Giant Miscanthus Best Management Practices

DRAFT

I. Introduction

The University of Iowa (UI) currently has a goal to obtain 40% of its energy from renewable sources by 2020. The UI is pursuing biomass in the form of dedicated energy crops from perennial herbaceous plants in southeast Iowa as a means to achieve this goal. Specifically, a sterile hybrid species of Miscanthus grass, Miscanthus x giganteus (Giant Miscanthus, or Mxg) has emerged as a preferred species for use as fuel in the UI’s Main Power Plant. Specifically, the UI is planning to plant the Illinois clone of Mxg. In 2010, the UI formed a Biomass Partnership Project with government and industry partners as well as academics from the UI, ISU, and UNI to investigate and pursue various potential biomass fuel sources.

Miscanthus is a perennial, warm-season grass native to Asia with a C4 photosynthetic pathway. Mxg is a sterile triploid hybrid variety of Miscanthus resulting from a cross between Miscanthus sacchariflorus, a tetraploid species, and Miscanthus sinensis, a diploid species. Mxg plants can reach 12 to 13 feet tall with roots extending to a depth of more than 8 feet, and the estimated productive life span of a Mxg stand is between 15 and 20 years. Although it is a warm-season grass, Mxg is cold tolerant and has a longer growing season than most C4 grasses.

Mxg’s high yield potential makes it an attractive option for energy crop development. In pursuing Mxg as a source of fuel, the UI must take steps to mitigate any adverse environmental consequences of producing Mxg. The best management practices discussed below will address adverse environmental impacts from Mxg such as invasiveness, soil erosion, water quality degradation, adverse impacts on wildlife, and the presence of pests and disease.

II. Environmental Concerns

Although it is likely that growing Mxg will improve the environmental performance of Iowa’s lands, there are several environmental concerns that must be addressed when planting and growing Mxg.

A. Invasiveness

Invasiveness is the primary environmental concern regarding Mxg. Invasive species cause over $120 billion in damage in the United States annually. Many of these invasive species were intentionally introduced for beneficial purposes and subsequently spread out of control.
Researchers have found that “successful, high impact invasions are low probability, but high impact, irreversible events.”

Because species invasions are exceptionally difficult to reverse, prevention is key. The first step in preventing invasions is to choose species that pose a low risk of invasion. Unfortunately, characteristics that make species good candidates for dedicated energy crops are typically also characteristics that increase the likelihood that a species will be invasive. These characteristics include quick establishment, rapid growth, efficient nutrient and water utilization, competitiveness, and tolerance of a range of climate conditions. Despite these characteristics, certain biomass energy crops pose a lower risk of invasiveness than others.

A review of available research indicates that Mxg poses a low risk of invasion. Because Mxg is a triploid hybrid, that produces sterile spikelets instead of seed. Therefore, Mxg cannot spread via seed dispersal. Instead, Mxg propagates vegetatively via rhizomes and stem fragments. Although its sterility reduces the risk of invasiveness, Mxg may still spread vegetatively. Arundo donax, commonly known as Giant Reed, is also sterile but has a high risk for invasiveness due to its more aggressive vegetative propagation and location of plantings in stream beds.

It is unlikely, however, that Mxg poses the same risk for invasiveness as Arundo donax. Multiple weed risk assessments have determined that Mxg poses little threat of invasion, primarily because Mxg does not produce seeds, spreads slowly, and has no known history of weediness. In 2007, New Zealand approved the release of Mxg into the country stating that it was “highly improbable” that Mxg would form successful escaped populations, particularly considering the ease of eradication. Additionally, Mxg has been grown in Europe for thirty years without a recorded case of escape from planted fields. Previously, Mxg rhizome spreading was observed at the pace of approximately 10 cm/year. However, test plots in Illinois have shown Mxg spread rates between 1.3 and 3.9 feet/year. Nonetheless, it is likely that Mxg will escape its field only in the presence of frequent and severe land disturbance or movement of viable stem fragments following harvest and transport.

