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Switchgrass Cost of Production: Data from On-Farm Trial, 2001-2005

Richard K. Perrin
University of Nebraska-Lincoln, rperrin@unl.edu

Kenneth P. Vogel
USDA-ARS, Ken.Vogel@ars.usda.gov

Marty R. Schmer
USDA-ARS, University of Nebraska - Lincoln, marty.schmer@ars.usda.gov

Robert B. Mitchell
USDA-ARS, rob.mitchell@ars.usda.gov

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Richard Perrin [1]
Kenneth Vogel[2]
Marty Schmer [2]
Rob Mitchell[2]

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[1] Department of Agricultural Economics, University of Nebraska
[2] Agricultural Research Service, USDA, University of Nebraska

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Abstract:

Switchgrass is considered a potential commercial biomass feedstock but field scale production and production cost data have been limited. The costs of production incurred on ten commercial-sized fields in the northern Great Plains, between 2000 and 2005 have been reported in a scientific journal paper[4]. This report provides the detailed information, in English metric units, that was used to conduct the economic analyses. The average annualized cost to produce and store switchgrass on these farms was $60 per ton of dry matter, which translates to an ethanol feedstock cost of about $0.66-0.75 per gallon of ethanol, depending upon the ultimate ethanol yield.

I. Objectives and Methods

The United States Department of Energy (DOE) designated switchgrass as a potential bioenergy feedstock because of its wide adaptability and high yields on marginal lands. But because switchgrass is not presently a commercial crop, the cost of production, and therefore the price that would bring forth commercial production, is conjectural. While there have been estimates of the cost of producing switchgrass (Walsh (1994), Duffy and Nanhou (2001)), they have been based on inferences from plot-level yields and engineering cost budgeting approaches. Because of this dearth of commercial-scale cost information, DOE and the USDA's Agricultural Research Service funded a collaborative project with the University of Nebraska[5], to estimate commercial-scale production costs in the northern Great Plains, by contracting with collaborating farmers to produce the crop and report detailed records on costs.

The on-farm studies were conducted on ten rainfed fields of 15-20 acres each, scattered from southern Nebraska up through South Dakota to northern North Dakota (see Figure 1 and Table 1.) The fields selected had characteristics that would have qualified them for the Conservation Reserve Program (CRP), and were typical of their surrounding geographical region. In this report, the fields are identified by the name of the nearest town. The sites are briefly described in Table 1. The Nebraska fields were established in 2000 and continued through 2004. The South Dakota and North Dakota fields were established in 2001, and continued through 2005. The Atkinson, NE, site changed size during the study. It consisted of two "pivot corners", the non-irrigated

[4] A journal version of this report, in metric units, is to appear in BioEnergy Research, March, 2008. (Give full citation)

[5] USDA-University of Nebraska Cooperative Agreements 58-5440-0-305 and 25-6224-0060-001, "Economic Evaluation of Switchgrass Grown as a Biomass Energy Crop in the Central and Northern Plains, USA."

triangles formed at the corners of a square field in which the irrigated circle of a center pivot irrigations system is inscribed. One pivot corner field was abandoned after the second successive failure to establish a switchgrass stand, reducing the total number of hectares from seven to three for the final three years.

Figure 1. Locations of Switchgrass Fields

Farm cooperators managed all aspects of crop production and harvest except that the Nebraska switchgrass fields were planted by USDA-ARS, Lincoln, personnel. A general set of recommended management practices, based on previous small plot research, were given to all farm cooperators. These management practices detailed seedbed preparation, planting depth, planting dates, herbicide use, and harvesting dates. Cultivars selected for each field were based on prior research within respective geographical regions. Seeding rates were 322 pure live seed (PLS) m^2. Soil samples were taken on each field before switchgrass establishment to assess soil fertility. No fertilizer was applied the establishment year. Subsequent fertilization recommendations ranged from 60 to 100 lbs N per acre, varying with the potential productivity,

establishment year weed populations, and previous climatic conditions for a field. Not all fields were fertilized in the second year, however, because of drought conditions. The average rate of nitrogen application was 67 lbs per acre. Farmers harvested switchgrass with conventional round-bale equipment, and stored the bales in or near the fields. A sample of three bales were weighed, and a core from each bale was extracted, sealed, and sent to project headquarters to measure moisture and other characteristics. Yields reported here are measured in quantity of dry matter.

