Community Assistantship Program

Wadena Agricultural Community Biomass Assessment Project

Prepared in partnership with
Wadena Ag Alternatives

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Photo courtesy of Jamie Robertson, 2007.

Wadena Agricultural Community Biomass Assessment Project

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II. Executive summary

The community of Wadena, Minnesota’s interest in rural development and bioenergy led to a three month pilot project to inventory currently available agricultural biomass. Agricultural lands and grasslands were surveyed within a local “fuelshed,” a concept region capable of supplying biomass-based energy to a community or facility.

Fuelshed boundaries were established with a transportation cost computer-based model. Land classification activities and harvest rates were derived from a protocol that employed local land managers, GIS-based soil maps and field surveying. The methodology and information sources are well documented and repeatable in other regions. The current agricultural resources within the fuelshed are estimated to produce 407,770-542,032 tons annually. Producer-to-producer interviews where used to highlight issues surrounding agriculture-to-energy systems. Further research is needed to identify other available feedstocks, such as forestry residue, brushlands and dedicated energy crops. More robust land classification and yield information, along with established sustainable harvest guidelines, would further define feedstock availability.

III. Introduction

As public interest in addressing carbon dioxide emissions, energy security and rural development is growing, a renewed interest in biofuels can be observed worldwide. Currently, the United States consumes 140 billion gallons of gasoline per year with ethanol contributing 4.5 billion gallons or 3.2% of the total demand (Yang and Lu, 2007). Recent studies, bold statements and supportive policies intend to increase the contribution of biofuels to the overall energy supply. The 2007 State of the Union address called for a 20% reduction in gasoline consumption within ten years (Tiffany, 2007). To accomplish this, 35 billion gallons of ethanol need to be produced. Perlack et al. found that 130 billion gallons of ethanol could be produced from cellulosic sources, such as forestry residues and prairie grasses (Perlack, 2005).

The major drivers behind these biofuel development goals are often the opportunities in rural development. The feedstocks of today, largely corn and soybeans in the US, have boosted the price of corn and spurred development in the Corn Belt. In Minnesota alone, five new plants with capacities total 450 million gallons of ethanol annually will contribute to the existing 16 plants producing 620 million gallons annually (Minnesota Department of Agriculture, 2007). However, expanding the economic benefits of biofuel development and meeting the national objectives will require moving into a new generation of feedstocks, such as dedicated energy crops and agricultural residues. There are other drivers in the move to next generation feedstocks. Public interest in the "food versus fuel" debate surrounding corn grain ethanol and the increased environmental costs of expanding production also weigh heavily into the debate (Business Week, Feb 5, 2007).

The national interest in biofuels and rural development, supportive national policies and projected increase in demand have pushed many communities to align themselves for the impending influence of biofuel development. Among these biofuel enthusiasts is the community of Wadena, Minnesota.

Wadena is a predominantly agricultural region in north-central Minnesota. The region is located in the transitional zone between the mixed conifer forests of the north and the prairies of the south and west. Forested morainal hills of oak and aspen are interspersed with lowland shrubs and wetlands across outwash plains. Fine, sandy soils and the northern climate have favored pastures, hay lands and hardy small grains over traditional biofuel feedstocks such as corn and soybeans. The region contains hundreds of miles of high quality streams and rivers and very few lakes. The fire-dependent jack pine and oak brush lands of the region discouraged the timber industry development that took place in the surrounding areas.

Many socio-economic indicators reflect the interest that Wadena residents have in rural development. While surrounding lake-related tourism regions have shown growth in population over the past few years, Wadena's population has declined[*]. Since 2000,

[*] *Data for Ottertail County is not presented in the figures because of its large size and data availability. County-wide data would presumably be skewed by the more productive soils and growing communities of western Ottertail.*

Wadena and Todd counties have experienced a 2% and 0.2% decline in population, respectively. Median income is also significantly lower in this region when compared with the rest of the state (e.g., median income in Wadena County is $34,615, or 69% percent of the state median income of $51,202) (US Census Bureau, 2007).

Wadena Agriculture Alternatives† collaborated with the University of Minnesota Central Sustainable Regional Partnership and the University of Minnesota Extension to coordinate a project to measure the biomass potential in the region. The concept of a "fuelshed," a region capable of supply biomass to a community or facility, was used to identify existing feedstock sources in the region.

IV. Biomass inventory

A. Summary of existing reports

As interest in energy from biomass sources has grown nationally, a number of government and private sectors have undertaken studies to quantify existing and potential sources of biomass. The existing inventories primarily differ in terms of *scale, objectives and types of feedstock*. The inventories were conducted at a variety of scales: the USDA's Billion Ton gathered information at the national level while the Renewing Rock-Tenn report was conducted on a multi-county regional scale (Perlack, 2005; Nelson et al, 2007). The existing inventories were also undertaken with a wide variety of goals. Many reports, such as the Washington and Wyoming state inventories, were designed to paint a broad picture of the potential sources and wastes with no specific end-uses while other reports, such as the Oregon's three-county study, were completed to specifically address the mounting costs of disposal (Peak Environmental Management, 2002; McNeil Technologies, 2003; Frear et al., 2005). The many inventories also varied in the breadth and types of feedstocks quantified. The Minnesota Department of Natural Resources (MN DNR) Logging Residue Analysis project specifically targeted forestry residues from timber harvesting operations, whereas the Hawaii State Inventory included biomass from agricultural, food, forestry, industrial and domestic sources (Turn et. al, 2002; Sorensen, 2006). To frame the objectives of the Wadena community's proposed biomass inventory in the context of other inventories, a review of existing surveys was completed. The inventories are summarized in the following table:

Table 1. Inventory comparison chart.

