Energy Sorghum Response to Nitrogen and Production Cost

Choolwe Haankuku
Oklahoma State University
Department of Agricultural Economics
Email: Email: choolwe.haankuku@okstate.edu
Phone Number: (405) 744-6156

Francis.M. Epplin
Oklahoma State University
Department of Agricultural Economics
Email: Email: f.epplin@okstate.edu
Phone Number: (405) 744-6156

Gopal Kakani
Oklahoma State University
Department of Plant and Soil Sciences
Email: Email: v.g.kakani@okstate.edu
Phone Number: (405) 744-4046


Copyright 2013 by Choolwe Haankuku, F.M. Epplin, and Gopal Kakani. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.
Energy Sorghum Response to Nitrogen and Production Cost
Choolwe Haankuku, F.M. Epplin, and Gopal Kakani

Introduction
The U.S. Department of Energy’s (2011) 21 Billion-Ton Update reported that 40 to 60 million acres of U.S. cropland and pasture could be converted to produce dedicated energy crops. Forage sorghum was considered as the model dedicated annual energy crop. In addition to being an annual crop, forage sorghum possesses several agronomic characteristics that make it a potential candidate for biofuel feedstock production. Forage sorghum is attractive because of its yield potential, water-use efficiency, drought tolerance, rotation possibilities, and because it has an established production system, including seed production infrastructure and the potential for genetic improvement.

Agronomic characteristics are necessary but not sufficient for forage sorghum to be an economically viable biorefinery feedstock. It remains to be determined if a technology can be developed to produce economically competitive products from lignocellulosic feedstock. And, if the technology is developed, forage sorghum would have to be a lower cost feedstock than alternative biomass sources such as urban waste, forest and wood byproducts, crop residues, and alternative energy purpose grown crops such as switchgrass and miscanthus. Forage sorghum would require the use of cropland or high quality pasture land as well as fertilizer including nitrogen.

Objective
The objective of the research is to determine forage sorghum response to nitrogen, the optimal level of nitrogen fertilizer, and to determine its farm gate production costs for use as a bioenergy feedstock.

Data and Methods
Data were produced in designed replicated field experiments conducted over four production years (2008-2011) at two locations. Treatment variables included variety (three) and four levels of nitrogen fertilizer. Several functional forms were used to fit the data. The best fit was obtained with a linear response stochastic plateau model which included year random effects (Tembo et al. 2008). The stochastic plateau model captures the yield variability that resulted because one out of the four years of field experiments was dramatically affected by a drought.

Enterprise budgets were used to calculate expected production costs with production operations based on average custom operation rates for Oklahoma (Doye et al., 2012).

Results
• Yield response to nitrogen varied greatly both in magnitude and direction. Average yield over the four years across treatments ranged from 12.3 Mg/ha when no nitrogen was applied to 14.5 Mg/ha when 252 kg/ha of nitrogen was applied.
• The lowest average farm gate cost of $50/Mg was obtained from the 84 kg of nitrogen/ha treatment. The highest average farm gate cost of $53/Mg was obtained from the 252 kg of nitrogen/ha treatment.
• Based on the linear response stochastic plateau function, applying a kg of nitrogen increased yield at a rate of 0.07 Mg/ha until the plateau level yield is achieved. When nitrogen price is $1.11/kg and farm gate biomass feedstock price is $65/Mg, the optimal level of nitrogen fertilizer was determined to be 106 kg/ha at the stochastic plateau level yield of 14.88 Mg/ha.

Conclusions
Based on the yields and response to nitrogen observed in the field experiments, and the inputs and prices, production of feedstock from forage sorghum would be economically feasible only if the farm gate biomass price is $50/Mg or higher. This is a minimum price that would be required to offset the opportunity costs to convert from other crops to forage sorghum. A higher price could be expected to be required to provide an incentive for growers to switch from current crops.

Additional research would be required to determine how to store and transport the biomass as required to provide a continuous flow of feedstock throughout the year to a biorefinery.

References