The Texas Journal of Agriculture and Natural Resource 23:42-49(2010)

Inventory of Cotton Gin Trash on the Texas High Plains and Bio-Energy Feedstock Potentials

Curtis Wilde
Jeff Johnson
Michael Farmer
Department of Agricultural and Applied Economics, Texas Tech University, Box 42132, Lubbock, TX 79409-2132

ABSTRACT

With the increasing demand for bioenergy, agricultural products are being studied to determine their availability and feasibility for use as feedstock in bioenergy production. Availability is one of the most important factors in the feasibility of the use of any product for bioenergy production. Cotton gin trash is a potential feedstock for electricity or ethanol production. The objective of this study was to determine the availability of cotton gin trash in the Texas High Plains (THP) and to estimate the potential supply of bioenergy generated from cotton gin trash. County cotton production data was used to determine energy supply given fixed energy content for cotton gin trash. Thirty counties produced 64% of the total cotton production in Texas and 22% of United States' cotton production from 2001 to 2006 resulting in 994,736 tons of cotton gin trash produced annually. An average of 4.3 million mmBTUs of energy exists annually from gin trash in THP with an annual minimum of 2.5 million mmBTUs and maximum of 6.5 million mmBTUs. On average, cotton gin trash in the area could supply 12.5 million gallons of ethanol or 65,000 megawatt hours (MWe).

KEY WORDS: agricultural waste, bioenergy, energy, feedstock, gin trash

INTRODUCTION

Increases in prices for crude oil and natural gas, and concerns for the environment, have led to a call to reduce the United States' reliance on foreign energy. The increased importance and demand for biofuels can be seen in new policy development, especially the Energy Policy Act of 2005 (U. S. Environmental Protection Agency, 2007), which calls for the use of 7.5 billion gallons of ethanol and biodiesel by 2012 with some political calls for even more use of biofuels. To meet these goals, agriculture is being called upon to assist in the development of bioenergy.

Cotton gin trash is a byproduct of the cotton ginning process and consists of the dried burr of the cotton boll, stems, leaf fragments, and some short or damaged cotton fibers, all of which are high in cellulose. Although cotton gin trash has not been a popular feedstock for biofuel production as have grains for ethanol or switchgrass and wood byproducts for cellulosic fuels, it is abundant in the southern and southwestern region of the United States and in approximately 80 countries where cotton is a major cash crop. The use of cotton gin trash could help fill the increasing demand for bioenergy feedstock, thereby increasing its value by providing extra revenue to cotton gins and cotton growers as well as offer a means of disposal of the trash created during the ginning process.

The objective of this study was to determine the availability of cotton gin trash for the Texas High Plains (THP) and estimate the potential supply of energy that can be created.

LITERATURE REVIEW

Two studies reported on the fate of cotton gin trash. Cohen and Lansford (1992) determined that most cotton gin trash was disposed of by spreading on the land, composting, feeding to livestock, landfill disposal, incineration, conversion to energy, making pellets for fuel in heat stoves, building materials, and insulation. Incineration was a recommended method of disposal that controlled pink bollworm and generated energy for the gin until the practice was discontinued in 1975 by the Clean Air Act of 1970 (Hainze 1999). Castleberry and Elam (1998) conducted a survey of cotton gins in the Texas High and Low Plains and reported that 47.9% of cotton gin trash was used for livestock feed, 33.2% was spread on the land as a soil amendment, and 15.9% was composted. Gins that reported composting as a disposal method were concentrated within a 50 mile radius of southeastern Lubbock County where a composting operation was located. Average disposal cost of cotton gin trash was $1.44 per ton and a cotton bale produced 741 lbs. of gin trash from the ginning process.

The proceedings from the Symposium on Cotton Gin Trash Utilization Alternatives, held in Lubbock, Texas in April 1982, is a rich source of reports of early studies of biofuel uses for cotton gin trash. Avant (1982) reported that cotton gin trash had immediate potential as a boiler or combustion unit fuel for regional processing industries and utilities, and long term possibilities included methanol and ethanol production. A study of combustion and gasification of cotton gin trash, conducted by LePori, et al., (1982), determined that cotton gin trash collected at a gin has potential of supplying all the energy needed for the gin in stripper harvesting areas. Lacewell, et al., (1982) reported that each pound of trash could yield 7,000 BTUs. They determined that the major cotton producing counties of the THP produced a yearly average of 596,988 short tons of gin trash with a potential of 8,357,832 million BTUs from 1970 to 1974. Beck and Clements (1982) showed that ethanol production from cotton gin residue was both technically and economically feasible. It was also determined that gin residue varies widely from crop year to crop year. In their study, the Texas South Plains counties produced an annual average of approximately 900,000 tons of cotton gin residue. The conclusion of the study was that it was economically feasible to produce ethanol from cotton gin residue in large-scale plants. Additionally, the research demonstrated that 37.8 gallons of ethanol can be produced per ton of gin trash.