Table I
Site Locations and Characteristics

Location	Field size (acres)	Rainfall, 30-yr average (inches)	Cultivar(s)	Previous crop
Munich, ND	15.0	15.0	Sunburst	soybean
Streeter, ND	19.0	14.3	Sunburst	oats
Bristol, SD	15.0	16.6	Trailblazer	soybean
Highmore, SD	15.0	14.3	Trailblazer	soybean
Huron, SD	15.0	16.1	Trailblazer	soybean
Ethan, SD	15.0	17.9	Shawnee	maize
Crofton, NE	20.0	19.0	Trailblazer, Shawnee	oats
Atkinson, NE [a]	17.4	19.1	Trailblazer	pearl millet
Douglas, NE	23.4	24.6	Cave-in-Rock, Trailblazer	soybean
Lawrence, NE	18.5	21.9	Cave-in-Rock, Sunburst, Trailblazer	sorghum/maize

[a] 17.3 acres in year 1,2; 7.4 acres remaining in years 3,4,5

Costs were determined using a variety of methods. Although the farmers did not always follow the recommended practices for growing the switchgrass, the costs reported here are those actually incurred by the farmers. Actual custom rates were used for farmers that hired custom operators. Other farmers used their own equipment to perform production tasks, thus a value must be assigned for the use of this equipment. In this case, cooperating farmers were asked to report the type and size of the equipment used as well as the number of hours required to complete the tasks. Rates for these services were taken from Selley, Barrett and Klein (2004). In addition, an hourly wage of $10 was used to report the value of the farmer's time. Additional costs were those that were actually paid. Land rental rates, as estimated by the cooperating farmers for similar land types in their areas, were within the range of rental rates reported in general surveys of rental rates (such as Johnson, *et al.* (2005).)

Special considerations involving the time value of money are required to determine the cost of producing perennial crops such as switchgrass. In this study, this is done by calculating the "annualized cost" of production, as described by Perrin (1972) and Burt (1992), using a real discount rate of 10%. While the average real prime discount rate in the US is only about 4%, and the historic real rate of return to land is similar (see Johnson, *et al.* (2005)), a real rate of 10% is a more conservative estimate of the rate that is appropriate for enterprises with risks comparable to those of a switchgrass crop. (The use of a 4% rate rather than 10% was found to reduce the cost per ton by about 4%, relative to the numbers for the 10% rate, to be reported below.) To calculate annualized cost per hectare, the present value of the sequence of annual expenditures, E_t , was first calculated using the 10% discount rate as $PV=\Sigma_t (E_t /(1.10)^t)$. Planting expenditures considered to occur at time t=0, and all other expenditures and the harvest itself were considered to occur at the end of the respective crop year, *i.e.*, at t=1, …, 5. This present value was converted to an annuity of value A, paid at the end of each year through year 5, such that the present value of the annuity is identical to the present value of the expenditures incurred, *viz.*, $A= PV[0.10/(1-(1.10)^{-5})]$. Thus, actual expenditures over the 5-year period are equivalent in present value to an "annualized" expenditure of A per acre at the end of each year for the five years. To convert this annualized per acre cost to cost per ton, the "annualized yield" was calculated in exactly the same manner. Cost per ton was then obtained by dividing annualized cost by annualized yield.

To provide an estimate of the cost of production for a projected ten-year cropping period, rather than the five-year period observed, the average yield and expenditures for the last four years at each site were projected to occur at that site for each year from year six through year ten. The annualized cost of production over this ten-year period was then calculated as described above.

II. Costs and Yields by Site and Year

Costs at each site, as determined as described in section I of this report, are tabulated below.

