

Level of Carbon Tax Required for Switchgrass and Miscanthus to Compete with Coal for  
Generating Electricity

Sijesh C. Aravindhakshan, Francis M. Epplin, Charles Taliaferro

Sijesh C. Aravindhakshan; sijesh@okstate.edu  
Francis M. Epplin; f.epplin@okstate.edu  
Charles Taliaferro; charles.taliaferro@okstate.edu

Francis M. Epplin (Primary Contact)  
Department of Agricultural Economics  
Oklahoma State University  
Stillwater, OK 74078  
Phone: 405-744-6156

Sijesh C. Aravindhakshan is a graduate research assistant, Francis M. Epplin is Charles A. Breedlove professor. And Charles Taliaferro is Professor Emeritus. This material is based on work supported in part by USDA Special Research Grant award 2008-34417-19201 from the National Institute of Food and Agriculture. The project is also supported by the USDA National Institute of Food and Agriculture, Hatch grant number H-2574. Support does not constitute an endorsement of the views expressed in the poster by the USDA.

*Poster prepared for presentation at the Agricultural & Applied Economics Association 2010 AAEA, CAES, & WAEA Joint Annual Meeting, Denver, Colorado, July 25-27, 2010.*

*Copyright 2010 by S.C. Aravindhakshan, F.M. Epplin, C.Taliaferro. 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.*

# Level of Carbon Tax Required for Switchgrass and Miscanthus to Compete with Coal for Generating Electricity

Sijesh C. Aravindhakshan, Francis M. Epplin, Charles Taliaferro  
Oklahoma State University



## INTRODUCTION

Coal is the primary fuel used by the nation's electric power industry. Coal produces 36% of the carbon dioxide emissions from energy use [1].

Cofiring with cellulosic biomass is more efficient in reducing greenhouse gas emissions than when it is used for producing ethanol. Cofiring requires only minor modifications and minimal investments in existing plants [2].

A key decision to ensure a cost-efficient long term supply of biomass feedstock depends on the selection of species and management practices.

Switchgrass (*Panicum virgatum*) serves as a model dedicated energy crop. Miscanthus (*Miscanthus x giganteus*) is an alternative.



Switchgrass



Miscanthus

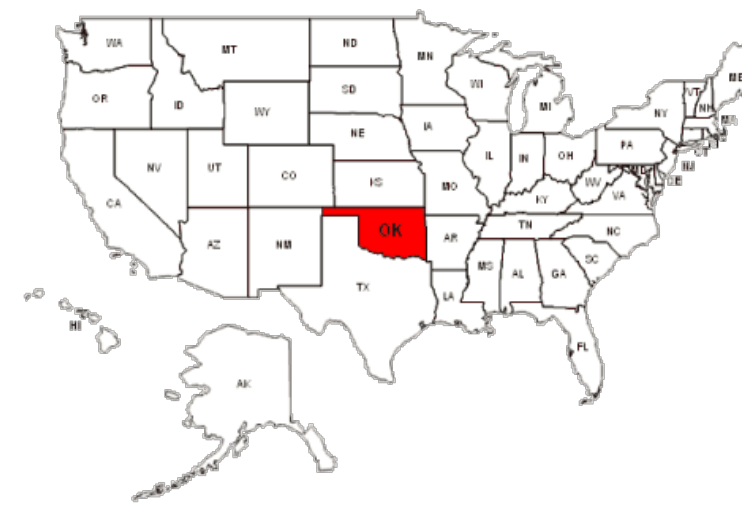
Biomass is more expensive than coal if the externalities of burning coal are ignored. A tax on CO<sub>2</sub> emissions could be used to incentivize cofiring with biomass.

## OBJECTIVES

To determine the most economical species and harvest frequency (once or twice per year)

To determine the CO<sub>2</sub> tax required for either of the two candidate feedstocks to be an economically viable alternative for cofiring with coal to generate electricity

## MATERIALS AND METHODS



Annual dry-matter yield and gross energy data were produced in side-by-side trials conducted in Stillwater Oklahoma.