Sharma-Shivappa and Chen (2008) reviewed several studies of various conversion processes but concluded that continued studies must be conducted to improve process efficiency and economic efficiency for bioethanol production. Other processes for biofuel production include briquettes, pyrolysis, and anaerobic digestion. Two recent studies near the THP include Holt et al., (2004) in Lubbock, Texas which produced fuel pellets from gin trash and Macia-Corral, et al., (2005) in eastern New Mexico which produced methane gas from gin trash and dairy manure.

METHODS AND PROCEDURES

The study area is the 30 county region of the Texas High Plains shown in Figure 1 and consists of the counties of Andrews, Armstrong, Bailey, Borden, Briscoe, Castro, Cochran, Crosby, Dawson, Deaf Smith, Dickens, Floyd, Gaines, Garza ,Glasscock, Hale, Hall, Hockley, Howard, Lamb, Lubbock, Lynn, Martin, Midland, Motley, Parmer, Randall, Swisher, Terry, Yoakum. These counties represent 64% of the total cotton production in Texas and 22% of U.S cotton production from 2001 to 2006 (U.S. Department of Agriculture, 2007).

County cotton production data, from 2001 to 2006, was retrieved from USDA's National Agricultural Statistics Service (NASS) for the 30 counties listed above (U.S. Department of Agriculture, 2007).

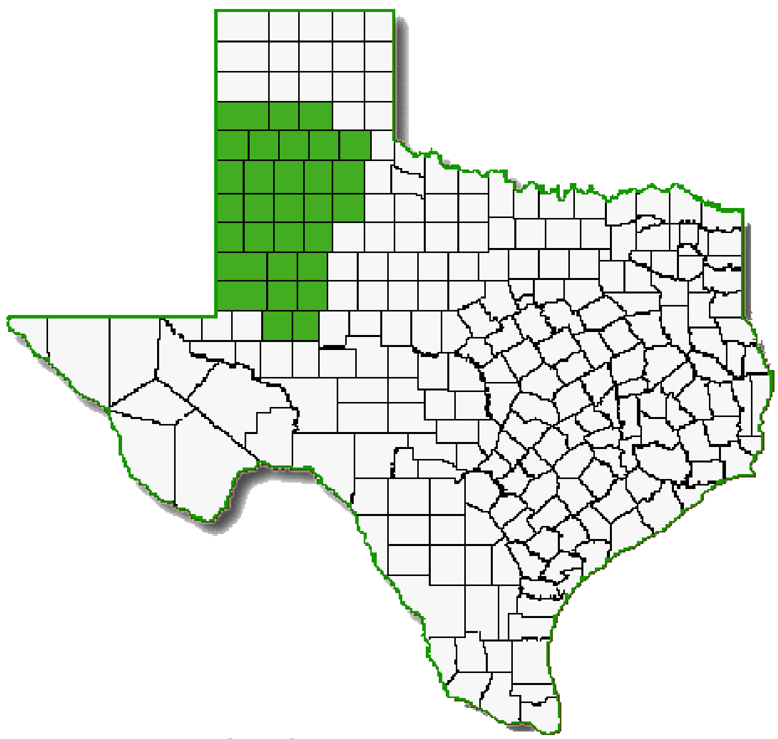

Figure 1. Cotton Gin Trash Study Area in Texas.

The cotton production data from these counties was used to determine the gin trash production based on lint and trash turnout percentages. Potential bioenergy production was estimated using the following function:

$$E = (CP / TO) * TR * BTU,$$

where E represents energy production in BTUs, CP represents cotton lint production in tons, TO represents the turnout percentage, TR represents the trash production as a percentage of seed cotton, and BTU represents the energy in BTU generated per ton of cotton gin trash. The cotton lint production in tons was calculated from the NASS reported production for each county in bales, assuming a 480 pound bale. The turnout percentage is the weight of lint as a percentage of the weight of seed cotton ginned and was estimated by Mitchell et al., (2007) to be 27.35% for recent cotton varieties. The trash percentage was estimated to be 29.75% (Mitchell et al., 2007). The amount of cotton gin trash per bale is lower than previously reported by Castleberry and Elam (1998) due to the increased use of burr extraction in harvesting and picker harvesting and the adoption of new varieties with higher lint yields per boll in the THP. The value for BTU generated per ton of cotton gin trash is 13.10 mmBTU/ton of gin trash (Curtis et al., 2003).