Inventory	Year published	Scale	Objectives	Feedstocks considered
USDA Biomass as Feedstock for a Bioenergy and Bioproducts Industry (Perlack et al., 2005)	2005	National	Determine if US land resources are capable of producing biomass sufficient to replace 30%+ of petroleum consumption	Agricultural, forestry

† *The Wadena Ag Alternatives is comprised of 20-40 area residents and county agency staff interested in revitalizing the area's rural agriculture economy through diversification, including value added agriculture opportunities.*

BioCAP A Canadian Biomass Inventory: Feedstocks for a biobased economy. (Wood and Lyzell, 2003).	2003	National	Quantify resources for energy, chemical and materials; address climate change	Agricultural, Forestry, Municipal Waste
Colorado Office of Energy Management and Conservation Colorado Agriculture: land, water, energy use and bioenergy potential. (Carlson and Leeper, 2004)	2004	State	Assess water, fertilizer, energy and pesticides use to evaluate efficiency and conservation; renewable energy potential	Agriculture
National Renewable Energy Lab; Minnesota Biomass: hydrogen and electricity potential (National Renewable Energy Lab, 2005)	2005	State	Reduce waste streams; alternative to fossil-fuels	Forestry, mill residues, agriculture, energy crops, urban wood residue
Ohio Department of Development/Ohio State University: Assessing Ohio's Biomass Resources of Energy Potential Using GIS. (Jeanty, et. al, 2005)	2004	state	Air quality, energy security, global climate change; emerging bioenergy industry requirements	Forestry, Agriculture, Municipal Solid waste, processing residues
Oregon Department of Energy; Biomass Resource Assessment and Utilization Options for Three Counties in Eastern Oregon. (McNiel Technologies, 2003).	2003	Multi-county	Assess location and cost of feedstocks; utilization facility location; economic development, fuelwood reduction for fire	Agriculture, Forestry, wood products
Oregon Office of Energy; Oregon Cellulose-ethanol study (Graf and Koehler, 2004)	2000	state	Cellulose feedstock availability, policy overview, near-technology review, economic feasibility	Agricultural, Forestry, Wood products industry
University of Minnesota; Ethanol from Biomass: Economic and Environmental Potential of Converting Corn Stover and Hardwood Forest Residue in Minnesota. (Petrolia, 2006).	2006	state	Reduce dependence on rogue nations for petroleum, cost analysis for proposed facility	Agricultural residue from corn; Forestry residue from hardwood
Renewing Rock-Tenn: biomass fuels assessment for Rock-Tenn's St..Paul Plant. (Nelson, 2007).	2007	Multi-county region	Assess alternatives fuel source for existing facility	Forestry, urban wood waste, milling residues, agriculture, energy crops
Center for Energy and Environment; Identifying effective biomass strategies. (Butcher, 2005).	2007	state	Identify strategies to develop biomass based electric facilities	Agriculture, Forestry
Washington Department of Ecology and Washington State University; Biomass inventory and bioenergy assessment. (Frear, et al., 2005).	2005	state	Reduce organic residuals in solid waste, sustainable energy policy	Agriculture, Forestry, Urban Wood Waste, wood products industry, food processing, etc.

Minnesota Department of Natural Resources Logging Residue Analysis (Sorenson, 2006).	2006	Forested regions- state	Summarize forest residues by cover type, silvicultural prescription, and location	Forestry
Local roadmaps for biomass fuel sheds (Russelle et al, 2006).	2006	Multi-county regional area	Map net energy production to increase efficiency and lower risk	Agriculture products and residues- corn grain, corn stover, soybean, alfalfa
Madelia Bio-based eco-industrial assessment. (Meschke, 2007).	2007	Multi-county regional area	Survey biomass resources for eco-industrial development; address soil and water problems, rural developments	Agriculture, energy crops, food processing wastes municipal wastes.

The objectives of the pilot project were prioritized after reviewing existing inventories and presenting the information during various meetings with the Wadena community. During these meetings, efforts were directed towards assessing the types, detail and availability of information the community required. The following table was created and placed in the context of existing inventories.

Table 2. Wadena Community Inventory in perspective

Inventory	Year published	Scale	Objective(s)	Feedstocks considered
Wadena-area community biomass inventory: agricultural residues	2007	Community wide	Quantify agricultural resources to support rural economic development, improve environmental quality; increase carbon sequestration	Agriculture residues

B. Protocol and project development

Conducting inventory of the existing agricultural residues requires understanding of the types of agricultural systems, the relative management schemes and the productivity of these systems. Once these parameters are known, delineation of the area of interest is possible. This pilot project took this aforementioned approach by 1) establishing the fuelshed boundary, 2) delineating agricultural lands and determining productivity, and 3) establishing technical and sustainable harvest rates.

