ANNUAL WARM SEASON GRASSES FOR BIOFUEL PRODUCTION IN THE WEST

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ABSTRACT

Biofuel can be produced from a variety of feedstocks including grain, sugar, cellulose and oil seed crops. Most biofuel in the United States is produced from corn grain in the form of ethanol at the present time. However, in the future, more ethanol will be produced from other grains and the cellulose contained in the stems and leaves of various plants. Annual warm season grasses that potentially can be used to produce biofuel are grain sorghum, forage sorghum, sweet sorghum, sorghum x sudangrass hybrids, sudangrass, and teff.

Key Words: biofuel, ethanol, corn, sorghum, sudangrass, teff.

INTRODUCTION

Production of biofuels is increasing in the United States for several reasons. Most importantly, the Energy Independence and Security Act of 2007 established a renewable fuel standard (RFS) requiring fuel producers to use 36 billion gallons of biofuel by 2022, and established minimum biofuel requirements for each year up to 2022.

Biofuel can be produced from a variety of crops or feedstocks including grain, sugar, cellulose, and oil seed crops. Corn is the primary feedstock that is used in the United States to produce biofuel, and examples of other grain crops used for this purpose are sorghum and wheat. Brazil produces ethanol from sugarcane, but sugar beets and sweet sorghum are examples of other sugar crops that can be used as feedstocks for ethanol. Ethanol can be produced from the cellulose in a variety of crops or waste materials, the most commonly mentioned is switchgrass. Biodiesel can be produced from soybean or other oilseed crops such as rapeseed. Algae can also be used to produce biodiesel.

Annual and perennial grasses will be important sources of ethanol in the future since ethanol production from grain from corn is capped at 15 billion gallons by the Renewable Fuel Standard.

WARM SEASON GRASSES

Annual warm season grasses are highly productive and valued as feed crops. Many of them also have potential as biofuel crops because of their inherent high productivity. Annual crops have the advantage of not tying up the land for several years as occurs with perennial crops. These crops are versatile and can be used between alfalfa stands or after a crop that failed. Grasses are

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good rotational crops, and can be used for pasture, hay, silage, or biofuel as mentioned above. The disadvantages of annual grasses are that the establishment cost is higher than perennials and the nitrogen fertilizer cost is greater than for legumes. Furthermore, under certain conditions, many of the annual warm season grasses in the sorghum family contain levels of prussic acid and nitrate toxic to livestock.

Corn (Zea mays L.***).*** Corn is grown for grain and silage. Corn for grain is the primary biofuel crop in the United at the present time. Corn stover (plant material remaining after grain harvest) can be used for cellulosic ethanol. Only about half the stover of corn can be removed and still maintain soil quality.

Grain sorghum (Sorghum bicolor (L.) Moench). Grain sorghum is sometimes called milo and is used primarily for grain but can also be used for silage. Grain sorghum is short (3 to 5 ft tall) and usually planted in rows spaced 20 to 40 inches apart, but it can also be seeded in drill rows. Grain sorghum for silage is not as digestible by animals as forage sorghum. Grain sorghum uses less nitrogen and water than corn. Grain sorghum can be used as a feedstock in ethanol plants similar to grain corn.

Forage sorghum (Sorghum bicolor (L.) Moench). Forage sorghum is in a class of sorghum referred to as sorghos. These types of sorghum are tall (6-15 ft) and usually have small heads compared to grain sorghum. Forage sorghum is typically used as silage, and has about 90% the feed value of corn silage. Forage sorghum is planted in rows, has coarse stems, and is cut once per season. High biomass types of forage sorghums are used for biofuel. Lignin, which is not digestible by animals or readily converted to ethanol, accumulates rapidly as the plant matures. The maximum TDN per acre is at soft dough, the stage recommended for cutting for silage. Forage sorghum has a lower water and nitrogen requirement than corn.

Sorghum x Sudangrass hybrids (Sorghum bicolor (L.) Moench). Sorghum x sudangrass hybrids are used for pasture or silage, but making hay from these plants is difficult due to the coarseness of the stems. These crops can be cut or grazed multiple times and are very productive. Sorghum x sudangrass hybrids are often used in soil reclamation since they can withstand very high pH.

Sudangrass (Sorghum bicolor (L.) Moench). Sudangrass is grown for hay or pasture and is commonly grown for export to Asian countries. Sudangrass has finer stems, more tillers, more leaves, and faster regrowth after cutting than forage sorghums. Sudangrass is cut multiple times. Sudangrass has less prussic acid than other types of sorghum. Prussic acid is a compound that accumulates under specific conditions and is toxic to livestock.

Sweet sorghum (Sorghum bicolor (L.) Moench). Sweet sorghum is in the class of sorghums called sorghos similar to forage sorghum. Many of the forage sorghums contain 5 – 10% sugars in their stalks, but the sugar content in sweet sorghum stalks can range from 10-20%. Sweet sorghums have been specifically bred for sorghum syrup or sugar production. The stems of sweet sorghum accumulate sugar later in the season. The sugar in the stems of sweet sorghum can be fermented directly into ethanol and the cellulose in the stem can also be converted into ethanol. Sweet sorghum plants can reach 10-15 ft tall.

Teff (*Eragrostis tef* Zucc. Trotter). Teff is a newly introduced grass used for hay particularly for horses. In its native Ethiopia, teff is used for grain. Teff is a fine-stemmed grass suitable for multiple cuttings.

BIOFUEL POTENTIAL

The primary feedstock for biofuel at the present time is the grain of corn. Switchgrass, a perennial warm season grass, is thought to have the most potential of all cellulosic ethanol sources. The warm season annuals, particularly the sorghums, also have potential as feedstocks for ethanol plants. Comparing feedstocks is not straightforward since different parts of the plant are used and the crops are grown differently. Therefore, when comparing feedstocks, the use of the whole crop should be considered. For example, about half of the corn stover can be recovered without significant detriment to soil quality and made into ethanol. The same could be said for grain sorghum. The sweet sorghum plant can be used in several ways: sugar in the juice of the stems can be fermented, the cellulose in the baggase or pressed stalk can be made into ethanol, and the starch in the grain can be made into ethanol. The advantage of annual warm season grasses such as the sorghums compared to corn is more ethanol produced per unit of nitrogen fertilizer and water.