ADVANTAGES OF FORAGE SORGHUM FOR SILAGE IN LIMITED INPUT SYSTEMS

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ABSTRACT

Water shortages are threatening the sustainability of irrigated agriculture in dry environments such as the Southern High Plains (SHP) of the U.S. Corn has been a staple silage crop grown to supply the enormous forage demand associated with dairy and beef feeding industries. The relatively high water use of corn, however, is limiting the extent to which corn can be grown. Although irrigated, corn in the SHP is greatly dependent upon growing season rainfall. Recent droughts have exposed the vulnerability of many of the corn systems and well capacities in the region. Forage sorghum can be a viable alternative to corn in silage systems experiencing water reductions and where extended dry periods affect the ability of marginal irrigation systems to meet the water demand of corn. While the benefits of forage sorghum are many, a few weaknesses of the crop, coupled with little practical experience, has limited broad utilization. Improvements in varieties and a better understanding of proper management should lead to a greater acceptance and willingness to grow this alternative silage crop. However, the lack of water and desperation will likely be the main drivers behind any major cropping changes.

Key Words: forage sorghum, corn, irrigation, management, drought, nutritive value

INTRODUCTION

As declining water availability continues to threaten irrigated agriculture sustainability, alternative forage sources must be utilized that reduce water inputs and allow for flexibility in extreme climatic conditions (e.g., drought). Corn (*Zea mays* L.) is an important and extensively grown silage crop for dairy and beef industries in the U.S. In the semiarid southern Great Plains, corn production is a risky prospect due to the commonly hot, dry, and windy environment coupled with marginal irrigation supplies barely capable of meeting crop water demand. Because of its high water use efficiency and tolerance to prolonged periods of drought, forage sorghum [*Sorghum bicolor* (L.) Moench.] has been promoted as a substitute for corn silage in dairy and beef cattle rations. Despite research in the region that has shown comparable yields with less water and yield advantages in limited input systems (Bean and McCollum, 2006; Howell et al., 2008; Marsalis et al., 2009, 2010), forage sorghum acceptance has been low and corn continues to be the dominant silage crop grown.

Limited acceptance of forage sorghums has been due to several factors including: low nutritive value, lack of weed control options, potential lodging, and varietal extremes in maturity and yield. The perception that all sorghums are low in nutritive value and that they are more difficult

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to manage than corn are two of the main arguments against them given by producers and feeders. However, in recent years sorghum forage nutritive value has improved through extensive breeding efforts and selection of highly nutritious varieties for use as silage. Many varieties now have similar or better feed value as corn (Bean and McCollum, 2006). In addition, the brown midrib (BMR) trait in sorghum, characterized by reduced lignin, has significantly improved the digestibility to a level close to that of corn (Contreras-Govea et al., 2010; Oliver et al., 2004). Unfortunately, yields of many BMR forage sorghums have been lower than conventional types and even lower than corn (Marsalis et al., 2009, 2010). In contrast, conventional forage sorghum produces more forage than BMR in most cases and also more than corn when water in the system is limited. In short, sorghum type and variety selection has only added to the perceived complexity of forage sorghum production that has deterred many producers. With more research information and long-term trends being defined, benefits of forage sorghum in limited input systems will become more evident and potential acceptance increased.

MEETING A DEMAND

The Southern High Plains (SHP) regions of New Mexico and Texas contain over 150 dairies and 425,000 milking cows (Figure 1) and the greater region is characterized by the highest concentration of beef cattle in the country. Dairy cow numbers have increased steadily since the late 1980s and subsequent forage demand has accompanied the rapid growth. Most of this demand has been met by corn silage (Figure 2). Sorghum forages, however, have only seen slight increases over the same period. Consistent yields under irrigation, high feed value, and ease of management of corn have accounted for the bulk of this discrepancy. In more recent years, forage sorghum has gained some ground as regional acreage capable of growing corn (i.e., well capacity to meet demand) has reached a maximum and several university studies have shown the benefits associated with growing improved cultivars of forage sorghum.

