Novel Approaches to Developing On-Farm Biomass Production Systems

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Novel approaches to developing on-farm biomass production systems

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Introduction

Energy security and climate change are issues facing many countries today. Finding clean, renewable fuel sources has provided a challenge to look beyond the obvious and search for new ways to use old resources. Switchgrass (*Panicum virgatum* L.) is a warm season grass native to many parts of the United States. In 2007, the University of Kentucky (UK) College Of Agriculture started a collaborative project with the UK Cooperative Extension, farmers in northern Kentucky, Kentucky Forage and Grassland Council and East Kentucky Power Cooperative to explore and demonstrate how switchgrass can be grown, harvested and utilized in an economical and environmentally friendly way (Greenwell 2012a,b). This pilot project was funded by the KY Agricultural Development Fund and successfully established 60 ha of switchgrass between 2007-2011 and produced >500 t of biomass that was combusted for electricity production.

Switchgrass was chosen as the biomass crop of choice for this area for a variety of reasons. It can be grown on marginal soils that are not well suited to row crops. It produces high yields with relatively low inputs and can be harvested with equipment that is common on typical US farms. Because it is a native grass, there is little concern of it becoming invasive and it provides wildlife habitat for local animal species. Additionally, when harvested at a vegetative stage, it produces high quality forage.

On farm briquetting

A major challenge of switchgrass as a bioenergy crop is the cost of transporting a low density product and the specialized equipment required for handling at the power plant. In 2008 and 2010 harvested switchgrass was ground and mixed with coal, but several handling issues were encountered. Densification through briquetting solves many of the transportation and handling problems. Briquettes have a consistency similar to coal allowing a seamless integration with coal handling equipment.

We collaborated with a start-up biofuel company to briquette the material in 2009. However, this increased the final value of the material and since there was transportation to and from the briquetting site, the carbon emission benefit of switchgrass over coal was not realized. Locating a briquetting unit at the power plant was also explored; however this still requires transporting a low density product with added costs for the producers. In 2011/12 two medium sized briquetting units were purchased and mounted on a flat bed trailer to create a mobile briquetting unit (Fig. 1). This type of system allows a group of producers to move the unit for on-farm briquetting. The added value of the product on farm allows the producers to capture a greater profit and the power company to receive a suitable feedstock.

Figure 1. Mobile briquetting units (above) and pelleted switchgrass being loaded on a barge with coal (below).

Economics

Most people agree that biomass production and utilization has benefits to the global community, but producers must be able to realize economic benefits before they can justify removing land from hay or crop production to grow switchgrass. With this in mind, the University of Kentucky researchers created an interactive excel spreadsheet that allows producers to input their cost of production based on their local prices and situations and compare the net value of hay vs. switchgrass production (Halich 2010). The decision aid accounts for many variables including establishment, fertilizers and herbicides, equipment and labour, depreciation and taxes for both switchgrass and hay production. It allows producers to determine whether

Figure 2. *Microtus* (above) and *P. leucopus* (below) specimens captured in a field of switchgrass

switchgrass is more profitable than hay for their farming operation before they sign long-term biomass production contracts.

Choosing Dual Purpose Biomass Crops

Currently, renewable energy biomass markets in northern KY are limited, therefore producers growing switchgrass have no stable markets for off-farm sales. However, one of the primary reasons for selecting switchgrass for this project was the alternative use: hay production and summer grazing for cattle. In 2011, a University of KY a study was conducted to determine the *in vivo* digestibility with beef steers of two types/varieties of switchgrass (lowland Alamo, upland Cave-in-Rock) harvested for hay at 3 different maturities (Davis 2013). It was concluded that switchgrass has acceptable digestibility and protein for growing steers. Not surprisingly, the early vegetative harvest showed the highest digestibility, but the late vegetative harvest had sufficient digestibility as a maintenance ration and the seedhead harvest was acceptable for mature beef cows. The forage use for switchgrass allows progressive producers to establish and utilize switchgrass before the biomass market has fully developed. The yield, quality and drought tolerance attributes of switchgrass have encouraged some producers to consider forage their primary use and biomass as a potential secondary use.

Wildlife and conservation benefits

The benefits of switchgrass production go beyond its value as biomass or forage. Switchgrass is a native grass in KY and provides excellent wildlife habitat. It is ideal for soil and water conservation and qualifies for many state and federal cost share programs for stand establishment and maintenance. Several studies have shown that the dense canopy, clear understory and abundant seeds make switchgrass an excellent habitat for small mammals such as mice and voles (Fig. 2). Schwer (2011) showed that switchgrass stands managed for biomass improved small mammal habitat over hay and corn production. Since small mammals are at the bottom of the food web they are useful indicators of overall health of the surrounding ecosystem. Switchgrass also has a deep root system that can improve soil quality and carbon sequestration.

Conclusion

Switchgrass is a useful biomass crop in northern KY. It performs well on the marginal soils, has the potential to produce returns on investment and can serve as summer grazing or hay for cattle until the biomass market develops. Briquetting material on-farm has the potential to allow producers to add value of the product, reduces transportation cost and allows for simple integration into coal burning power plants.

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