Table II.1
Costs per acre by field operation at Munich, ND

	year						Annualized (10%)	
Operation	1	2	3	4	5	Total	per acre	per ton
Seedbed and planting	$39.29	$0.00	$0.00	$0.00	$0.00	$39.29	$10.36	$4.25
Fertilizing	$0.00	$11.85	$25.77	$17.35	$16.28	$71.25	$13.48	$5.53
Weed control	$16.49	$9.40	$22.36	$19.71	$6.18	$74.14	$15.00	$6.15
Harvest	$20.11	$34.89	$39.01	$42.10	$39.59	$175.70	$34.23	$14.04
Rent	$40.02	$40.02	$40.02	$40.02	$40.02	$200.08	$40.02	$16.41
Total Cost	$115.90	$96.16	$127.17	$119.17	$102.07	$560.46	$113.09	$46.39
Yield (tons/acre)	0.4	2.1	3.6	3.7	3.1	12.9	2.4	
Cost per ton						$43.51	$46.39	

Table II.2

Costs per acre by field operation at Streeter, ND

	year						Annualized (10%)	
Operation	1	2	3	4	5	Total	per acre	per ton
Seedbed and planting	$48.89	$0.00	$0.00	$0.00	$0.00	$48.89	$12.90	$6.45
Fertilizing	$0.00	$0.00	$16.51	$15.98	$21.46	$53.94	$9.67	$4.83
Weed control	$30.79	$0.00	$35.82	$4.87	$6.69	$78.18	$16.46	$8.22
Harvest	$0.00	$25.55	$36.01	$29.60	$25.15	$116.31	$22.16	$11.08
Rent	$26.01	$26.01	$26.01	$26.01	$26.01	$130.05	$26.01	$13.00
Total Cost	$105.69	$51.56	$114.36	$76.46	$79.31	$427.38	$87.19	$43.57
Yield (tons/acre)	0.0	2.0	2.2	3.7	2.7	10.7	2.0	
Cost per ton						$39.96	$43.57	

Table II.3

Costs per acre by field operation at Bristol, SD

	year						Annualized (10%)	
Operation	1	2	3	4	5	Total	per acre	per ton
Seedbed and planting	$53.35	$0.00	$0.00	$0.00	$0.00	$53.35	$14.07	$3.52
Fertilizing	$0.00	$36.81	$27.61	$29.51	$0.00	$93.94	$18.82	$4.71
Weed control	$72.78	$22.52	$8.86	$0.00	$14.81	$118.96	$26.54	$6.64
Harvest	$33.81	$37.01	$44.35	$53.69	$54.36	$223.23	$43.55	$10.89
Rent	$48.02	$48.02	$48.02	$48.02	$48.02	$240.10	$48.02	$12.01
Total Cost	$207.96	$144.37	$128.84	$131.22	$117.18	$729.58	$151.00	$37.76
Yield (tons/acre)	2.0	3.9	4.4	5.1	5.4	20.8	4.0	
Cost per ton						$35.13	$37.76	

Table II.4

Costs per acre by field operation at Highmore, SD

	year						Annualized (10%)	
Operation	1	2	3	4	5	Total	per acre	per ton
Seedbed and planting	$67.37	$0.00	$0.00	$0.00	$0.00	$67.37	$17.77	$10.55
Fertilizing	$0.00	$0.00	$19.28	$28.61	$0.00	$47.89	$8.98	$5.33
Weed control	$0.00	$16.34	$0.00	$0.00	$0.00	$16.34	$3.56	$2.11
Harvest	$0.00	$0.00	$61.02	$84.23	$56.56	$201.82	$36.54	$21.69
Rent	$35.01	$35.01	$35.01	$35.01	$35.01	$175.07	$35.01	$20.79
Total Cost	$102.38	$51.35	$115.32	$147.86	$91.57	$508.48	$101.86	$60.47
Yield (tons/acre)	0.0	0.0	3.8	3.7	1.6	9.1	1.7	
Cost per ton						$55.77	$60.47	

Table II.5

Costs per acre by field operation at Huron, SD

	year						Annualized (10%)	
Operation	1	2	3	4	5	Total	per acre	per ton
Seedbed and planting	$57.35	$0.00	$0.00	$0.00	$0.00	$57.35	$15.13	$4.98
Fertilizing	$0.00	$0.00	$12.38	$18.31	$37.21	$67.89	$11.85	$3.90
Weed control	$25.89	$7.77	$13.41	$2.21	$10.19	$59.47	$12.63	$4.16
Harvest	$39.35	$53.62	$41.15	$47.22	$29.61	$210.95	$42.64	$14.04
Rent	$65.03	$65.03	$65.03	$65.03	$65.03	$325.13	$65.03	$21.41
Total Cost	$187.62	$126.41	$131.95	$132.76	$142.04	$720.78	$147.27	$48.50
Yield (tons/acre)	2.0	3.4	2.9	4.7	2.4	15.4	3.0	
Cost per ton						$46.81	$48.50	