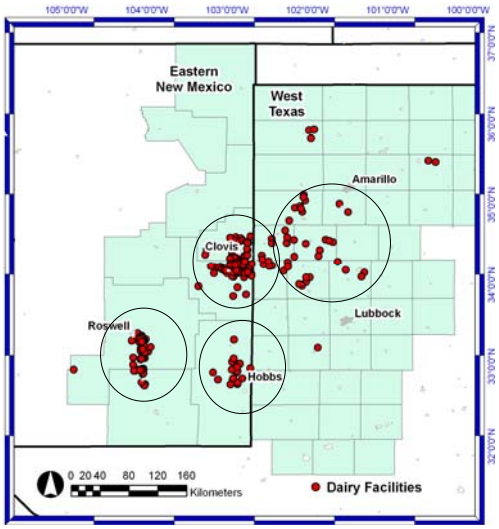

Figure 1. Dairy facilities in eastern New Mexico and Texas Panhandle.

WHY CHANGE?

Most farmers in the SHP understand that there is an impending paradigm shift in agriculture and that resources, namely water, are dwindling or becoming more expensive. However, many may not recognize the urgency of the situation facilitated by the rate of water decline. Each year, more producers are combining multiple

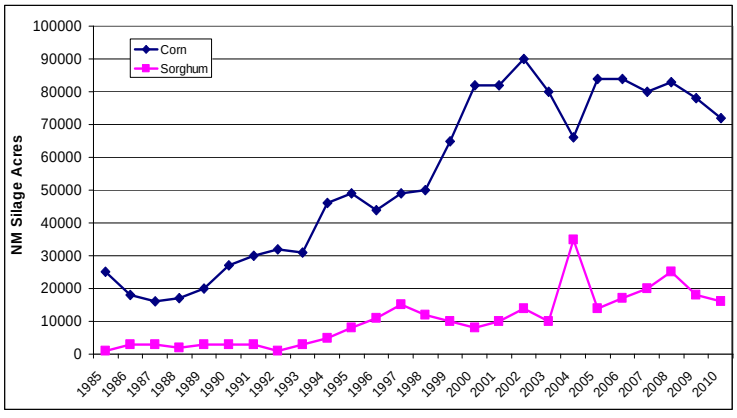

Figure 2. Corn and sorghum silage acres in New Mexico from 1985 to 2010. Source: NASS-NM.

irrigation wells in order to produce high water-use crops such as corn and alfalfa. In addition, recent regional droughts and the projected pattern of dry conditions to continue call for a more rapid shift in cropping tendencies. 2011 will likely be the driest year on record for the region and the widespread crop disasters associated with corn will not soon be forgotten. Abandoned fields, reduced acreages, and lower yields of corn and alfalfa have all led to extensive feed shortages and astronomical forage commodity prices. There is little doubt that the 2011 growing season will be a wakeup call to many producers to begin considering alternative silage and hay crops in the near future.

THE CASE FOR FORAGE SORGHUM

Forage sorghum is considered to be a viable alternative to corn silage, particularly when water becomes limited in irrigated systems and when input costs associated with seed and fertilizer are an impediment. Research in the SHP indicates that forage sorghum is competitive with corn on both yield and nutritive value levels. Over multiple years, experiments, and varieties we can begin to see patterns of the relationship among corn, conventional, and BMR forage sorghums. From 2005 to 2010, a series of studies was conducted in New Mexico to compare the yield potential of the three crops when water was restricted to roughly 2/3 (18-20 inches total) of what is considered 'fully irrigated' corn in the region. Results indicate that conventional forage sorghums are very high yielding and in dry or 'normal' rainfall years (e.g., 2005-2006) can out yield corn (Figure 3). In contrast, yields are comparable in years when in-season rainfall is high (e.g., 2008-2010). Corn's ability to compete is highly contingent upon rainfall in these systems. Further, in other studies, forage sorghum has yielded the same dry and wet tonnage with less water and nitrogen fertilizer as limited input corn (i.e., reduced plants/ac).