One additional invasiveness concern is the potential for Mxg to mix with naturally occurring varieties of Miscanthus to produce a fertile hybrid. On very rare occasions, sterile Mxg seeds have been reported for Mxg, although never for the Illinois clone. The level of risk from genetic mixing is currently not clear, although it is likely low.
B. Soil and Water Quality

It is likely that, over the long term, \textit{Mxg} will improve soil and water quality by preventing erosion and absorbing nutrients that would otherwise end up in Iowa waterways. Because of its deep root system and large leaf area, \textit{Mxg} retains soil and helps water infiltrate soil during rain events. Also, established \textit{Mxg} requires little maintenance in the form of soil-disturbing activities and few additional nutrients.\textsuperscript{21} Research indicates that, once established, \textit{Mxg} improves water and soil quality relative to other crops.\textsuperscript{22}

While the \textit{Mxg} stand is being established during the first few years, however, there is potential for increased erosion and nutrient loading in waterways. These negative effects are temporary and associated only with crop establishment. Over the long term, the soil retention and water quality benefits are expected to offset losses incurred during the establishment phase.\textsuperscript{23}

C. Biodiversity

Depending on the circumstances, \textit{Mxg} can be beneficial or deleterious to biodiversity. Generally, biodiversity increases with diversified habitats and decreases as surrounding landscapes become monocultured.\textsuperscript{24} Multifunctional landscapes are necessary for retention of biodiversity, and “a scenario of land segregation between intensive food production, intensive biomass crop production, urban development, and nature conservation reduced to whatever land is left would be a worst case situation for biodiversity.”\textsuperscript{25}

The biodiversity impacts of producing \textit{Mxg} differ depending on the type of land use \textit{Mxg} is replacing. If \textit{Mxg} replaces row crops, biodiversity will likely increase. If \textit{Mxg} replaces CRP land, unmanaged land, or pasture, biodiversity will likely decrease.\textsuperscript{26} \textit{Mxg} is not a food source for most wildlife, but the absence of tilling, reduced levels of pesticides, and shelter result in increased biodiversity in \textit{Mxg} fields.\textsuperscript{27} Biodiversity tends to be greater at the edge of fields than in field centers.\textsuperscript{28}

\textit{Mxg} fields tend to have the greatest biodiversity during the first 1-3 years, and biodiversity declines as the \textit{Mxg} stand matures. This is likely due in part to the presence of weeds during stand establishment. As the \textit{Mxg} establishes itself in the stand, weeds and other vegetation disappear along with food and shelter for certain wildlife species.\textsuperscript{29}

D. Pests and Disease

An additional consideration for producing \textit{Mxg} is the potential for \textit{Mxg} to be a host plant for pests and diseases that will than spread to nearby crops or natural areas. \textit{Mxg} has been shown
to be a potential host for row crop pests such as western corn rootworm and multiple species of aphids, although instances of deleterious effects on surrounding crops or natural areas have not yet been reported.\textsuperscript{30}

**III. Best Management Practices**

The following is a list of general Mxg best management practices. Each field will have its own management plan, which be developed in collaboration with the landowner and will include whichever management practices are applicable given the characteristics of the field and surrounding area. Each field-specific management plan will be incorporated by reference into the applicable land rent lease.

A. **Before and During Planting**

The following practices should be followed prior to Mxg planting:

- Choose appropriate locations for planting Mxg. Avoid planting Mxg in floodplains to reduce the risk of plant fragments escaping during storm events.\textsuperscript{31} Sites with winter high water tables should be avoided if access to harvesting equipment is questionable.\textsuperscript{32}
- Develop a management plan for each Mxg planting based on the attributes of the specific field selected. Take into account any sensitive areas, transportation vectors, nearby structures, slope of the field, and other factors that may cause concern. The plan should include education and training for field, transportation, and storage staff.\textsuperscript{33}
- Conduct education and training every six months to discuss best management practices, new research and findings. This is also an opportunity to review producers’ observations and experiences.\textsuperscript{34}
- Develop a monitoring plan for Mxg to monitor escapes, wildlife uses or changes in use, and to identify potential diseases and pests.
- Develop an eradication plan in the event that escapes are found.\textsuperscript{35} Eradication and restoration plans should include a minimum of 3 years of active treatment followed by 2 years of monitoring for sprouts.\textsuperscript{36} If the planting is ultimately not successful, the field cannot be abandoned; eradication methods must be employed.\textsuperscript{37}

The following practices should be followed during Mxg planting:
• Rhizome and stem pieces should be contained during transport to and from production fields.\(^{38}\)
• Before and after planting, equipment used during transportation and planting should be inspected for vegetative planting material and all material should be removed.\(^{39}\)
• Excess live planting material should be hand planted in the biomass field or killed either by drying on an impermeable surface for 48 hours or burning. Excess planting material should not be disposed of at the edge of the \(Mxg\) field. Killed planting material should be disposed of at a site not immediately adjacent to sensitive natural areas, artificial or natural water bodies, or areas subject to flooding. The disposal site should be recorded by GPS coordinates and checked annually for \(Mxg\) sprouts. If sprouts are observed, herbicide or mechanical methods should be used to eradicate them.\(^{40}\)