Table II.6

Costs per acre by field operation at Ethan, SD

	year						Annualized (10%)	
Operation	1	2	3	4	5	Total	per acre	per ton
Seedbed and planting	$48.35	$0.00	$0.00	$0.00	$0.00	$48.35	$12.75	$6.10
Fertilizing	$0.00	$24.01	$40.27	$17.76	$35.01	$117.05	$22.15	$10.59
Weed control	$0.00	$9.00	$0.00	$0.00	$11.33	$20.34	$3.82	$1.83
Harvest	$0.00	$39.52	$54.42	$41.63	$61.56	$197.13	$36.99	$17.68
Rent	$80.03	$80.03	$80.03	$80.03	$80.03	$400.16	$80.03	$38.26
Total Cost	$128.38	$152.56	$174.72	$139.42	$187.94	$783.03	$155.74	$74.46
Yield (tons/acre)	0.0	1.8	3.6	3.1	2.7	11.1	2.1	
Cost per ton						$70.39	$74.46	

Table II.7

Costs per acre by field operation at Crofton, NE

	year						Annualized (10%)	
Operation	1	2	3	4	5	Total	per acre	per ton
Seedbed and planting	$40.85	$0.00	$0.00	$0.00	$0.00	$40.85	$10.78	$6.16
Fertilizing	$17.81	$10.00	$10.92	$14.82	$19.21	$72.75	$14.43	$8.26
Weed control	$9.45	$35.83	$2.50	$11.25	$9.35	$68.39	$14.13	$8.09
Harvest	$0.00	$21.26	$31.26	$43.38	$28.88	$124.78	$23.38	$13.37
Rent	$90.04	$90.04	$90.04	$90.04	$90.04	$450.18	$90.04	$51.51
Total Cost	$158.14	$157.13	$134.72	$159.48	$147.48	$756.96	$152.75	$87.39
Yield (tons/acre)	0.0	1.3	2.1	3.2	2.8	9.5	1.7	
Cost per ton						$79.96	$87.39	

Table II.8

Costs per acre by field operation at Atkinson, NE

	year						Annualized (10%)	
Operation	1	2	3	4	5	Total [a]	per acre	per ton
Seedbed and planting	$40.46	$28.12	$0.00	$0.00	$0.00	$105.23	$20.96	$18.88
Fertilizing	$0.00	$0.00	$18.28	$25.70	$35.49	$51.16	$9.14	$8.23
Weed control	$27.48	$12.06	$0.00	$0.00	$0.00	$60.66	$14.06	$12.66
Harvest	$0.00	$20.08	$17.27	$29.52	$29.38	$79.84	$15.48	$13.95
Rent	$50.02	$50.02	$50.02	$50.02	$50.02	$250.10	$50.02	$45.06
Total Cost	$117.96	$110.28	$85.57	$105.24	$114.90	$547.00	$109.66	$98.78
Yield (tons/acre)	0.0	0.6	0.9	2.2	2.5	6.2	1.1	
Cost per ton						$0.00	$0.00	
Cost per Mg						$97.50	$108.65	

[a] Total is weighted by numbers of hectares each year, which are not identical

Table II.9

Costs per acre by field operation at Douglas, NE

	year						Annualized (10%)	
Operation	1	2	3	4	5	Total	per acre	per ton
Seedbed and planting	$32.29	$3.24	$0.00	$0.00	$0.00	$35.53	$9.30	$4.25
Fertilizing	$0.00	$26.72	$22.87	$24.71	$32.78	$107.08	$20.18	$9.22
Weed control	$9.87	$38.56	$0.00	$14.26	$0.56	$63.25	$13.43	$6.14
Harvest	$0.00	$25.76	$35.64	$62.47	$49.38	$173.26	$32.02	$14.64
Rent	$85.03	$85.03	$85.03	$85.03	$85.03	$425.17	$85.03	$38.86
Total Cost	$127.20	$179.31	$143.54	$186.48	$167.75	$804.29	$159.97	$73.11
Yield (tons/acre)	0.0	2.7	1.7	3.9	3.3	11.7	2.2	
Cost per ton						$68.72	$73.11	