1. Establishing the fuelshed boundary

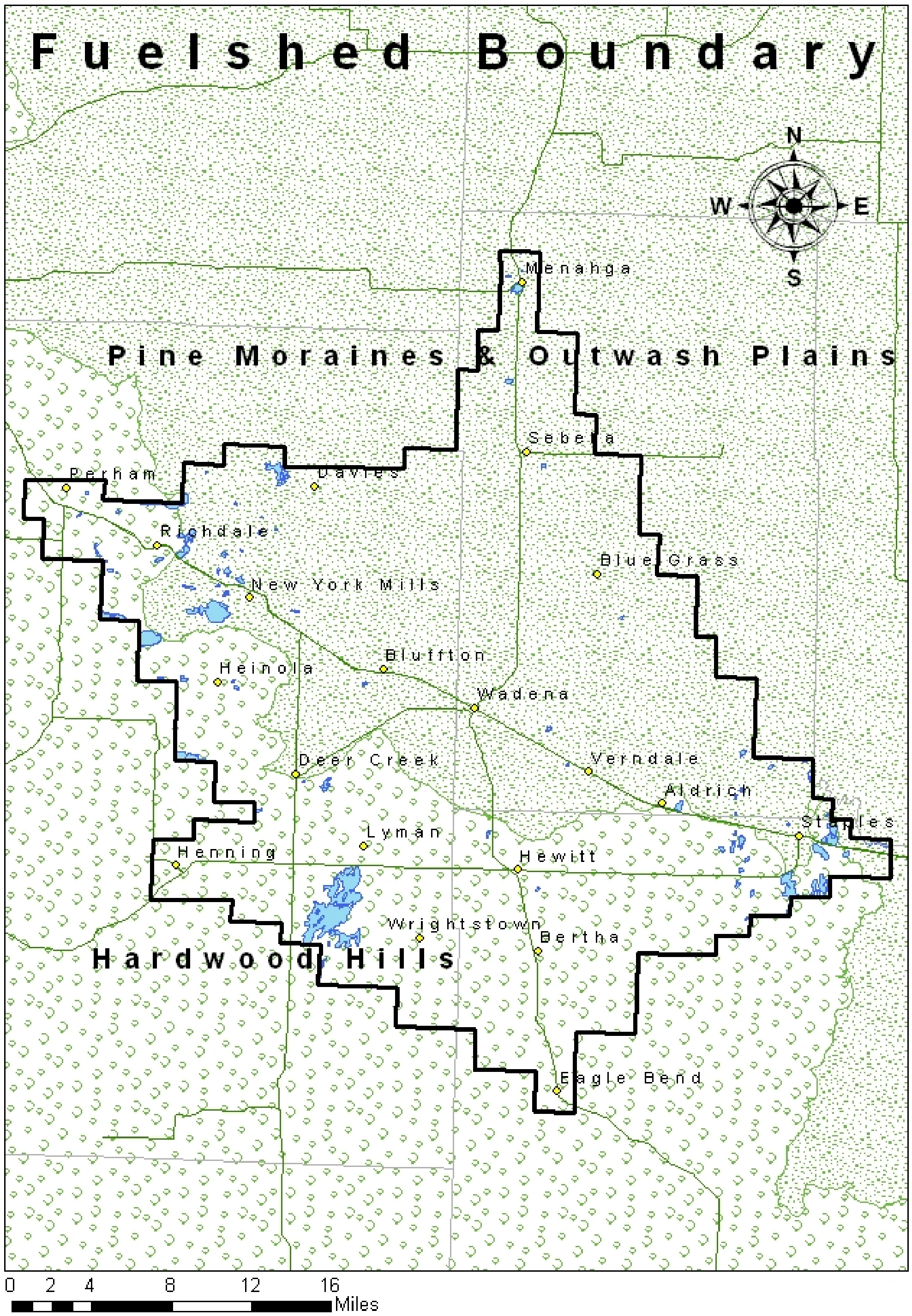
As the demand for feedstock grows, transportation costs are predicted to play an increasingly important role in determining the extent of fuelsheds. Facilities located in close proximity to biomass sources will increase the competitive advantage of the operation. Furthermore, communities interested in benefiting from the production and conversion activities, as with the case of the Wadena project, are interested in local biomass sources. For these reasons the project investigated a number of fuelshed definition options.

The first approach focused entirely on the energy equation of transporting biomass. The premise was that the amount of energy feasibly "extracted" from the feedstock should be considerably greater that the amount of energy consumed in transportation. However, most conversion technologies are in precommerical stages; the amount of energy present in the biomass hauled depends on the approach. Furthermore, truck capacity will greatly depend upon densification (ie, round bales are more voluminous but contain less biomass then square bales). However, the energy-balance approach may warrant further investigation for its potential contribution to the "fuelshed" concept.

The second fuelshed definition approach employed existing political boundaries, particularly county units. Much of the data useful for inventory, such as agricultural statistics and soil maps, are readily available at this level. However, after consultation with the Wadena community, political boundary definition was abandon for a number of reasons: First, the city of Wadena is located at the intersection of many different counties, none of them being uniform in size or situated to make it logistically practical to define the boundary this way. Secondly, the group felt strongly that political regions are often unfairly favored over ecological regions. Lastly, the community group saw the region being socially, ecologically and economically diverse enough that a finer scale of resolution needed to be pursued.