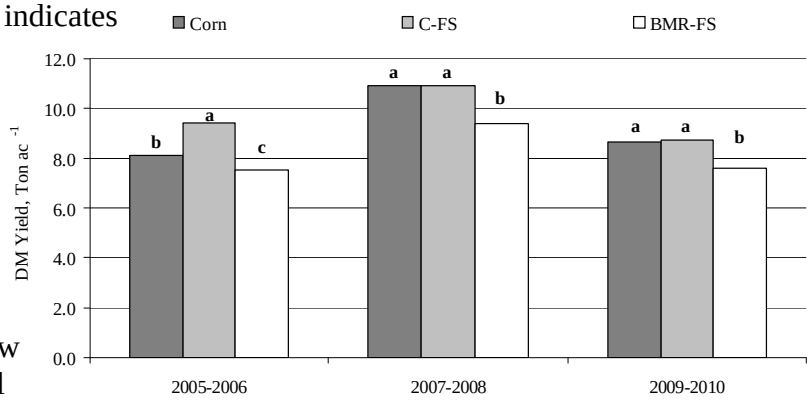

Figure 3. Dry matter yield of corn, conventional forage sorghum (C-FS) and brown midrib forage sorghum (BMR-FS) grown in 3, 2-yr experiments at NMSU Agic. Sci. Center at Clovis from 2005 to 2010.

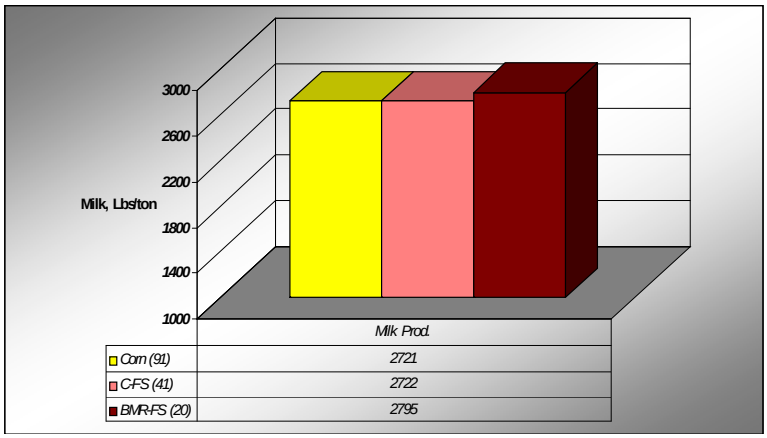

Figure 4. Estimated milk production per ton of corn, conventional forage sorghum (C-FS) and brown midrib forage sorghum (BMR-FS) grown over 4 years of variety trials at NMSU Agic. Sci. Center at Clovis.

Nutritive value and milk production can be comparable to corn with conventional forage sorghums and higher with BMR due to greater

digestibility of the fiber in the plant (Figure 4; Lusk et al., 1984; Oliver et al., 2004). Six years of variety trials at Bushland, TX have shown that several varieties of forage sorghum, including some BMR types, have yields 90% or more and digestibilities (IVTD) 95% or more of corn when grown with the same amount of water (Bean and McCollum, 2006).

Sorghum has the ability to withstand significant drought and high temperatures, more so than corn. This characteristic makes it possible to plant later in the spring without negative effects on the crop, thereby giving more time for land preparation (e.g., soil profile filling with irrigation) and more time to get any winter crops harvested prior to planting sorghum in double cropping situations.

Finally, input costs can be considerably less with forage sorghum than corn. Seed cost, for example, is a fraction of that of new high-yielding corn hybrids and one bag of sorghum seed will plant many more acres. In addition, silage growers can potentially save on fertilizer expenses when growing forage sorghum. Excellent yields (up to 30 tons/ac) have been obtained with 200 lb/ac or less of nitrogen, which is less than what is commonly put on corn for the same yield goal. Hence, there are several positive attributes of forage sorghum and evidence is strong in support of its ability to supplant, at least to a moderate extent, corn acreage in the SHP.

THE CONCERNS

Forage sorghum, however, is not without its limitations. In the past, the sorghums were mismanaged when grown as a high-input silage crop under irrigation. Seeding rates were often twice as much as needed and nitrogen fertilizer was over applied for the expectant yield. As such, plants had a tendency to lodge in the windy environment of the SHP, particularly the BMR types. Current recommendations are that there are no yield or nutritive value advantages to planting more than 100,000 (~6 lbs) seeds/ac and acceptable yields can be obtained with rates as low as 75,000 seeds/ac (Marsalis et al., 2010; Marsalis and Bean, 2010).