Table II.10

Costs per acre by field operation at Lawrence, NE

	year						Annualized (10%)	
Operation	1	2	3	4	5	Total	per acre	per ton
Seedbed and planting	$33.21	$0.00	$0.00	$0.00	$0.00	$33.21	$8.76	$4.54
Fertilizing	$0.00	$25.44	$25.99	$27.36	$16.38	$95.17	$18.31	$9.49
Weed control	$11.64	$8.11	$1.08	$7.24	$0.81	$28.89	$6.21	$3.22
Harvest	$0.00	$49.48	$47.48	$56.92	$57.99	$211.87	$39.95	$20.71
Rent	$60.02	$60.02	$60.02	$60.02	$60.02	$300.12	$60.02	$31.12
Total Cost	$104.87	$143.06	$134.57	$151.55	$135.21	$669.26	$133.26	$69.08
Yield (tons/acre)	0.0	2.0	2.3	3.2	2.8	10.3	1.9	
Cost per ton						$65.01	$69.08	

III. Chemical and Fertilizer Applications by Site and Year

Table III.1
Amounts of herbicides applied (lbs./acre) by location and year.

	year					
Site	Pre-plant	1	2	3	4	5
Munich, ND	Ru 1.90	Pa 0.50, Az 2.10	Br 1.00	Pa 0.31	Ev 0.032	Bx 1.00
Streeter, ND	Ru 1.81	Ba 1.87, Pa 0.50,		Pa 0.50	Ru 4.00	24D 2.00
Bristol, SD		Pa 0.34, Su 0.75, Az 2.40, Bu .91, Cu 1.50, Br 1.50, Gr 2.67	Az 4.00, Cu 2.00	Az 0.13		24D 1.00, Az 1.00
Highmore, SD	Ru 3.39		Pa 0.50			
Huron, SD		Pa 0.50,	24D 1.50	Cl 0.50	Cl 0.06, Az 0.27	Cl 0.50, Az 4.16
Ethan, SD			At 2.00, Pa 0.58			Cl 0.62
Crofton, NE		Az 3.12	Az 2.37, Pa 0.50	24D 3.05	Gr 1.67	24D 3.00
Atkinson, NE		RU 2.90, Az 2.90	Pa 0.56, Ra 0.69			
Douglas, NE		Az 1.00	Pa 0.54, Az 1.00	Gr 2.00, Az 4.00		
Lawrence, NE		A4 4.28			24D 1.20	

24D= 2,4-D; A4=Atrazine4C; At=Atrox; Az=Atrazine; Ba=Banvel; Br=Bromac; Bx=Bromoxynil; Cl=Clarity; Ev=Everest; Gr=Grazon; Pa=Paramount; Ra=Ratrex90; Ru=Roundup; RU=Roundup Ultra

Table III.2
Nitrogen applications (lbs. /acre) by site and year.

	Harvest year				
Site	2	3	4	5	mean
Munich, ND	59.8	105.3	99.9	46.4	77.6
Streeter, ND	0	46.4	99.9	99.9	61.6
Bristol, SD	189.1	67.8	96.4	0	88.3
Highmore, SD	0	59.8	50	0	27.7
Huron, SD	0	30.3	46.4	60.7	33.9
Ethan, SD	99.9	124.9	46.4	99.9	92.8
Crofton, NE	19.6	99.9	44.6	46.4	52.6
Atkinson, NE	0	59.8	66.9	76.7	50.9
Douglas, NE	88.3	99.9	73.2	102.6	91
Lawrence, NE	74.9	98.1	80.3	80.3	83
Weighted avg	52.6	80.3	70.5	63.3	66.9

IV. Weather Data by Site and Year

Table IV.

Weather data for switchgrass locations.