The third fuelshed definition approach intended to bring together the parameters that the Wadena community group felt were most important. A GIS-based transportation cost model developed by the University of Minnesota was tested to calculate biomass transport costs (Nacionales, 2007). The model takes spatial inputs (ie., a delivery points and average highway speeds) and feedstock parameters (ie., weight and volume) to determine travel time costs. Travel cost data was then overlaid with the Department of Natural Resources Ecological Classification System (ECS) subsections, which defines regions based on ecological variables, among them glacial, climate, pre-settlement vegetation, and soil parameters. To facilitate sampling locations, township sections (one square mile) were used. The resulting boundary was entirely contained in two ECS subsections: Hardwood Hills and Pine Moraines and Outwash Plaines (Figure 1). The boundary was less than or equal to a thirty minute semi-truck drive. This boundary roughly equated the 25-mile boundary originally proposed by the group.

Figure 1. Fuelshed boundary map of Wadena community biomass inventory



2. Classifying agricultural lands and determining productivity

A diverse group of local land managers, datasets and procedures were consulted to determine the amount of land in agricultural production, the types of crops grown, associated yields, and yield to residue ratios.

To determine soil type extent and productivity, the county-wide Natural Resource Conservation Service (NRCS) Soil Survey Geographic (SSURGO) soil maps were used (Soil Data Mart, 2007). With the assistance of the staff of Ottertail, Wadena and Todd counties' USDA Service Center, the soil types were partitioned into groups based on similar yields, management schemes and biophysical properties (I. Rienke, personal communication. 15 July 2007; M. Smith, personal communication. 21 July 2007). Classification on these parameters, in consultation with local experts, deserves further investigation as a useful tool for such inventories. In addition, published yields for common soil types available in the NRCS Field Office Technical Guide may serve useful in classifying soils. Due to time and capital constraints, the soils were broadly categorized into three management-yield-biophysical categories: 1) soils characterized by often lower-yielding sandy, outwash soils under dryland conditions, 2) soils characterized by the higher-yielding moderately slopped soils of the drumlins and moraines, and, 3) the irrigated, flat outwash soils with higher-yielding crops of soybean, corn and potatoes (Figure 2). Table 3 outlines the land classifications and associated crops yields of the various management units.

Figure 2. Land classification map of the Wadena community biomass inventory. (total acreage= 542, 825 cropland = 296,604 acres)