B. In Field

The following practices should be followed during the \(Mxg\) growing period:

• No-till methods are preferred, since any activity that disturbs the earth after planting creates a high risk of spreading rhizomes outside the planned planting area.\(^{41}\)
• There should be a minimum 25 foot buffer around a \(Mxg\) stand.\(^{42}\) Ideally, this border should be planted to native perennial or cover crops such as native prairie or switchgrass.\(^{43}\) Another buffer planting option would be a Roundup Ready crop that is planted on a rotation with another crop. Buffers help to control invasiveness, reduce soil erosion, improve water quality, and provide habitat for wildlife. Native prairie or switchgrass in buffers may also be harvested as dedicated energy crops. A setback is not necessary if the \(Mxg\) is planted adjacent to cropland or actively managed pasture with the same operator.\(^{44}\)
• If concentrated flow areas on the field are eroding, grassed waterways or similar structures should be installed with a 25-year storm event design criteria before planting begins.\(^{45}\)
• If the field is sloped by 5% or more, additional downslope barriers practices such as terraces or diversions may be necessary to intercept crop fragments and soil.\(^{46}\)
• Fields should not be placed near transportation vectors such as rivers, streams, irrigation canals, and utility rights-of-way.\(^{47}\) There should be a setback of at least 15 feet from any
high water marks.\textsuperscript{48} Although marginal land is an attractive option for Mxg planting, the field’s location and characteristics must be carefully considered to minimize adverse environmental impacts such as escapes, erosion, and degraded water quality.\textsuperscript{49}

- **Mxg** should not be planted within 1300 feet of any natural or planted varieties of *Miscanthus*.\textsuperscript{50}
- There should be a 30 to 100 foot firebreak near structures, utilities, and field borders to reduce the risk of fire.\textsuperscript{51}
- The *Mxg* field and surrounding areas up to 150 feet should also be periodically monitored for spread of *Mxg* outside of planting areas, wildlife uses or changes in use, and identification of disease and pests.\textsuperscript{52} Nearby areas within 1000 yards should be occasionally be monitored for escaped plants, particularly if natural areas are present.\textsuperscript{53}
- Indicator species may be planted to provide early warning in the event of pest problems.\textsuperscript{54}

C. **Harvest**

The following practices should be followed when harvesting *Mxg*:

- Harvest should occur in late winter or early spring, when the crop is dry enough to store safely (less than 20% moisture) and will not require supplemental drying.\textsuperscript{55}
- Harvesting equipment should be checked for stem fragments and cleaned before leaving the field.\textsuperscript{56}
- Harvest should occur outside of nesting periods to avoid adverse impacts on native bird populations.

D. **Storage and Transportation**

The following practices should be followed during storage and transportation of *Mxg*:

- If harvested before a killing frost, *Mxg* should be transported from the field in covered equipment and covered when stored.\textsuperscript{57}
- *Mxg* should be transported along routes that avoid crossing sensitive habitats.\textsuperscript{58}
- Transportation routes should be monitored periodically to ensure that no escapes occurred.\textsuperscript{59}
IV. Conclusion

Although there are potentially negative environmental impacts associated with growing Mxg, the environmental benefits of biomass fuel production likely outweigh the potential costs. Additionally, following the above practices will minimize negative environmental impacts and help to ensure that Mxg will improve the performance of Iowa lands.

7 Raghu et al., Ecological Considerations in the Sustainable Development of Terrestrial Biofuel Crops, 3 CURRENT OPINION IN ENVIRONMENTAL SUSTAINABILITY 15, 17 (2010).
14 Jorgensen, Benefits Versus Risks of Growing Biofuel Crops: The Case of Miscanthus, 3 Current Opinion in Environmental Sustainability 24, 28 (2011).

Quinn et al., *Empirical Evidence of Long-Distance Dispersal in Miscanthus sinensis and Miscanthus x giganteus*, 4 Invasive Plant Science and Management 142, 142 (2011).

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53 Quinn et al., *Empirical Evidence of Long-Distance Dispersal in Miscanthus sinensis and Miscanthus x giganteus*, 4 Invasive Plant Science and Management 142, 142 (2011).


