Herbaceous biomass sources for the southeastern United States: Have all the options been properly evaluated?

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Background

Focused research on evaluating ligno-cellulosic, herbaceous biomass for energy in the United States started in 1985. This program was funded by the US Department of Energy through Oak Ridge National Laboratory. Initially, a wide range of both annual and perennial herbaceous crops were evaluated. The objective in these early studies was to identify crops that were capable of high biomass yields with low inputs. Clearly, it was assumed that yield and input costs were among the most important factors that would affect profit for growers and feedstock costs for energy plants, and therefore, economic viability of any particular feedstock.

More recently, some attention has been given to the potential of crop residues (especially corn stover, but also wheat straw and cotton stalks) as energy feedstocks. However, two common problems with all crop residues are the relatively low yield per acre which may not even cover costs of collection, handling and transport, and the difficulty of avoiding contamination with soil during collection.

Switchgrass

Results from initial screening studies led to switchgrass (*Panicum virgatum*) being selected as a model herbaceous energy crop for further development throughout the United States. Over the last decade research has demonstrated that this species is capable of high yields (10 to 20 Mg/ha/yr under commercial conditions) with low inputs (eg. maximum yield when fertilizated with only 100 kg/ha of N) over a very wide range of soils and climates. In addition, switchgrass offers several other advantages: 1) it is native to the United States, thus reducing potential resistance from environmental groups that have concerns about introduced species becoming invasive; 2) it is easy to harvest, handle, store and transport; 3) it dries quickly (usually within two days) after mowing in warm, dry weather; 4) it has a massive root system which constitutes effective soil carbon sequestration, reduces soil erosion, and improves soil productivity; 5) it can be used also as forage (hay or grazing) for livestock; and 6) it serves as excellent habitat for a wide range of wildlife, including birds, rodents and mammals.

Despite the advantages of switchgrass, anecdotal information obtained from scale-up studies suggest that there could be some barriers to commercialization of this crop in the southeastern United States, where it is not grown at present, as it is in other regions of the country (Mid-West and Great Plains) for conservation purposes. In particular, the crop has proved difficult to establish in certain regions, it produces relatively little biomass (and therefore, no economic return) in the first year, and takes three years to reach full yield. In addition, Alamo switchgrass stubble readily punctures tires of tractors and equipment. While this problem can be overcome by various means, such as filling tires with silicone, some growers seem reluctant to resort to these measures. Finally, commercial availability of ‘Alamo’ (the variety most suited to the gulf states) switchgrass seed is somewhat restricted due to limited demand, and it would take several years to develop a substantial supply.

Alternatives to Switchgrass

In order to overcome the limitations of switchgrass, alternative perennial crops or cropping systems need to be already established, less severe on the tires of tractors and equipment, and possess as many of the advantages of switchgrass as possible. Clearly, such an option would eliminate the cost and risk

associated with establishment, and allow for immediate income. The most promising options that meet these criteria are tall fescue (*Festuca arundinacea* Shreb.), bahiagrass (*Paspalum notatum*), and hybrid bermudagrass (*Cynodon dactylon*). These species are currently grown throughout the southeast, mainly as forages. They were mostly planted over 30 years ago, and are used as both pasture and hay crops for beef production. Consequently, the only change that would be needed by cattle producers in order to use them as energy crops would be reduction or elimination of their beef herds, and modified management to maximize biomass yield. Since net economic return for beef enterprises is usually below $100/ha/yr, the economic incentive to induce such a change would not be as high as is needed to induce replacement of annual row crops (probably over $200/ha/yr) with an energy crop.

Tall Fescue

Tall fescue is a cool season perennial grass that is established from seed. It has a bimodal growth pattern which peaks in fall and spring. There are approximately 14 million ha (35 million acres) of tall fescue in the eastern United States. The northern boundary of the fescue belt runs from northern Missouri to Washington DC, while the southern boundary runs through the middle of Mississippi, Alabama and Georgia. Due to its temperate nature and preference for heavy clay soils, tall fescue does not survive in the immediate vicinity of the gulf coast, where summers are long and very hot, and soils are typically sandy and prone to drought. However, it grows well in the Black Belt region, which runs westward from Montgomery, through Selma in Alabama, and into Mississippi. In this location it is commonly found in a mixture with dallisgrass (*Paspalum dilatatum*), a warm season perennial grass that establishes voluntarily. This mixture of both a cool and warm season species clearly results in a very long growing season. The western boundary of the fescue belt is eastern Kansas and Oklahoma, and the eastern boundary is constituted by the Carolinas. Research conducted on tall fescue when managed for forage typically indicates yields of 5 to 10 Mg/ha/yr. However, no data are available on yields from old stands of these species when managed as an energy crop (less frequent defoliation).

Bahiagrass and Bermudagrass

Bahiagrass and bermudagrass are warm season perennial grasses. There are probably over 4 million ha (10 million acres) planted to each of these species, starting in east Texas, and including Louisiana, southern Arkansas, Mississippi, Alabama, Georgia, Florida and the Carolinas. Bahiagrass is established from seed, while most varieties of bermudagrass are sterile hybrids that need to be established by planting sprigs or cuttings. Growth usually starts in April and ceases in October. However, cool season annuals such as rye (*Secale cereale*) and ryegrass (*Lolium multiflorum*) are often no-till seeded into the sod of these two species to extend the grazing season. Clearly, it is possible that this strategy could also be used to maximize biomass production in a low input double cropping system. However, once again, almost all research on these two species has been conducted on newly established plots and under management for forage, and no data are available for old stands when managed for maximum biomass production. Under forage management yields from bermudagrass are commonly 10 to 20 Mg/ha/yr, while bahiagrass production is generally a little lower.

Research Needs

Given the advantages of having a total of over 22 million ha (45 million acres) already established to tall fescue, bahiagrass and bermudagrass, but no available data to indicate the biomass potential of these stands, a comprehensive research program aimed at generating this information seems well justified.