Feedstocks Availability

Joe Burton

Crops that can be produced in a sustainable manner with regard to inputs- (soil, water, greenhouse gas emission and wild-life diversity)

Sustainable crop production with respect to inputs would require efficient use of non-renewable resources and use of inputs that maintain or improve the soil and water resource base for agricultural productions. For particular crops, those inputs will vary depending on the geographical region, climate, and soil properties where the crops are produced. Most crops produced in the U.S. usually have had research on various agronomic practices which is published in peer reviewed literature, and there is individual farmer experience that informs best farming practices. So even if sustainability per se has not been addressed in particular research projects, ideas about appropriate sustainable farming practices can be inferred from general knowledge about the crop species and research results.

In terms of inputs, perennial systems are probably the most sustainable. They add organic matter to the soil and have very little soil erosion. They are in place for several years and thus require less time and fuel for tillage and planting. Often less inorganic N fertilizer is required. Among perennial crops considered for biofuel production, switchgrass (*Panicuum virgatum* L.) is one with much promise. It is a grass that is native to North America and has wide adoptability. It has good biomass yields on land that would be marginal for grain crops. Nitrogen fertilization is usually required, for maximum yields with the rate dependant on soil fertility. Adding a symbiotic N fixing legume to the system could supply some of the N requirement. There is also some research to suggest that a mixture of diverse grassland perennial can have high bioenergy yields. Perennial systems also provide good wildlife habitat.

After perennials, soybean (*Glycine max L. Merr*.) may be most sustainable in terms of inputs. Soybean fixes N symbiotically and requires no N fertilizer. It can be successfully produced with minimum tillage, which results in less soil erosion and less fossil fuel expenditure. Sixty years of plant breeding has produced productive varieties than are adapted for specific latitudes from the northern to the southern borders. Diseases are managed by genetic resistance and sporadic insect infestations are managed with minimal application of insecticides. In this decade, about 75 million acres have been planted each year, so there is a wealth of knowledge regarding the efficient production of soybeans.

Among oil seeds, canola (*Brassica napus* L.*)* and sunflower (*Helianthus annus* L.*)* have potential for increased U.S. production. Both can be grown in most regions where other row crops are produced, and in southern latitudes, canola can be double cropped with soybean. Sunflower has an extensive root system and is generally considered to be drought tolerant and an efficient user of nutrients.

Sorghum (*Sorghum bicolor L*.), especially sweet sorghum, is another crop with excellent potential for bioenergy production. It requires low to moderate N fertilization and has high water use efficiency. The sugars produced by sweet sorghum can be feedstock for fermentation and anaerobic digestion to produce ethanol and methane. The structural carbohydrates can be co-fired with coal or serve as feed stock for thermo chemical processes.

Maize (*Zea mays L.)* is a highly productive crop, but requires relatively high inputs of N fertilizer and water. Even so there is much knowledge on maize production which can be used to make the production system more sustainable from an input perspective. This includes minimum tillage and elimination of over application of fertilizer.

Is there greater potential for oil seeds, fermentation based biofuels from starch, sugar and/or cellulosic crops?

Until the use of cellulosic feed stocks becomes efficient and routine, I believe there is greater potential for the oil seeds as a feed stock for aviation biofuels. Soybean oil is the major oil produced in the U.S. (about 90% of the total). We produced 69 billion pounds of soy oil in 2008, but exported another 13 billion pounds of oil in whole seeds. That is oil that could be produced in the U.S. The protein meal could be exported rather than the whole beans. Also, there is opportunity to genetically alter soybean so that it produces seeds with higher concentrations of oil. The acreage of other oil seeds, e.g. sunflower and canola, that have higher oil concentrations than soybean, can be expanded. For instance, in southern latitudes, canola can be double cropped with soybean. One should also consider that biofuels produced from vegetable oils can be combined with biofuels produced from waste fats (used vegetable oil and fats from animal processing). Together, the two would make a significant contribution to aviation fuel needs.

Because of the wide variety of possible cellulosic feedstocks, those may have the most potential in the long term. Most of the plant species that would be used as cellulosic feedstocks are perennial as well and would likely require fewer inputs to produce than annual crops.