RESULTS

The 30 counties in the study area produced an annual average of 994,736 tons of cotton gin trash with a minimum of 606,156 tons and a maximum of 1,485,929 tons for the period from 2001 to 2006. Seven counties each produced an annual average of over 60,000 tons, comprising 39% of cotton gin trash for the study area, including Gaines, Hale, Hockley, Lamb, Lubbock, Lynn, and Terry. Hale County produced the highest yearly average cotton gin trash with 104,080 tons. Three counties produced an annual average between 40,000 and 60,000 tons, comprising 16% of cotton gin trash for the study area, including Crosby, Dawson, and Floyd counties. Six counties produced an annual average between 20,000 and 40,000 tons, comprising 19% of cotton gin trash for the study area, including Castro, Cochran, Martin, Swisher, Parmer, and Yoakum counties. These 16 counties that annually produced at least 20,000 tons of cotton gin trash produced 74.68% of the cotton gin trash in the study area. The counties with the highest cotton gin trash production in the study area are centered on the Southern High Plains of Texas, shown in Figure 2.

This study assumes that the demand for gin trash for use as livestock feed and for composting will remain constant and that the gin trash that is currently used for soil amendment will be used for energy production. According to Castleberry and Elam (1998), about one third of the gin trash from the THP is currently being used for soil amendment. Using one third of the total gin trash estimated to be produced, the counties in the study area can provide an average annual supply of energy of 4.3 million mmBTUs with an annual minimum of 2.6 million mmBTUs and maximum of 6.5 million mmBTUs for the 2001 to 2006 period. Each county's average, minimum and maximum energy supply is shown in Table 1. It is important to consider the maximum and minimum values, as the available feedstock will fluctuate with production conditions, especially weather related conditions.

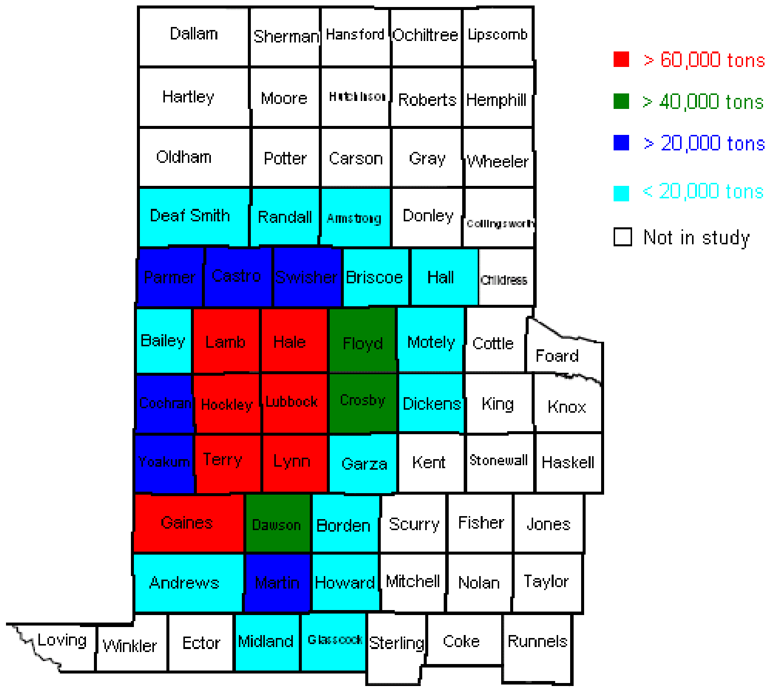

Figure 2. Yearly Average Tons of Cotton Gin Trash in 2001-2006 in THP.

The minimum, maximum and average energy values for each county are shown in Figure 3 with a tick mark representing the average.

The seven counties with an annual average of over 60,000 tons produced could supply 2.2 million mmBTUs of energy, while the ten counties producing over 40,000 tons of gin trash could supply 3.0 million mmBTUs.

If available gin trash in the study area was converted to ethanol using a conversion factor of 37.8 gallons of ethanol per ton of gin trash (Beck and Clements, 1982), 12.5 million gallons of ethanol would be supplied by cotton gin trash. If available gin trash in the study area was converted to electricity using a conversion factor of 1 MWe per ton of gin trash (Capareda 2009), 331 thousand MWe of electricity would be supplied by cotton gin trash.

