Factsheet # 2

Title: SWITCHGRASS AND MISCANTHUS AS BIOMASS CROPS FOR ONTARIO, CANADA

By

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Sponsored by: OMAFRA KTT project initiative and the University of Guelph

Collaborator: Ontario Biomass Producer Cooperative (OBPC)

WHAT ARE PERENNIAL BIOMASS CROPS?

Perennial biomass crops (PBCs) are fast growing herbaceous grass species with the ability to contribute to the production of biomass energy. They are a renewable and carbon neutral energy source, where electric power is created by burning of organic material (1). Perennial biomass crops, namely switchgrass and miscanthus, are becoming increasingly popular in Ontario due to their ability to produce high biomass yields with little inputs and low soil nutrients, while improving soil health (2). The growing biomass and renewable energy sector are creating increased demand for biomass crops, providing a sustainable economic avenue for farmers, especially on marginal or degraded lands (2). The integration of biomass crops into Ontario's agricultural community is an economically and environmentally conscious decision.

Figure 1: Switchgrass crops (left) and miscanthus crops (right) growing in Ontario, Canada. (2,3)

SUITABILITY FOR ONTARIO

The economic and environmental benefits of PBCs are increasing their popularity across Ontario's agricultural community (4). The Ontario Biomass Producers organization is currently implementing strategies encouraging farmers to convert unproductive or marginal farmlands to PBC production (5). As biomass energy crops, they have the ability to improve the productivity and health of marginal agricultural land, while providing economic income for farmers (5). Their high biomass yields on degraded soils, strong environmental tolerances, low nutrient inputs and similar management to other major crops grown in the region (corn, soy) make both miscanthus and switchgrass effective crops for growth in Ontario (6). The climate and water availability in southern and western Ontario are well suited to both crops; they establish well on most soil types and have optimal air temperature ranges from 25°- 29°, which coincides with the growing season months (7). Miscanthus and switchgrass are both C4 plants with deep rooting systems that allow them to use 50% less water than C3 crops per tonne of biomass and be 40% more effective at solar energy conversion (7). As water availability is typically the limiting factor in Ontario biomass yields, this makes switchgrass and miscanthus highly suitable for Ontario's agricultural production. In regions with poorer quality soils and higher temperatures, switchgrass is the preferred crop, whereas in other regions miscanthus is preferred for its increased nutrient use efficiency and carbon sequestration potentials (8). With the available marginal quality and low yield production lands in Ontario, the integration of biomass crops shows substantial promise both economically and environmentally.

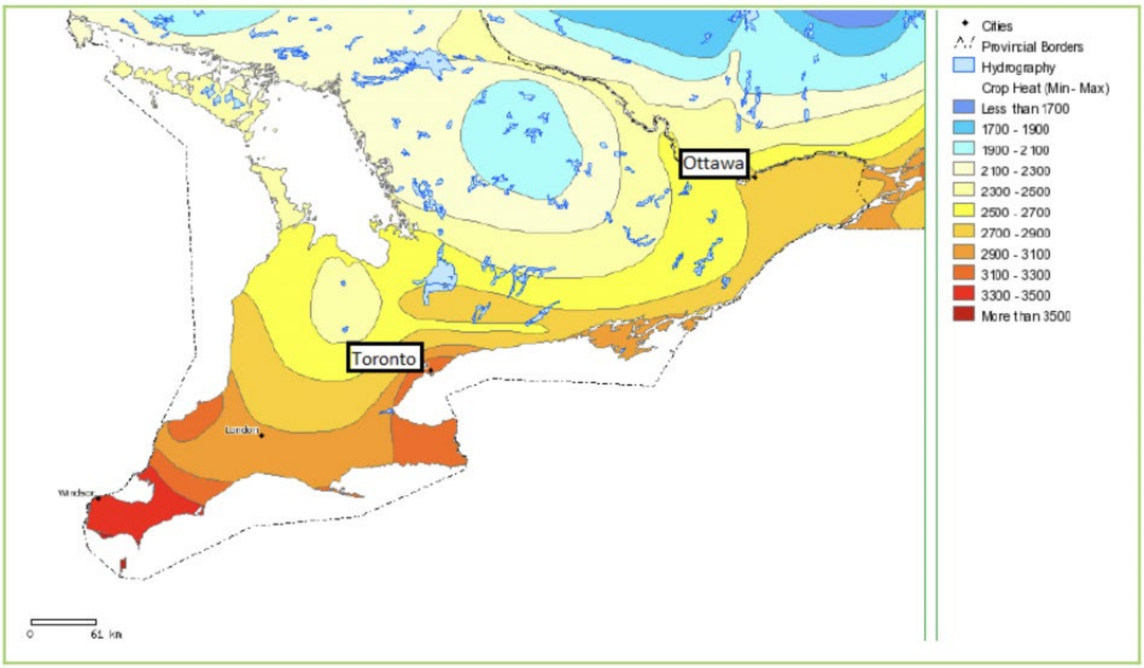

Figure 2: Marginal class 3 lands and zones of 2100-2700 CHU are optimal target areas for switchgrass production in Ontario, Canada. (2)

