Cost Methodology for Biomass Feedstocks: Herbaceous Crops and Agricultural Residues

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Outline

- **Introduction**
- **Cost elements**
- **Brief review of calculation procedure**
- **Sensitivity analysis**
- **Example delivered biomass costs**
- **Concluding remarks**

Introduction

- A question that often arises with regard to biomass resources is: How much does it cost? Estimates of costs from various sources may have very different assumptions regarding interest rates, labor costs, and fuel prices.
- The objective of this work is to describe an appropriate standardized methodology for estimating the delivered cost of biomass crops that is acceptable to industry, academia, and government.

General approaches

- An engineering-economic approach where engineering parameters (e.g. machine speed, width) are combined with economic parameters (e.g. purchase price, price of diesel) to determine the cost of producing a crop.
- Econometric approach that relates parameters to the cost of production via an econometrically estimated equation based on historical data.
- For biomass crops, historical data on production and their handling is limited scale
- Engineering-economic approach allows estimation of costs of production for biomass crops based on assumed equipment characteristics, input prices, and estimated crop yields.

Costing methods

- American Society of Agricultural and Biological Engineers EP496 and D497 (ASABE 2007)
- American Agricultural Economics Association (AAEA 2000).
- The AAEA method incorporates much from the ASABE method.
- The challenge: assumptions and parameter values to produce, harvest, transport, and store biomass :
  - Determining appropriate assumptions of the costs of land, fertilizer, seed, machinery and buildings, and
  - Estimating the performance, or efficiency, of machinery in handling and processing biomass.

Production costs

- Equipment cost
  - Capital recovery (depreciation and interest)
  - Repair and maintenance
  - Fuel and lubrication
  - Insurance, housing, and taxes
  - Labor
  - Overhead
  - Interest (on operating expenses)
- All costs are adjusted to a base year
- Detailed procedure, tabulated values, and equations for calculating equipment costs are outlined in the text

Year	Production items	Machinery
2007	160	189
2006	146	182
2005	139	173
2004	131	162
2003	124	151
2002	119	148
2001	120	143
2000	116	139
1999	111	135
1998	113	132
1997	119	128
1996	115	125
1995	108	120
1994	106	113
1993	104	107
1992	101	104
1991	100	100
1990	99	96

Sources: USDA/NASS (2000, 2006, 2007a, 2008)

Biomass costs are categorized

- Variable costs and fixed costs
  - Labor and variable costs are expressed in $/h.
  - Fixed cost is an annual cost that includes annualized capital cost plus storage, taxes, and insurance.
  - Overall cost: for an assumed number of working hours per year for machinery, the annual cost is expressed in $/h and is added to variable cost
- The costs associated with the performance of machinery are expressed in $/Mg ($/ton), $/item-, or $/ha ($/ac).
- For example, we may express mowing a field in $/ha ($/acre), baling in $/bale, and grinding the biomass in $/ton.

Example of equipment cost

- **Custom operation**
- **Ownership cost**

Equipment	List price ($)	Life (hr)	Annual use (hr)	Fix costs ($/yr)	Operating ($/hr)	Total ($/hr)
Tractor	82,222	12,000	800	8,992	25.45	51.62
Mower-conditioner	29,111	2,500	300	3,897	10.43	22.62
Forage harvester	26,665	2,500	300	3,621	7.87	19.24
Windrow pickup head	4,800	1,000	300	1,101	4.76	7.63
High dump forage wagon	25,021	2,000	300	3,606	6.98	18.5

For each hour of implement use the tractor operates 1.1 hours and labor 1.2 hours.

Fuel, lube, oil ($/hr)

Labor $15.93/hr

Transport costs

- **Truck cost is calculated using**

Y = a T + b X

a is $/hr that include purchase cost and labor,

b is $/mile that includes fuel and lube, tires, maintenance, insurance

Typical values

a = $31.43/hr

(assuming 50,000 year life with 5000 hours annual use)

b = $0.97/mile

(assuming $2.89/gal for diesel)