Table 1. County Energy Supply in Gin Trash in 2001-2006.

County	5 yr Average Production (Bales)	Available gin trash [1] (short ton)	Average BTU (mmBTU)	Min BTU (mmBTU)	Max BTU (mmBTU)
Andrews	21,367	1,859	24,357	13,680	43,091
Armstrong	2,183	190	2,489	0	5,928
Bailey	69,267	6,028	78,961	13,908	127,676
Borden	16,400	1,427	18,695	4,218	40,925
Briscoe	29,667	2,582	33,819	18,809	46,852
Castro	141,617	12,323	161,438	97,695	199,038
Cochran	126,900	11,043	144,661	37,847	222,293
Crosby	207,450	18,052	236,485	112,856	377,328
Dawson	225,783	19,648	257,385	93,477	455,985
Deaf Smith	48,317	4,205	55,079	27,473	67,486
Dickens	16,433	1,430	18,733	9,120	30,323
Floyd	189,567	16,496	216,099	73,414	302,090
Gaines	314,717	27,387	358,765	216,593	525,523
Garza	34,800	3,028	39,671	18,239	81,507
Glasscock	69,250	6,026	78,942	39,899	170,995
Hale	398,683	34,693	454,484	213,857	584,801
Hall	67,083	5,838	76,473	36,479	127,676
Hockley	255,867	22,266	291,679	153,895	434,326
Howard	63,317	5,510	72,179	9,120	141,013
Lamb	272,400	23,704	310,526	107,043	387,018
Lubbock	282,550	24,588	322,097	166,435	532,363
Lynn	229,900	20,006	262,078	70,108	489,044
Martin	81,467	7,089	92,869	21,089	204,053
Midland	17,317	1,507	19,740	10,260	32,489
Motley	15,183	1,321	17,308	10,602	30,551
Parmer	142,967	12,441	162,977	42,635	217,961
Randall	3,533	307	4,028	2,508	5,130
Swisher	104,500	9,094	119,126	69,652	137,936
Terry	234,383	20,396	267,188	136,226	466,245
Yoakum	127,500	11,095	145,345	92,907	220,013
Total	3,810,367	331,579	4,343,679	2,646,881	6,488,558

[1] Available gin trash is one third of total gin trash produced and represents the amount of gin trash estimated to be used currently as soil amendment.

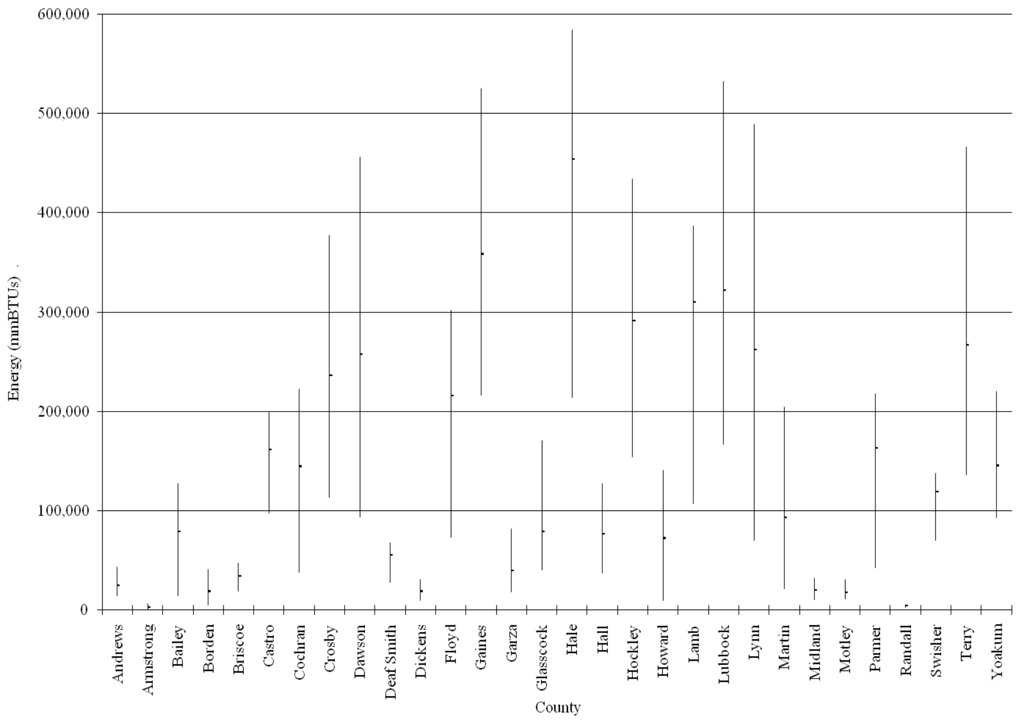

Figure 3. County Energy Supply in 2001-2006.