	2000	2001	2002	2003	2004	2005	5-yr mean	30-yr mean
Annual precip. (in.)								
Munich, ND	-	18.0	20.3	13.8	23.6	22.7	19.7	18.1
Streeter, ND	-	15.6	16.3	14.5	22.1	16.2	16.9	17.1
Bristol, SD	-	16.3	16.8	20.4	26.9	26.1	21.3	22.0
Highmore, SD	-	17.2	11.5	15.1	24.0	18.6	17.3	18.6
Huron, SD	-	26.8	14.9	16.4	29.7	25.8	22.7	20.9
Ethan, SD	-	25.3	20.7	18.9	28.1	28.9	24.4	22.9
Crofton, NE	23.8	32.5	21.8	25.3	28.4	-	26.3	27.8
Atkinson, NE	16.8	28.2	13.5	15.6	22.2	-	19.3	24.7
Douglas, NE	25.9	38.0	21.6	22.8	29.3	-	27.5	30.7
Lawrence, NE	26.7	29.9	24.1	24.3	27.1	-	26.4	26.7
Mean annual temperature (°F)								
Munich, ND	-	37.94	36.5	36.68	35.42	37.94	36.86	38.48
Streeter, ND	-	41.54	40.46	39.74	39.56	41.54	40.64	39.74
Bristol, SD	-	44.96	45.14	44.42	44.6	44.06	44.6	42.98
Highmore, SD	-	46.22	46.76	46.22	45.68	46.4	46.22	43.7
Huron, SD	-	45.86	46.94	46.04	46.58	47.66	45.86	45.32
Ethan, SD	-	46.76	47.66	48.02	48.56	49.64	46.76	46.22
Crofton, NE	48.56	48.92	48.92	48.38	48.56	-	48.56	47.84
Atkinson, NE	50.54	50.54	50.54	50.36	50.54	-	50.54	48.38
Douglas, NE	51.98	52.16	52.34	51.26	51.26	-	51.98	50.54
Lawrence, NE	55.04	54.68	54.68	53.78	53.42	-	55.04	52.52

V. Average Costs Across Sites

In the following two tables, average final cost per ton reflects rounding errors incurred in the process of adjusting weights to account for the loss of part of the field at Atkinson, NE, after the second year.

Table V.1

Weighted per acre averages: costs by operation, with yields (dry matter) and fertilizer rates

	Year						Annualized (10%)	
Operation	1	2	3	4	5	Total[a]	per acre	per ton
Seedbed and planting	$45.04	$3.26	$0.00	$0.00	$0.00	$48.30	$12.74	$5.74
Fertilizing	$2.06	$13.77	$21.82	$21.72	$21.14	$80.51	$15.04	$6.78
Weed control	$20.32	$17.52	$8.94	$7.01	$6.17	$59.95	$12.95	$5.84
Harvest	$8.07	$30.32	$41.33	$50.19	$43.64	$173.55	$32.65	$14.72
Rent	$59.36	$59.36	$59.93	$59.93	$59.93	$298.53	$59.70	$26.91
Total Cost	$134.85	$124.23	$132.02	$138.86	$130.88	$660.84	$133.08	$59.98
Yield (tons DM/acre)	0.4	2.0	2.8	3.7	3.0	12.0	2.2	
Nitrogen rate (lbs/acre)		52	80	71	64	267	67	

[a]Total is weighted by numbers of acres each year, which are not identical

Table V.2 Weighted average cost by category of input.

	Annualized Costs	
	$/acre	$/ton [b]
Machinery and labor		
Seedbed preparation and seeding	5.57	2.51
Herbicide application/weed control	3.48	1.57
Fertilizer application	2.42	1.09
Cut/swath	6.21	2.79
Bale and store	26.43	11.90
Total machinery and labor expenses	$44.12	$19.86
Materials		
Seed	6.58	2.96
Herbicides and other chemicals	10.05	4.52
Fertilizer	12.61	5.68
Total materials expenses	$29.24	$13.16
Subtotal	73.35	33.02
Land rent	59.67	26.86
Total cost	$133.03	$59.87