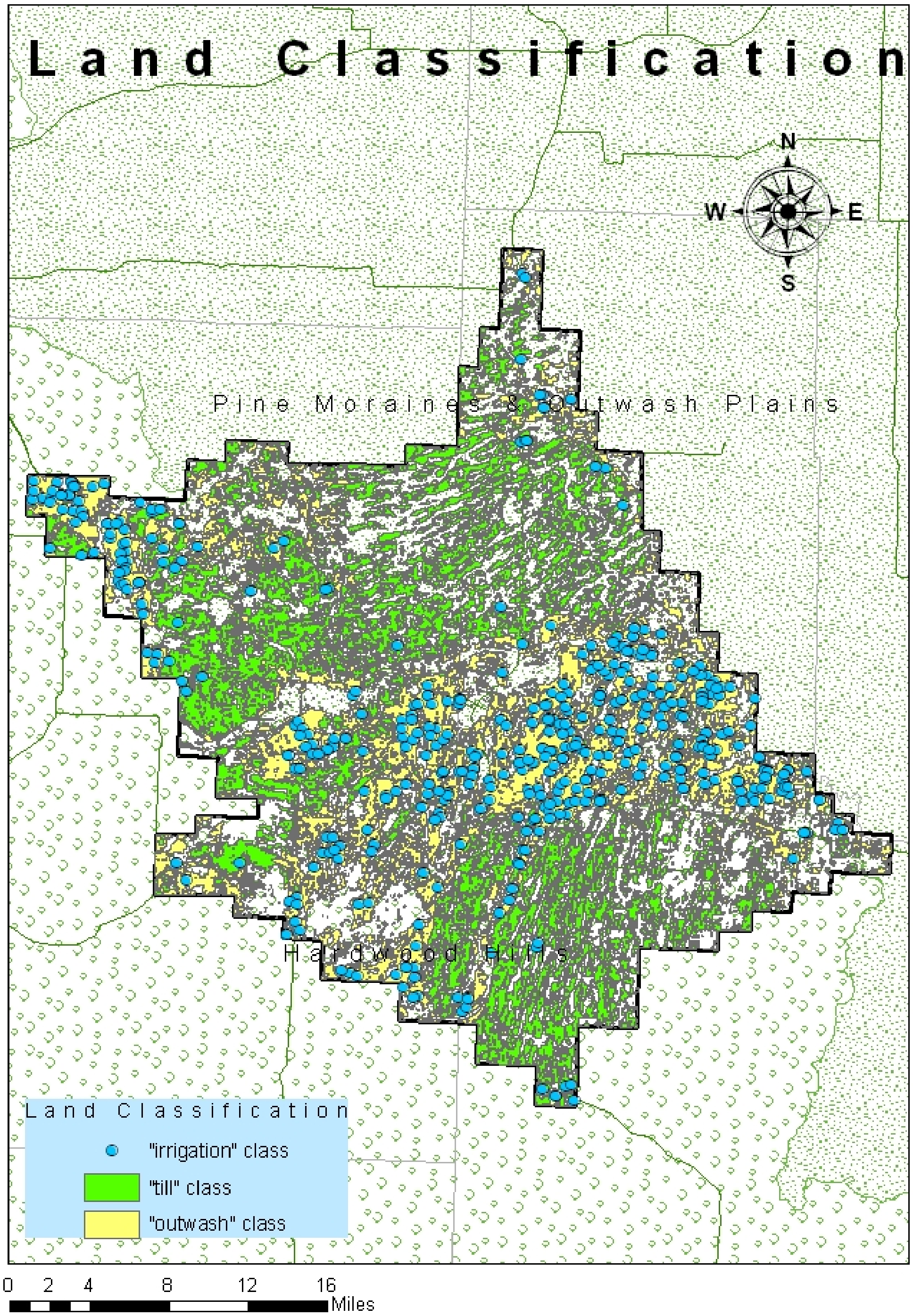


Table 3. Estimated yield of various crops according to land classification based on NRCS staff and field office technical guide.

	Land classes (yield/acre)		
Crop	outwash	till	irrigated
alfalfa hay	2.2-2.6 tons	2.9-4 tons	5 -6 tons
barley	40-60 bu	40-60 bu	60-80bu
corn	50-80bu	130-150 bu	150-220 bu
old field	1.5 tons	2.2 tons	n/a
hay other	1.5-2 tons	2-3.3 tons	n/a
hybrid poplar			n/a
oats	60-80 bu	60-80 bu	60-80 bu
wheat	40-60 bu	40-60 bu	60-80 bu
sunflower	n/a	1800 lbs	n/a

The Department of Natural Resources Gap Analysis Program (GAP) landcover data was used to determine cropland (DNR Data Deli, 2007). The fuelshed area was compiled from 1999/2000 satellite imagery with an accuracy rating of 85-90%. A total of 296,604 acres of cropland are found within the fuelshed. The need for finer resolution required surveys to be conducted to further breakdown the agricultural land into common classes such as alfalfa, corn and abandoned agricultural fields. Thirty three-mile transects, comprising of over 13,020 acres or 4.4% of the agricultural land in the fuelshed, were surveyed using a “windshield” approach (ie; sites are visited and current crop is recorded on aerial imagery) (Figure 3). The Federal Farm Service Administration (FSA) Arial imagery from 2003 (1m) and 2006 (2m) combined with ArcTools Spatial Analyst were used to determine crop type breakdown. Using a single season “snapshot” of subsequent years has its downfalls. For example, the recent increase in corn acreage in response to the ethanol market most likely over represents the long-term average of corn acreage. Future research would be improved by including multiple year data.