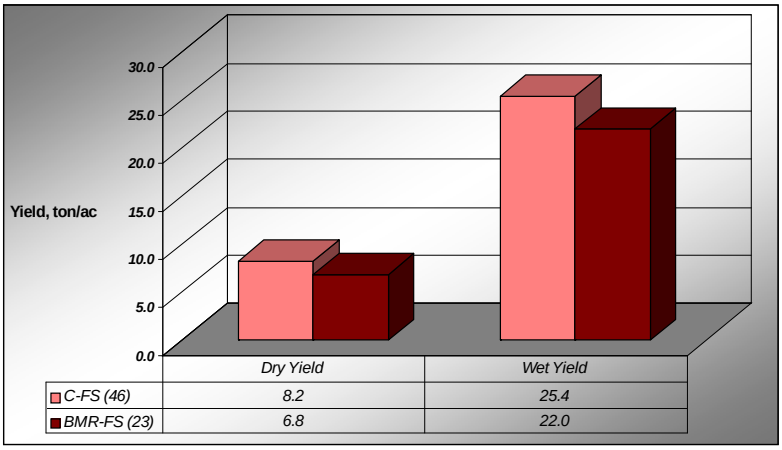

Figure 5. Dry and wet yields of conventional forage sorghum (C-FS) and brown midrib forage sorghum (BMR-FS) grown over 4 years of variety trials at NMSU Agic. Sci. Center at Clovis.

Another consistent pattern has been observed not only from the 3 studies mentioned above, but from several years of variety trials conducted at the same location. That is, BMR forage sorghum usually yields less forage than both corn and conventional types (Figures 3 and 5). This, combined with a greater potential for lodging (result of lower lignin), has been a major limitation of the crop. Future agronomic and breeding efforts with BMR forage sorghum should focus on improving yields in order to make them more competitive with corn and conventional sorghums.

It is well known that forage sorghum has an inconsistent dry down leading up to harvest. It is difficult to gauge optimum harvest windows based solely on grain maturity. Plants with grain at the soft dough stage of maturity may or may not be at the 65% whole-plant moisture stage. In fact, there is a great deal of variation among the many different cultivars of sorghum with respect to plant moisture. Grain may be close to mature by the time the whole plant has dried enough for proper ensiling. This leads to less grain being digested and starch available to the ruminant animal. To avoid this condition, many growers will harvest the crop too wet and negatively impact silage quality. A better method of facilitating dry down is to not irrigate the crop all the way to soft dough grain stage, but terminate irrigations near or after flowering assuming there is deep soil moisture for the plants to draw from. Variety trials conducted in the region give producers information on yield potential and plant moisture content at harvest to help them make informed decisions on variety selection.

While these shortcomings have caused many growers to be leery of forage sorghum in the past, with a proper understanding of how these issues can be overcome through management and variety selection, more may reconsider exploring the benefits of sorghum silage. Research will continue in the SHP to help address, not only the management of forage sorghums, but the increasingly ominous water situation that will affect agriculture practices and all crops for years to come.

CONCLUSIONS

The drought and heat tolerance of forage sorghum combined with the ability to resume growth after drought makes it an ideal candidate for silage systems in dry climates facing pending water shortages in the future. Under full irrigation (5-6 GPM/ac or greater) or when water is not limiting, corn often has a yield advantage (regional observations; Howell et al., 2008). However, every year fewer and fewer irrigation systems are able to meet this capacity in areas of eastern New Mexico and West Texas. With limited irrigation, forage sorghum is very competitive with corn with respect to yield and nutritive value. It is unlikely that corn silage will be replaced completely in dry regions because of its consistent performance, high energy, ease of management, and high yield potential under optimum growing conditions. It is, however, in less than ideal conditions that forage sorghums have the greatest advantage. One need not look any further than the 2011 growing season to see that under extreme drought in semiarid environments, forage sorghum has a clear advantage. Irrigation restrictions are certain to increase as water resources are shifted from agricultural use to municipalities, thereby exacerbating the problem of dwindling supplies. Silage producers must face the challenge of growing adequate feed supplies with considerably less inputs than in the past. Because water is the most imminent of the shortages on the horizon, water use efficient crops such as forage sorghum will likely increase in acreage in order to meet the ever-present feed demand in the region.

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