Storage costs

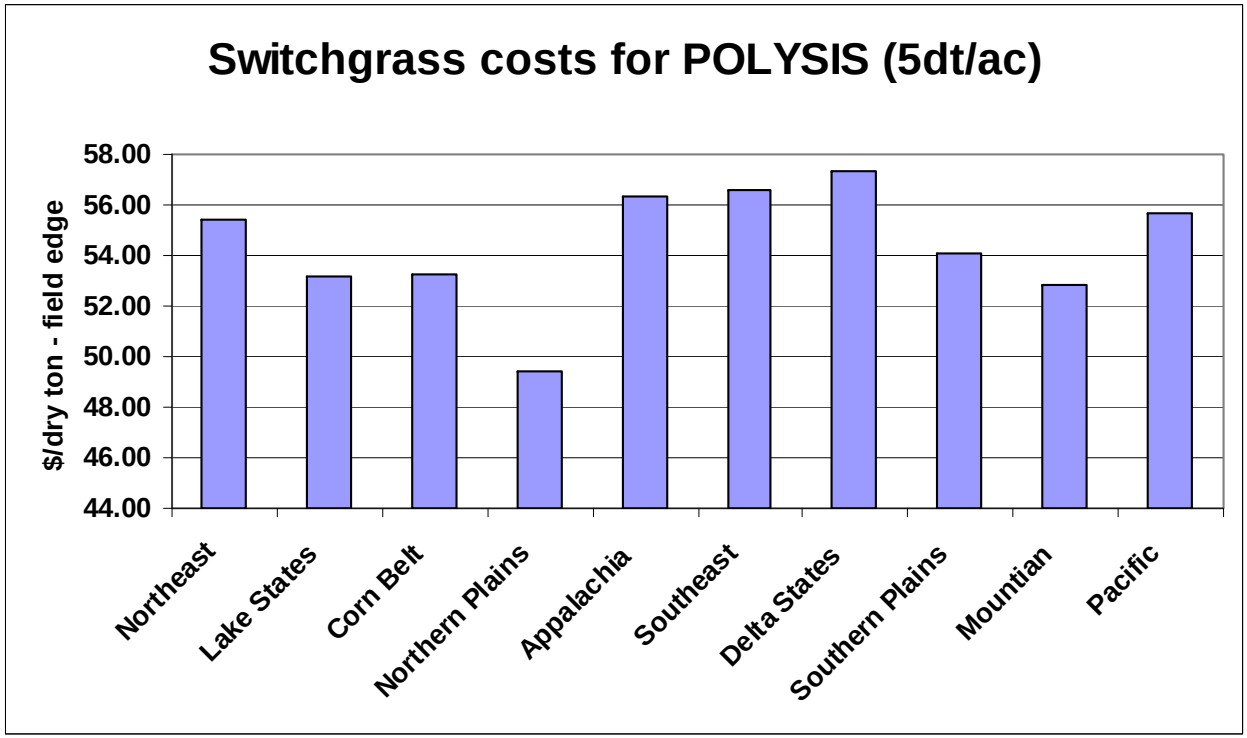
- **International Fire Code: Combustible Fibers, Chapter 29**
  - **limits storage of agricultural products (including hay, straw, and similar materials) to stacks of less than 100 tons separated from adjacent storage by at least 20 feet (Section 2903.4)**
- **Stack height should be 3 feet below ceiling**
- **Allow space for maneuvering large equipment and trucks.**
- **Biomass buildings and stacks should be at least 75 ft from surrounding facilities to minimize fire hazard.**

Store type	$/ft^2
Pole frame structure, all sides open	6.63
Pole frame structure, one side open	9.23
Pole frame structure, enclosed	10.37
Enclosed shed w/ concrete floor & foundation	15.74
Concrete floor and walls, plastic covering	13.99
Storage pad gravel	1.09
Storage pad asphalt	2.85
Hay tarp	0.27

Switchgrass costs by region for POLYSIS – an application of the costing methodology

Included costs

- Seed
- Lime
- Nitrogen
- Phosphorous
- Potassium
- Herbicides
- Insecticides
- Operating interest
- Repairs
- Fuel
- Lube
- Depreciation
- Interest
- Housing
- Taxes
- Labor
- Twine



Costs vary by region due primarily to fertilizer and lime requirements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Costing method for non organic fertilizer

Nitrogen	N^a	$P_2O_5{}^a$	K_2O^a	Price	N	P_2O_5	K_2O
	Fraction			$/ton	$/lb		
Anhydrous ammonia	0.82	0	0	523	0.319		
Ammonium nitrate	0.335	0	0	382	0.57		
Solution	0.28	0	0	276	0.493		
Solution	0.32	0	0	308	0.481		
Urea	0.45	0	0	453	0.503		
Phosphorous							
Triple superphosphate	0	0.45	0	418		0.464	
Potassium							
Muriate of potash	0	0	0.61	280			0.23
Mixed fertilizer							
Monoammonium phosphate					0	0.428	
N valued at anhydrous ammonia plus $0.11/kg ($0.05/lb) application cost					0.369	0.35	
N valued at typical value for other than anhydrous ammonia	0.11	0.52	0	445	0.5	0.322	
Diammonium phosphate					0	0.48	
N valued at anhydrous ammonia plus $0.11/kg ($0.05/lb) application cost					0.369	0.336	
N valued at typical value for other than anhydrous ammonia	0.18	0.46	0	431	0.5	0.285	
[a]Source: USDA/NASS (2007a)							