[b] Calculated at the average annualized yield of 2.2 t/ac

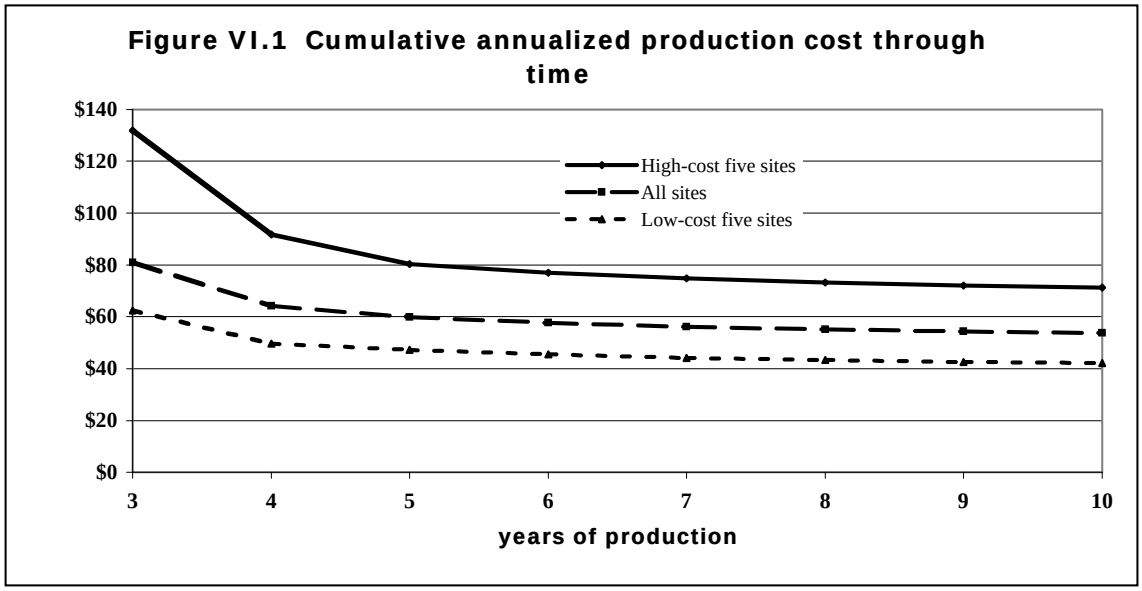
VI. Summary of Results and Extrapolation to a Ten-Year Crop

We project that overall annualized production cost of $60/ton would be reduced to about $54/ton if the crop had been grown for ten years on these sites, rather than five years (Table VI.1 and Fig. VI.1) To calculate the ten-year result, we assumed that the average conditions of years 2-5 would continue during years 6-10.

Table VI.1
Summary of annualized production costs for five-year and ten- year production periods

Site	Five years (observed)		Ten years (projected)	
	$ /acre	$ /ton	$ /acre	$ /ton
Munich, ND	112.10	45.87	110.88	41.08
Streeter, ND	87.01	43.34	84.17	37.26
Bristol, SD	150.95	37.68	142.85	33.48
Highmore, SD	101.98	60.35	101.58	53.12
Huron, SD	147.31	48.40	142.04	44.91
Ethan, SD	155.40	74.09	158.23	67.07
Crofton, NE	152.57	87.21	151.35	76.25
Atkinson, NE	109.67	97.11	106.43	83.35
Douglas, NE	159.85	72.92	163.49	66.05
Lawrence, NE	133.14	68.94	136.38	62.49
Weighted avg	132.74	59.75	132.33	53.61

It is notable also that the annualized cost of production on the five low-cost sites was only $47/ton ($42/ton for a ten-year crop – see Figure VI.1.) On the five high-cost sites the cost was $80/ton ($71/ton for a ten-year crop.)



We conclude from the results of this study that substantial quantities of biomass feedstock could have been produced in this region at a cost of about $50/ton of dry matter at the farm gate, which translates to about $0.55 per gallon of ethanol. (Delivered to the ethanol plant, the cost would be about $0.68/gallon, compared to a feedstock cost of about $1.00/gallon for corn delivered at $4.00/bushel.) These results provide a more reliable benchmark for current commercial production costs as compared to other estimates, which ranged from $25 to $100 per ton.

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