Biofuels Research Part II: Warm Season Grasses Fuel From Fields of Green

by Roger Samson

The evaluation and development of warm season grasses as biofuel feedstocks is the second major research project REAP is initiating this summer. In an earlier article (Switchgrass: a Living Solar Battery for the Prairies, Winter 1991) I outlined the potential of switchgrass as a promising warm season grass for the development of a cellulosic ethanol industry. As biofuel feedstocks, the major advantages that warm season grasses such as switchgrass appear to have over trees are:

1. Greater moisture use efficiency: enabling a much larger land base to be available for their production (ie the Canadian prairies)

2. Lower cost of production; currently native grass hay is being sold for < $30/tonne on the Canadian prairies. The studies estimating the lowest costs of farm grown wood energy estimate at least a 50% higher cost.

3. A more efficient carbon sink: Trees lose approximately 1/3rd of their annual dry matter production when fall comes and the leaves drop. Unfortunately most of this material simply oxidizes and is returned to the atmosphere. In warm season grass production the entire plant is harvested. However soil quality will not decline because tallgrass prairie species such as switchgrass have a 10' root system that turns over carbon directly at the root - soil interface With approximately 25% root turnover per year, soil carbon increases even though all the above ground biomass of the grass is removed. This is a tremendous benefit for CO_2 reduction because the warm season grass no longer only reduces CO_2 by replacing fossil fuels when used as an energy source but "sinks" CO_2 by increasing soil organic matter levels. From a CO_2 standpoint, planting warm season grasses rather than trees is probably the most efficient way to offset the greenhouse effect from both an economic and efficiency perspective. However, trees may play a most important role in improving warm season grass growth by acting as a windbreak.

In addition to using trees as windbreaks, we are also looking to bring more diversity to the biofuel feedstock industry by using other warm season grasses in mixtures or as complementary feedstocks to switchgrass. One way of approaching how to develop feedstocks for various environments is to learn from Wes Jackson teachings and look at "Nature as the Standard". After all, 30,000 years of natural selection should not be wasted as a lesson. If energy efficiency is the goal shouldn't we look at what nature put there as the standard for reducing the need for external inputs? So where are the big biomass type grasses in their native habitat? Well, ask an ecologist. Plant lovers have mapped grasses for years as well as placed them into various classification systems. While no classification system will please every prairie plant enthusiast, a basic breakdown may include 5 categories using soil moisture as a gradient (ie. dry prairie species to wet prairie species). Native species which appear to be good biomass producers are listed in Table 1 by their respective preferred habitat. As well, these species are also generally found in neighbouring moisture gradients but become less abundant the further they are away from their native soil moisture range. Another gradient that needs to be better established is a North-South range for Warm season grasses. For example Prairie cordgrass seems to be well adapted to cool wet climates even for a C4 species with its native range existing all the way up to Hudson's Bay. European researchers have found that it initiates earlier growth than other warm season species. Canopy closure occurred 6 weeks earlier in a prairie cordgrass stand than corn in one study comparing perennial and annual C4 species as energy feedstocks. These are the types of advantages that need to be identified if high biomass yields are to be achieved at a low energy input across a wide variety of environments.

Peak productivity

Studies of the native prairie have found that productivity is generally highest from the wetter prairie types with some species reaching a height of 6-10'. The question arises, can we cheat just a little and put a bigger biomass species a little out of its native range for a period of 5-25 years and increase productivity?. The early answer may be yes at least for some species. For example, switchgrass has been very successful in midwest prairie plantings where it has proven to be the most productive species in areas receiving a minimum of 15" of rainfall. However it is necessary to develop a number of species to maximize biomass production across the various types of field conditions and climatic conditions which will arise. Mixtures will undoubtedly be used in many instances, particularly on marginal lands where variable field drainage exists. Mixtures will also provide greater stability against disease and pest problems as well as improve wildlife habitat. Developing a number of species for biomass purposes will prove to not only be more ecologically stable but will likely assist in ensuring a more continuous supply of feedstocks to the energy conversion plants. For example, thick stemmed species such as prairie cordgrass and switchgrass may be suited to spring harvesting, avoiding the need to stored baled material over winter for spring supply.

In addition to native species we are also looking at introduced species for their biomass production as well. Elephantgrass (Miscanthis sinensis) is one of the most promising biomass crops in Europe with very high yields being obtained and trials evaluating its usefulness for both energy and fibre markets. Imported originally from Northern China and Japan its main use today in North America is an ornamental grass in gardens.