Environmental and Cost Efficiency of Corn Ethanol Plants

Kassu Wamisho
School of Natural Resource & Department of Agricultural Economics, UNL
UNL Research Fair ,April 12-14, 2011

University of Nebraska Lincoln | Nebraska Center for Energy Sciences Research

Source: http://www.anguil.com/industries-served/ethanol-biodiesel.aspx

Objective of this study:

•Determine the cost & environmental efficiency of seven recently built ethanol plants in the North Central region of the U.S

Method:

•Estimate a constrained multioutput net ethanol cost function to represent the plant technology, using a translog functional form
•Use this function to estimate minimum GHG production
•Measure Environmental Efficiency (EE) as the ratio of minimum achievable CO2 to the observed CO2

The Model:

I. The mimimum net ethanol cost function:

$$F(e,W,P,Z)=Min_{X,Y}\{WX-P_1Y_1-P_2Y_2 \mid (e,X,Y,Z)<T\}$$

where: e=ethanol output (gallons),
X= (corn (bu), N.gas (Btu), electricity (kwh)),
Y= (DDG (tons), WDG(tons))
W= vector of prices for X,
P = vector of prices for Y,
Z = quantity of other, fixed, inputs (in $).

The Translog approximation of the minimum cost fn:

$$\ln F=\alpha_o+\alpha' R+0.5R'\boldsymbol{\beta}R, \qquad R'=(\ln e,\ln W,\ln P,\ln z)$$

II. Observed GHG emission for a given level of ethanol

$GHG^0=a'X^0-b'Y^0$, **a '& b' =GHG coefficients of X & Y**

III. The minimum achievable GHG^M emission

$$GHG^M(e,a,-b,Z)=Min_{X,y}\{aX+bY)\mid (e,X,Y,Z)<T\}$$

Or, $\ln F=\alpha_o+\alpha' R+0.5R'\boldsymbol{\beta}R$, $R'=(\ln e, \ln a, \ln b, \ln z)$

IV. Environmental Efficiency (EE) $=GHG^0/GHG^M$

Data

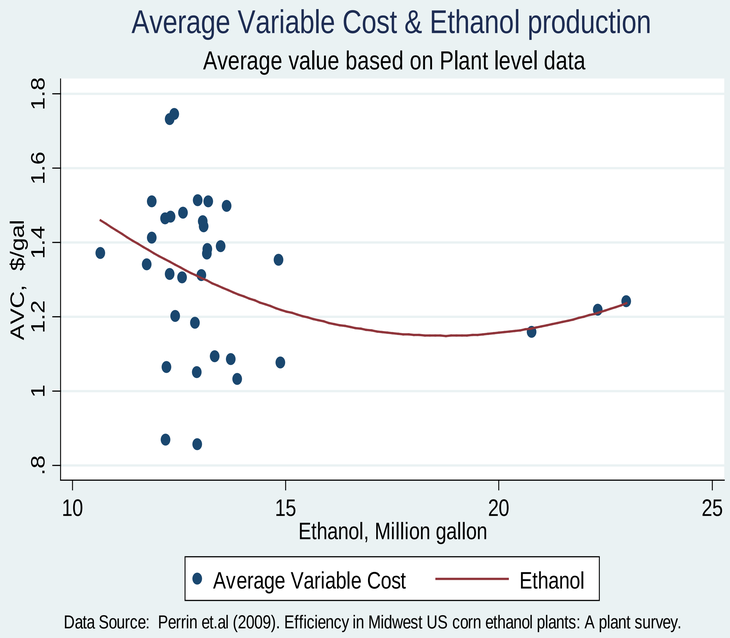
Survey results for ethanol plant quarterly inputs and outputs for seven dry mill ethanol plants in the midwest during 2006-07 (Perrin, et al, 2009).

Results and Discussion

I. Share of Input and by product in the total cost and GHG

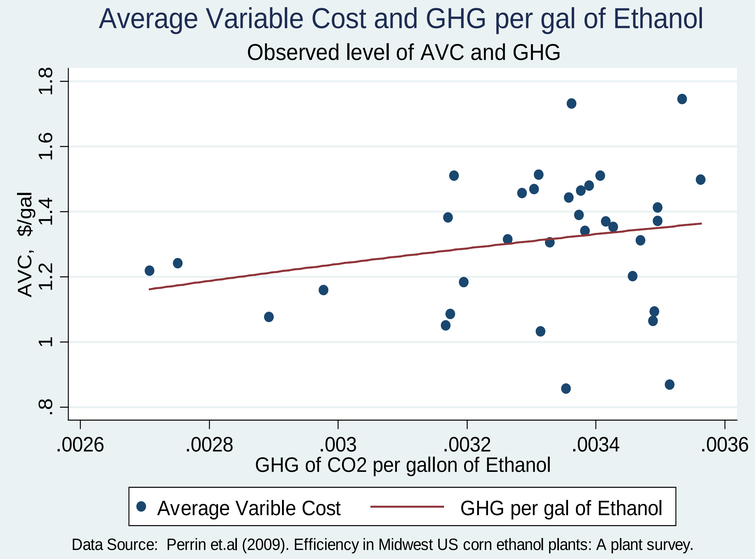
Inputs	Cost share	GHG share
Corn	0.804	0.713
N.gas	0.147	0.507
Electricity	0.019	0.130
DDG	-0.123	-0.220
WDG	-0.048	-0.129
Other cost	0.200	
Average VC, $/gal	1.308	

II. Observed Cost and GHG at plant level



Data Source: Perrin et.al (2009). Efficiency in Midwest US corn ethanol plants: A plant survey.

III. Observed Average Variable Cost and GHG per gal of ethanol



Data Source: Perrin et.al (2009). Efficiency in Midwest US corn ethanol plants: A plant survey.

Conclusion

A plant is environmentally efficient when it chooses the minimum CO2 per gallon of ethanol.

Evaluating how minimum cost increases with lower CO2 allows us to trace out the cost of reducing emissions.

Given the current fuel regulations of California and the likelihood that greenhouse gas emissions will be regulated by the federal government during the lifetime of most ethanol facilities in operation or under construction today, a thorough examination of environmental and economic efficiency of ethanol plants will provide valuable information to the industry in its efforts to comply with regulations, and to policy makers who must consider the CO2 abatement costs of the corn ethanol system.

Literature cited

Liska, A.J H.S. Yang, V. Bremer, D.T. Walters, G. Erickson, T. Klopfenstein, D. Kenney, P. Tracy, R. Koelsch, K.G.

Perrin, R.K., et al., Efficiency in Midwest US corn ethanol plants: A plant survey. Energy Policy (2009)

Sesmero J. P , Perrin, R.K, and Fulginiti E L. 2010. Environmental Efficiency Among Corn Ethanol plants. Department of Agricultural Economics, University of Nebraska, Lincoln, NE 68583, USA

Acknowledgments

This research has been supported by the Nebraska Center for Energy Sciences Research (NCESR),and supervised by Profesor Richard K Perrin and Lilyan E Fulginiti , Department of Agricultural Economics at UNL

For further information

contact: Kassu Wamisho at kassuwam@yahoo.com