AVAILABLE LAND AREA

Recent land use studies in Canada show that 37,790,608 ha of agricultural land are in use, with 3,650,789 ha of land located in Ontario (9). The Canada Land Inventory classifies land for agricultural purposes in 7 groups based on potential for productivity, with classes 1-3 being considered prime agricultural resources, and 4-7 as marginal quality land (10). Both switchgrass and miscanthus have been shown to establish well in areas of low nutrient and water availability, with higher yield production than many annual crops on class 3 lands (6,11). With around 3,644 ha of Ontario's agricultural land determined to be class 3 soils and an additional 320 000 ha of class 4-6 lands, there is a large potential for the integration of biomass crops in these areas (12,13). Furthermore, with the conversion of degraded agricultural lands to biomass crops there is potential to improve soil health, increasing the available land area for PBC production (14). Switchgrass grows optimally in regions with 2100-2700 Corn Heat Units (CHU), but as a cold-sensitive crop, it is less productive in cooler regions (<2400 CHU) (2). Miscanthus is more cold-tolerant than switchgrass and grows well in western and southern Ontario, with planting dates that begin in mid-April, as the majority of southern Ontario receives sufficient Growing Degree Days (GDD) for successful establishment (3).

Figure 3: Miscanthus crop being harvested. Biomass left on the field will protect soil from erosion over winter. (3)

YIELD POTENTIALS

Yield potentials of both switchgrass and miscanthus will depend on variety, soil type, growing conditions, and harvest timing. In Ontario, both crops produce high biomass yields with relatively low soil nutrients and fertilizer inputs (6,11). The most popular switchgrass cultivar in Ontario is Cave-in-Rock, which shows high yields, strong winter tolerances, and good establishment on a variety of soil types (2). With switchgrass, maximal yield potentials are generally not achieved in the first year; however, by the second growth year, yields reach about 60% of those of fully mature stands on clay soils, and 80% of fully mature stands on sandy soils. (2) Optimal yields are produced on well drained soils in regions with 2100-2700 (CHU) in Ontario. Cave-In-Rock cultivars in southern Ontario yield between 3-5 tonnes of biomass per acre, with marginal lands producing the lower end of the average yields (2). Miscanthus yields are largely impacted by GDD and selected cultivars vary among regions (3). The majority of southern Ontario receives adequate GDD for biomass accumulation, but regions with lower soil temperature and harsher winters may experience reduced yields (2,3). Biomass yields are reported to be higher when miscanthus is grown on adequately drained, fertile soils with good organic matter levels (class 1-3 soils). When grown on poorer quality soils (class 4-5), yields are typically lower, and the risk of poor establishment is higher (3). Miscanthus stands can remain productive for 20 years and are not harvested in the first year of growth, when biomass yields are low. Successful yields after the first year can range from 8–12 tonnes of biomass per acre, with 10 tonnes per acre considered a strong yield (3). Both crops require relatively low inputs, but the use of fertilizers do improve biomass production (2,3). The use of inorganic fertilizers can have negative environmental impacts; however, recent studies show that biofertilizers have similar, if not more effective yield results than inorganic fertilizers (15). Biofertilizers are less harmful to the surrounding land and aquatic habitats (15, 20).

POTENTIAL ENVIRONMENTAL SERVICES

A major reason for the support of biomass crops can be attributed to the environmental benefits they provide. As a carbon neutral and renewable energy source, PBCs reduce greenhouse gas (GHG) emissions derived from the agriculture sector by replacing fossil fuel combustion with biomass energy (16). Specifically, when biomass crops are grown on lower agricultural class lands, they play an important role in GHG mitigation by sequestering carbon into soils through organic matter inputs, increasing soil organic carbon pools (8, 4). Long term studies have demonstrated that marginal lands converted to biomass crops show higher gains in soil organic carbon than fertile lands, indicating the importance of converting marginal lands to PBCs (17). The integration of carbon into soils also positively influences the overall fertility and productivity of agricultural lands while the deep rooting systems of PBCs improve the soil structure, stability and health. (18) The deep rooting systems of switchgrass and miscanthus prevent significant soil erosion and help to prevent sediment and nutrient loading in nearby waterways while their reduced fertilizer needs, and high nutrient use efficiency contribute to decreased groundwater contamination (7, 14). The reduced tillage and pesticide use associated with biomass crops support increases in local biodiversity, and the associated ecosystem benefits, including the provision of habitat areas for important grassland bird species and wild pollinator populations (19,20) The potential for biofertilizer usage to replace inorganic fertilizers also supports increased biodiversity and ecological health within agricultural lands. (15) The conversion of marginally productive lands into perennial biomass crops supports a variety of greenhouse gas mitigations and ecological health benefits for Ontario's agricultural community.

Figure 4: Large switchgrass fields provide nesting sites and cover for grassland bird species, decreasing predation when compared to annual crops. Increases in biodiversity are also seen through greater abundance and diversity of insect and pollinator species. (2)

CONCLUSIONS

The conversion of marginal agricultural lands to perennial biomass crops shows high returns both financially and environmentally for Ontario's agricultural community. The ability of perennial biomass crops to establish well in marginal lands provides additional income for farmers while the associated environmental advantages range from greenhouse gas mitigation to soil erosion control and increases in agricultural biodiversity. The suitability of switchgrass and miscanthus for Ontario's climate along with their high biomass yield potential make the gains from these biomass crops significant. Taken together, the conversion of usable marginal land to biomass energy crops is a valuable practice and should be largely implemented within the agricultural sector in Ontario.

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