CONCLUSIONS

A large potential feedstock source exists for use in producing bioenergy centered around the cotton producing counties on the THP. One ton of trash converted into electricity would displace 1.31 mmBTUs in the energy market; while one ton of gin trash converted into ethanol would displace 76 mmBTUs. The use of this feedstock could help supply the call for greater bioenergy use and displace nonrenewable energy in the market while providing additional revenue for cotton gins and producers in the region.

Further study is warranted to determine the economic feasibility of the use of cotton gin trash as a feedstock for bioenergy production and the logistics that would be required to use cotton gin trash as a feedstock in bioenergy production. While the cost of producing energy products from cotton gin trash is important for investment decisions or development planning, that analysis was beyond the scope of this study. As technological processes become commercially viable, the costs of production and investment decisions can be more thoroughly analyzed.

REFERENCES

Avant, R. V. 1982. Energy From Cotton Gin Trash: A Perspective. *In* proceedings of the symposium on cotton gin trash utilization alternatives, Lubbock, Texas. April 8, 1982.

Beck, S. R. and L. D. Clements. 1982. Ethanol Production from Cotton Gin Trash. *In* Proceedings of the Symposium on Cotton Gin Trash Utilization Alternatives, Lubbock, Texas. April 8, 1982.

Capareda. S., 2009. Personal communication. Department of Biological & Agricultural Engineering, Texas A&M University.

Castleberry, M. and E. Elam. 1998. Production and Disposal/Utilization of Cotton Ginwaste from the Texas High and Low Plains. p. 1669-1674. *In* Proc. Beltwide Cotton Conf., San Diego, CA. 5-9 Jan. Natl. Cotton Counc. Am., Memphis, TN.

Cohen, T. M. and R. R. Lansford. 1992. Survey of Cotton Gin and Oil Seed Trash Disposal Practices and Preferences in the Western U.S. New Mexico State University Agricultural Experiment Station. Las Cruces, New Mexico.

Curtis, W., C. Ferland, J. McKissick and W. Barnes. 2003. The Feasibility of Generating Electricity From Biomass Fuel Sources in Georgia [Online]. Available at http://www.caed.uga.edu/publications/2003/pdf/FR-03-06.pdf (verified 17 Jan. 2007).

Hainze, M. 1999. Analysis of Cotton Gin Buildings in the South Plains Region. Unpublished Masters Thesis. Texas Tech University.

Holt, G.A., J.L. Simonton, M.G. Beruvides, and A. Cantu. 2004. Utilization of Cotton Gin By-products for the Manufacturing of Fuel Pellets: An Economic Perspective. Applied Engineering in Agriculture. 20(4): 423

Lacewell, R. D., D. S. Moore and C. B. Parnell. 1982. Pelleting Cotton Gin Trash for Energy. *In* Proceedings of the Symposium on Cotton Gin Trash Utilization Alternatives, Lubbock, Texas. April 8, 1982.

LePori, W. A., D. B. Carney, J. C. B. Parnell and R. D. Lacewell. 1982. Energy From Cotton Gin Trash. *In* Proceedings of the Symposium on Cotton Gin Trash Utilization Alternatives, Lubbock, Texas. April 8, 1982.

Macias-Corral, M.A., Z.A. Samani, A.T. Hanson, R. DelaVega, and P.A. Funk. 2005. Producing Energy and Soil Amendment from Dairy Manure and Cotton Gin Waste. Transaction of the ASAE. 48(4):1521-1526.

Mitchell, D. M., J. Johnson and C. Wilde. 2007. Impacts of decreasing cottonseed to lint ration on cottonseed markets. p. 797-800. *In* Proc. Beltwide Cotton Conf., New Orleans, LA. 9-12 Jan. 2007. Natl. Cotton Counc. Am., Memphis, TN.

Sharma-Shivappa, R. R., and Y. Chen. 2008. Conversion of Cotton Wastes to Bioenergy and Value-Added Products. Transactions of the ASABE 51(6):2239-2246.

U. S. Environmental Protection Agency. 2007. Renewable Fuel Standard Program [Online]. Available at http://www.epa.gov/otaq/renewablefuels/ (verified 6 Dec. 2007).

U.S. Department of Agriculture. 2007. Texas County Data - Crops [Online]. Available at http://www.nass.usda.gov/QuickStats/ (verified 16 Aug. 2007).