Figure 3. Survey sites for the Wadena community biomass inventory

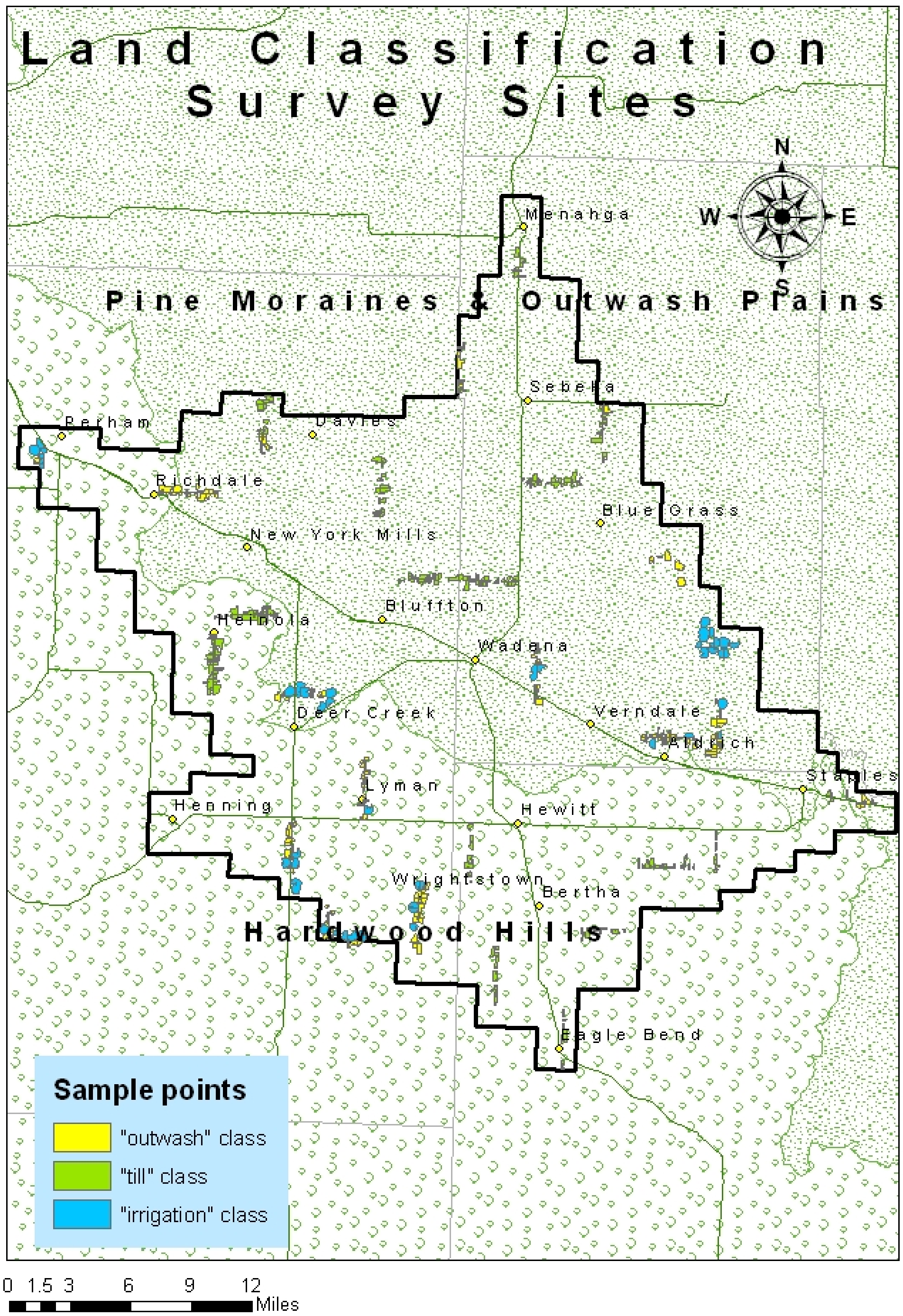


Table 4. Land classification crop cover based on survey points of the Wadena community biomass inventory.

	Land Classes		
Land cover	Outwash acres (%)	Till acres (%)	Irrigated acres (%)
alfalfa hay	14,803 (13.9)	21,468 (14.3)	966 (2.4)
barley	1,170 (1.1)	1,668 (1.1)	n/a
corn	20,404 (19.2)	28,736 (19.2)	21,766 (54.3)
old field	29,481 (27.7)	7,264 (4.8)	n/a
hay other	11,135 (10.5)	39,343 (26.2)	n/a
hybrid poplar	289 (0.3)	2,681 (1.8)	n/a
oats	2,273 (2.2)	3,592 (2.4)	260 (0.6)
pasture	12,426 (11.7)	25,104 (16.7)	n/a
soybean	8,616 (8.1)	13,699 (9.1)	8,297 (20.7)
wheat	5,706 (5.4)	5,829 (3.9)	2,592 (6.5)
potato	n/a	n/a	6,209 (15.5)
sunflower	n/a	816 (0.5)	n/a
total	106,313 (100)	150, 200 (100)	40,091 (100)

After determining the area that each crop occupies in the fuelshed and its associated yields on different soils, yields are converted to residue using the Soil Conditioning Index (SCI)(Natural Resource Conservation Service, 2004). SCI is a useful tool developed by the NRCS to determine the soil organic levels under different practices and rotations. Its empirical underpinnings may be useful to determine sustainable rates of residue removal, as well as generalized residue to yield ratios, for future inventories.

Table 5. Residue to yield ratios analysis of various crops based on the Soil Conditioning Index (SCI).

Crop	units	lbs/unit	residue: yield ratio
alfalfa hay	tons	2000	1
barley	bu	48	1.5
corn	bu	56	1
old field	tons	2000	1
hay other	tons	2000	1
oats	bu	32	2
wheat	bu	60	1.3
sunflower	lbs	1	2.2

3. Establishing technical and sustainable harvest rates

The calculated gross residue yields continue to filter through additional biophysical, technical, economic and social demands. Determining the amount of residue that is physically recoverable must be balanced with the amount that can be sustainably removed.

The NRCS states that sustainable harvest rates are determined by soil type, management practices, climate, topography, crop type and yield. Additional studies add crop rotation, timing of practices and nutrient application as other factors that determine sustainable harvest rates. Wilhelm (2004) and Kerstetter and Lyons (2001), highlight additional difficulties in generalizing harvest rates and the importance of considering local conditions (Wilhelm, 2004; Kerstetter and Lyons, 2001). For example, the use of cover crops and the timing and type of tillage can drastically impact the sustainable harvest rates.

Several studies have presented harvest rate data at regional scales using the revised universal soil loss equation (RUSLE) or wind erosion equation (WEQ) alone or in combination with Soil Conditioning Index (SCI) to obtain generalized rates (Nelson, 2002). The difficulty with employing these methodologies is that the regional diversity of crop rotations, microclimate, management practices and soil types within each area quickly complicate the procedure. The Wadena community is no exception; generalizing standard crop practices in a diverse landscape of pastured drumlins and irrigated outwash plains is out of the scope of this pilot project. Further research on developing sustainable harvest rates, as well as incorporating them into agriculture-to-energy systems is needed.

Removing residue may export valuable nutrients, increase the number of field entries, and require additional equipment. The producer's ability to contribute additional labor and capital inputs will affect the delivery rates and amounts.

Table 6. Technically feasible and sustainable harvest rates of select landcover classes for the Wadena community biomass inventory*

Crop	portion *technically* recoverable (%)	portion *sustainably* recoverable (%)	net recoverable portion (%)
alfalfa hay	100	100	100
barley	100	70	70
corn	50	46	46
old field	100	100	100
hay other	100	100	100
oats	100	70	70
wheat	100	70	70
sunflower	55	100	100

*Corn stover removal rates were based on Schechinger and Hettenhaus, 2004 and county-wide data from Walsh, 2005, reported in Green Institute, 2007. Small grain removal rates were based on Kerstetter and Lyons, 2001 and Biopet Version 1.0, Center for Energy and Environment. . Sunflower removal were based on Hickman and Schoenberger, 1989 and Biopet Version 1.0, Center for Energy and Environment.