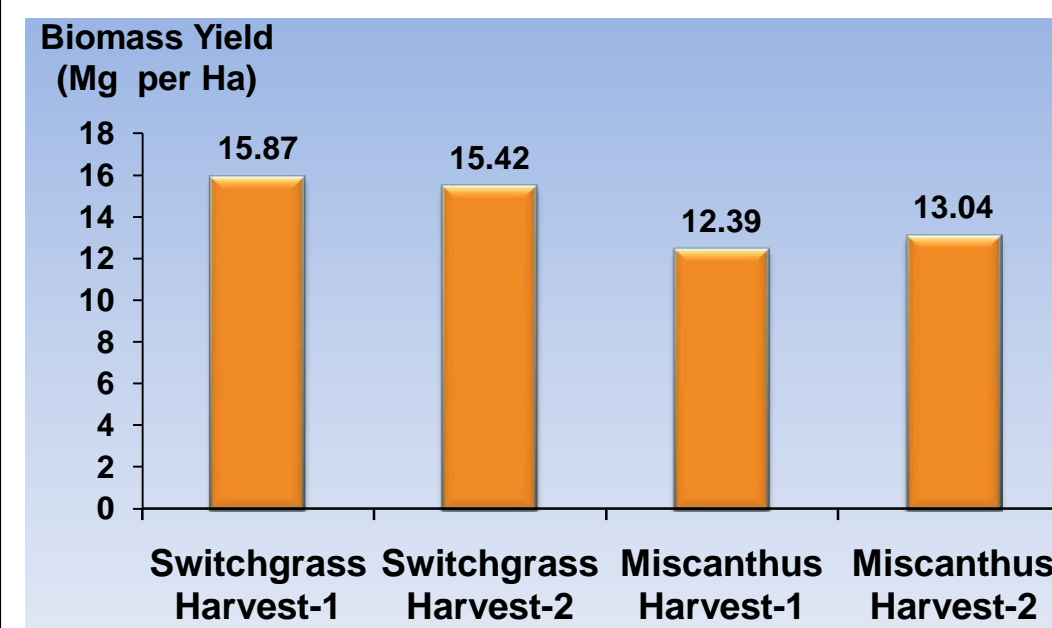
Fixed effects : Species and harvest levels  
Random effects: Replication and year

Separate models were estimated with biomass yield and energy content as dependent variables using the MIXED procedure of SAS.

## RESULTS

• Biomass yield differs across species. Annual yield is not enhanced by multiple harvest.

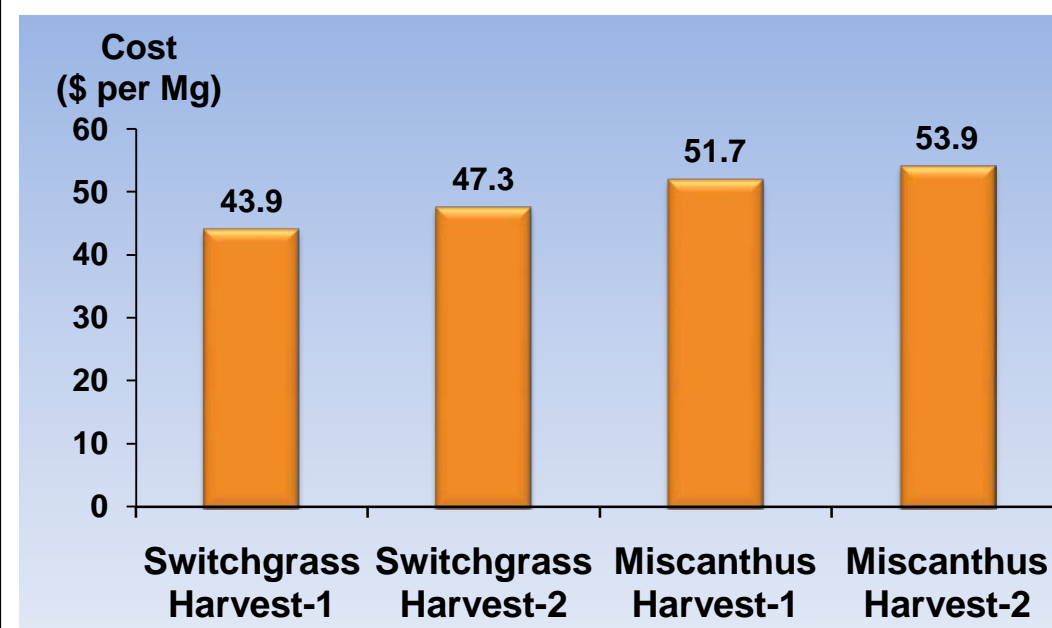
Fig 1. Biomass yield



• Switchgrass with a single annual post-senescence harvest produced more biomass than miscanthus.

