski *et al.* 2003, Muir *et al.* 2001). See appendix D for information regarding measuring stand establishment success.

Further information on planting switchgrass can be found:

- Establishing and Managing Switchgrass-UW Extension. Renz, Undersander, Casler; http://www.uwex.edu/ces/forage/pubs/switchgrass.pdf
- NRCS Technical Note No. 3, Planting and Managing Switchgrass as a Bioenergy Crop; http://www.plant-materials.nrcs.usda.gov/pubs/NPMtechnotes/npmptn3-13079.pdf

anticipated to be in, Wisconsin. The crop-specific information includes guidelines for site selection, preparation, planting, nutrient management, weed management, and harvest. Figure 1 shows an example of brief recommendations and links to further details, in this case, for planting switchgrass.

It is also notable that Chapter 3 includes information on systems such as shrubland and wetland—areas that may not become part of a regular biomass production system but that nonetheless may be harvested on occasion and which collectively could make substantial long-term contributions to the state's overall biomass capacity.

PROMISE

It is appropriate and inevitable that ideas for guiding something as new as broad-scale biomass production will be influenced by many organizations and opinions. Many good thoughts were generated during discussions about the Guidelines, and many were set aside in an attempt to find middle ground satisfactory to farmers, regulators, policy makers, entrepreneurs, and others involved in and potentially affected by biomass production. Some were discarded as premature, awaiting development of trends in biomass markets or for research to catch up and provide more definitive solutions. A few of these perspectives are noted below, both as considerations for future iterations of the Guidelines and for consideration in other jurisdictions that may face similar conditions.

Landscape Scale Analyses. Biomass production is one of many possible uses of a diverse and resilient "multifunctional" landscape that optimizes many ecosystem services (Jordan and Warner 2010). At the present time, though, we do not have data, metrics, and models that can be easily adapted to the decision-making needs of individuals to help them understand how their choices fit into a broader landscape matrix (Robertson et al. 2010; Schulte et al. 2010). Some aspects of this, such as contributions to water quality, are well known and widely practiced; we are at the beginning of understanding other aspects, such as greenhouse gas fluxes, carbon sequestration, and wildlife habitat impact assessment, and perhaps many years away from holistic models that incorporate metrics for all of these. The current Guidelines also incompletely capture the notion of biome-appropriate choices; for example, avoiding short-rotation woody crops in the midst of an area in which significant investments in grasslands restoration are being made.

Residue Management. It is very tempting to see currently "unused" crop residues as part of biomass feedstock supplies, but as every soil conservationist knows, residues are very important for long-term soil health and fertility. Precise estimates of sustainable levels of residue removal will have to account for rapidly changing biophysical conditions and management practices. Simple rubrics such as USDA Natural Resources Conservation Service soil conditioning index, used in the current version of the Guidelines, will need to be refined or replaced with measurements and models that incorporate more factors and dynamic conditions.

Tiered Guidelines. One potential use of the Guidelines is to provide specifications for contracts or incentives for public subsidies. Some of the guidelines could be designed with differing levels of performance, ranging from minimally acceptable to a high achieving "gold standard," with corresponding differences in payments or support. However, empirical data to base recommendations are available only for some production and harvesting choices. We decided to postpone the development of tiered recommendations to a future revision when more robust science is available to make those decisions.

Ecosystem Services. Dedicated biomass crops have great potential to provide environmental benefits in Wisconsin. Realizing those benefits (e.g., improved water quality, improved wildlife habitat, increased carbon sequestration) will depend on the types of crops planted, harvest regimes, and current economic markets, as well as willingness of farmers to adopt certain production methods. Our team initially set out to develop an ecosystem services "scorecard," detailing the types of services that could be achieved under different planting and harvesting scenarios. We found this to be an almost impossible feat primarily due to the lack of appropriate models and Wisconsin-specific data. Instead, we talk more broadly about ecosystem services and describe the tradeoffs and considerations biomass producers and consumers should understand. As with tiered guidelines, we think that quantifying the tradeoffs in ecosystem services is an important next step in sustainable biomass production. Current research, occurring at UW and other institutions, should allow us to develop an ecosystem services scorecard in the future.

Conservation Reserve Program Land. The US government has invested considerable funding in conservation set-aside programs such as the Conservation Reserve Program for a variety of public purposes, including protecting wildlife and water quality and greenhouse gas mitigation. As noted in the recent update to the "Billion Ton" study,

> Implementing switchgrass-based bioenergy production systems will require

converting marginal land from conservation plantings or annual row crops to switchgrass. Growing switchgrass on marginal sites likely will enhance ecosystem services more rapidly and significantly than on productive sites. There is concern of soil carbon loss associated with converting conservation grasslands such as those in the Conservation Reserve Program to bioenergy crops such as switchgrass. (USDOE 2011)

After much internal debate, we did not include a separate discussion of bioenergy cropping on former Conservation Reserve Program land in the Guidelines, though the tradeoffs as noted above in the US Department of Energy report, were included. The complex interaction of private choices, public policy and investment in ecosystem services, and biophysical change over time merits continued study so both growers and policy makers understand the consequences of choices they make when contracts expire.

These and other ideas will be grist for discussion for the Wisconsin Bioenergy Council as they contemplate an update or revision of the Guidelines for 2013. In the meantime, we invite comments on the current document to help improve the next version.

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