The following table presents the estimated total biomass available annually within the Wadena biomass fuelshed inventory project.

Table 7. Total estimated annual biomass from agriculture residue within the Wadena community biomass inventory.

	land classes (tons/class)					
crop	Outwash (tons)	Till (tons)	Irrigated (tons)	**total (tons)**	net recoverable (%)	***Net total (tons)***
alfalfa hay	32,567-38,489	62,258-85,872	4,832-5,798	99.657-130,160	100	***99,657-130,160***
barley	1,684-2,526	2,401-3,602	n/a	4,085-6,128	70	***2,860-4,290***
corn	28,565-45,705	104,589-120,690	91,418-134,079	224,582-300,474	46	***103,307-138,218***
old field	64,858	15,983	n/a	80,841	100	***80,841***
hay other	16,702-22,269	78,686-129,832	n/a	95,387-152,101	100	***95,387-152,101***
oats	4,365-5,819	6,897-9,197	500-667	11,762-15,684	70	***8,234-10,979***
wheat	8,903-13,354	9,093-13,639	6,065-8,086	24,060-35,079	70	***16,842-24,556***
sunflower	n/a	1,166-1,616	n/a	1,167-1,616	55	***642-889***
gross total	**157,644-193,020**	**281,083-380,431**	**102,815-148,631**	**541,542-722,082**		***407,770-542,032***

V. Producer participation rates: farmer-to-farmer interviews

A. Introduction

In addition to obtaining information on the biophysical resources, producer participation rates are important influences on biomass supply. Obtaining participation rates on a pre-commercialized technology can be difficult. Consequently, the project gathered qualitative data on the constraints and opportunities to producing feedstocks through personal interviews. In addition, the Wadena community organization felt that the interview sessions would also act as an educational opportunity to help prepare the community for potential biomass development. The interviews were designed to be administered by community members and local farmers, thereby increasing participation rates and reducing the workload of researchers. Before the interviews, interviewers attended a preparatory meeting to identify potential interviewees and outline procedures.

The questions were based on the work of Roger (2005) and Current (1999) that focused heavily on addressing risk at the farm-level (Roger, 2005; Current 1999). The following assumptions were undertaken:

- Developing a biomass energy facility requires an in-depth examination of the issues surrounding production, transportation, processing and conversion. *These interviews focused only on the collection and production phase only*.
- Many biomass sources, both wet (i.e. manure) and dry (i.e. forestry residues) should be evaluated when considering a facility. Due to the community objectives and resource constraints *the interviews focused only on woody and non-woody*

agricultural residues and products, which we referred to as "agricultural resources."

- The questions were designed to address four categories: *socio-cultural, economic, political-institutional and biophysical-technical factors.*

B. Methods

Interviews were conducted with 30 producers to a) determine producer participation rates b) raise awareness of issues confronting bioenergy development, and 3) identify additional technical, social and resource constraints and opportunities. Four core interviewers from the community conducted all of the interviews. Interviewees where identified both non-randomly through local contacts and then randomly at the local county fair. Interviews took place in local homes, businesses and at the county fair booth over the course of four weeks. Debriefing sessions with the interviewers took place after the interviews.

Several biases exist and should be addressed in future interviews. The first is that the interviewers all received different levels of training. Second, several of the interviews took place in a setting poorly suited to obtaining good interview data. For example, several interviews were conducted at the potentially distracting county fair. Lastly, the subjects may have been partial to the idea of bioenergy given that they were often associates of the interviewees or approached the county fair booth. Due to these biases and the limited structure, the following information should be noted with caution. The interview questions can be found in Appendix A.

C. Results

The majority of the participants were not aware of the proposed project; several had heard of the project locally publicized. Two participants were overtly optimistic about the project; five participants had overtly negative or pessimistic views of the proposed project.

When asked about the competitive advantage that the Wadena region had over other regions in terms of natural resources, economic and socio-cultural aspects, the answers could be categorized as followed:

- Marginal cropland with poor soils, interspersed with traditionally lower-valued wetlands and steeply-slopped areas are well-suited for non-traditional, perennial crops.
- The opportunity costs of converting to non-traditional energy crops are lower because lower-yielding land is not in direct competition with higher-valued crops, such as corn.
- Relative to the population, land is abundant. Population growth in the area is negative. Recreational land, especially for hunting, may soon change this dynamic.
- Abundant abandoned agricultural land; many acres are enrolled in the Conservation Reserve Program (CRP). Consideration needs to be given to the

difficulty in putting these often steeply sloped lands back into production due to gopher colonization.

- Producers are interested and willing to experiment with new crops due to the drought and recent failures with traditional crops.

The Wadena region landscape has many advantages over other regions, according to the participants. The diversity of forested and agricultural land with steep slopes, low lands and drought soils makes the region ideal for perennial grass systems. The difficulty in growing annual crops under drought-like conditions in the last few years would likely increase producer participation. At the same time, several producers saw these advantages as constraints; lower yields, wetlands and accessibility issues would hold bioenergy development back. To address soil and water conservation issues, producers suggested using energy crops that were perennial, required few chemical inputs, and performed well under dryland conditions. The high water table and increased use of irrigation and chemicals were often cited as conservation concerns. Generally, the participants were optimistic about the advantages of the local landscape and were aware of the feedstock characteristics that would work well in the region.