• Energy production per land unit was greater with switchgrass.

Fig 2. Estimated cost to deliver biomass

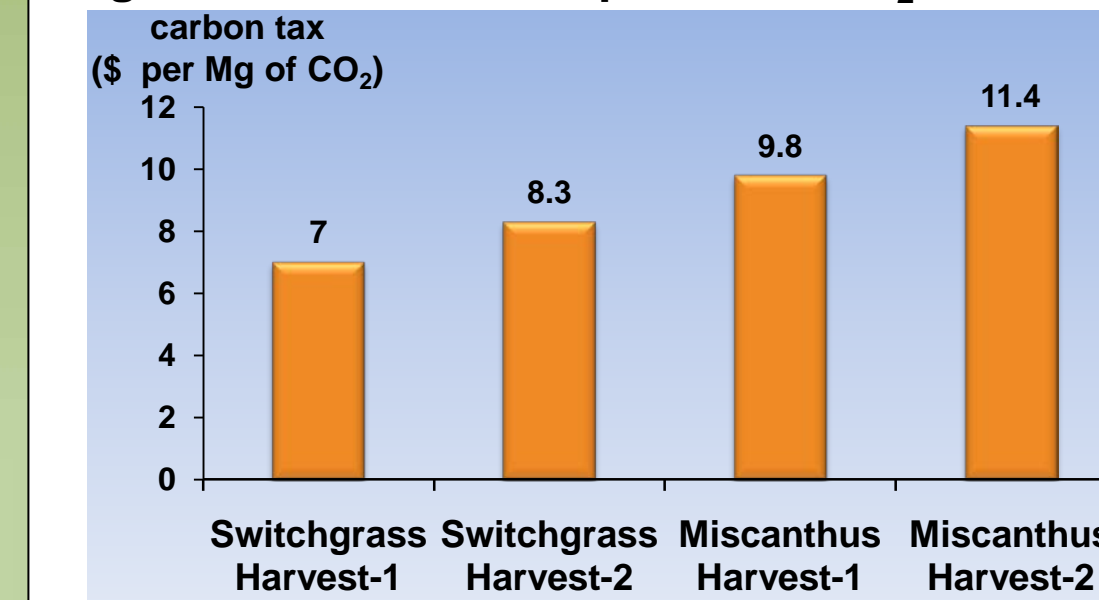


• For the U.S average coal price of \$40 per Mg, the value of switchgrass biomass based on energy content is estimated to be \$27 per Mg.

• The estimated cost to produce and deliver biomass a distance of 50 km was \$44 per Mg for switchgrass and \$52 per Mg for miscanthus.

## RESULTS

Fig 3. Estimated tax imposed on CO<sub>2</sub> emission



• None of the treatment combinations would produce positive net revenue if the biomass price was based on energy content relative to coal.

• Among the treatment combinations, switchgrass with one harvest requires the smallest CO<sub>2</sub> tax to breakeven.

## CONCLUSION

□ The best strategy for producing biomass in the region would be to establish switchgrass and harvest once a year after senescence.

□ Harvesting twice a year is not an economically viable cultural practice in the region for either species.

□ The carbon tax based on CO<sub>2</sub> emission, required for cofiring switchgrass biomass with coal to breakeven with using only coal is estimated to be \$7 per Mg of CO<sub>2</sub>.

□ The production of cellulosic biomass for cofiring is not financially viable without government intervention.

## REFERENCES

- [1] DOE/EIA. Emissions of green house gases in the United States. 2008. < [http://www.eia.doe.gov/oiaf/1605/ggprpt/pdf/0573\(2007\).pdf](http://www.eia.doe.gov/oiaf/1605/ggprpt/pdf/0573(2007).pdf)>
- [2] Fraas, A. and R. Johansson. Conflicting goals: energy security versus GHG reductions under the EISA cellulosic ethanol mandate. Discussion paper, Resources for the Future 2009.

## CONTACTS

Sijesh C. Aravindhakshan: Department of Agricultural Economics, Oklahoma State University, Stillwater OK, 74078. Ph: (405) 744-6042 email: sijesh@okstate.edu  
Francis M. Epplin : Department of Agricultural Economics, Oklahoma State University, Stillwater OK, 74078. Ph: (405) 744-6156 email: f.epplin@okstate.edu