The interviewers asked how well regional producers were informed about the potential of agricultural resources for bioenergy and where producers go for information. The majority felt that producers were not informed bout the issues. Three participants mentioned the excitement surrounding agriculture-to-energy issues in industry periodicals, such as Successful Farming. Additionally, many felt that knowledge within the community was often disseminated through seed dealers, bankers, local USDA field staff and other farmers. Several participants felt that the University of Minnesota Extension played a historically important role in the diffusion of knowledge. The need for demonstration plots and pilot facilities were mentioned many times. Demonstration meetings should take place in the early spring to avoid conflict with planting and harvesting.

The majority of producers felt confident that agriculture could produce feedstocks with a competitive market. There was an overtly optimistic view that cost barriers are minimal. Traditional costs such as fertilizer, transportation, equipment, land rent and seed costs were surprisingly absent. However, at the same time many participants were unsure about the future in the market. This suggests either a somewhat desperate community eager for any alternative or a prenatal industry too far from commercialization to realistically consider the change. The participants regarded the privatization of the agriculture-to-energy industry as a positive step forward. The interviews suggested that producers are often price-takers, bearing the costs of transportation and processing. Many interviewees saw agriculture-to-energy development as an opportunity to change this dynamic. The few costs that were specifically mentioned were high-costs of nutrients, transportation and competition with the local dairy industry.

The participants were also asked about the role that the Federal Farm Bill has in agriculture-to-energy development. Interviews highlighted the following issues:

- Farm Bill is ever-changing and often complicated. Producers are unable to follow and adequately weigh in on its development. Many interviewees were unaware of reform options or did not express opinions about the Farm Bill.
- Another group of producers felt that the Farm Bill discouraged experimental practices and should be reformed or phased-out. Participation in the program is too rigid to allow the production of energy crops.
- Seven participants mentioned the ability of the Conservation Reserve Program to produce energy feedstocks. Policy changes could open up these set-aside acres to harvest. These producers felt that converting CRP acres to a perennial biomass program is a good option to make the Farm Bill bioenergy compatible.

Transition from current management practices to a system which produces dedicated energy crops or utilizes agricultural residues was a peripheral problem for the participants. When asked what percentage they are willing to dedicate to agriculture-to-energy systems, given a fair price, all but four participations stated 90-100% of their production. The outliers have livestock operations, need more information and require long-term contracts to consider switching. It is unclear why so many participants are willing to convert. Frustration with recent yields and the desire to pursue practices that add-value to the operations may help explain such willingness to participate

The obstacles in converting from current management practices were primarily the high costs of new equipment, the number of producers nearing retirement and difficulty in mobilizing necessary organizations, such as financial institutions and cooperatives. Several suggestions for overcoming these roadblocks were listed, among them, the availability of small grants for producers to cover start-up costs and the development of feedstock contracts with buyers. Several participants suggested focusing grants and technical assistance at smaller growers already producing crops with residues and without large infrastructure investments. For example, a smaller farmer producing hay and small grains would be better suited for supplying feedstocks than a diary or livestock producer set up for a different system.

VI. Conclusion

This report highlights the potential for community-driven research projects to contribute to the biofuels development. GIS tools and a user-friendly sampling protocol were combined with existing resources and local experts to help determine amount of biomass currently available from agricultural activities in the region. A fuelshed definition concept was introduced and soil-based classification systems were used to obtain robust data on resource-availability. Localized interviews highlighted the need for more research and technical assistance on harvesting and transporting feedstocks. This three month pilot project represented a positive step forward in helping the Wadena community determine how bioenergy development will proceed.

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VIII. Appendix

Interview questions

1. The following survey asks questions related to a proposed cellulosic ethanol project in the region. Have you heard of this proposed development?

2. *Ask the interviewee to think about the Wadena area, the land, the different cultures, people's values, etc.* How do these factors give Wadena an advantage over other regions for a bioenergy project from agricultural resources? What are some disadvantages of the Wadena region?

3. How well are producers informed about the potential use of agriculture resources for bioenergy? (list the sources of information) What can be done to help producers become better informed about potential undertakings?

4. What might be the greatest financial barriers to collecting and producing agriculture resource for bioenergy? How might producers overcome these costs?

5. How do you view the future in this market? (long-term vs. short-term)

6. What role does the Federal Farm Bill play in using agricultural resources for bioenergy? How could the program be modified to better support interested producers?

7. What additional polices and programs, (existing or new) could be used to overcome risks in producing and collection biomass?

8. When adopting new practices, where do you go for assistance?

9. What biophysical (soil, water, geographic, etc.) features make you land ideal for production of agriculture resources? What features make your land ill-suited?

10. How can landowners address land and water conservation issues surrounding the collection and production?

11. How difficult would it be to switch from your current management system to one that collects or produces crops for energy? What technical obstacles do you anticipate for you or one of your neighbors?

12. Now that we have discussed the types of issues that may arise from using agricultural resources for bioenergy, would you participate? Why or why not (what would it take to participate)

13. Number (%) of acres in cultivation:___
    Number (%) of acres willing to dedicate to energy crops and/or collect residue: __