Topic Paper #16

Yield Projections for Major U.S. Field Crops and Potential Biomass Crops

On August 1, 2012, The National Petroleum Council (NPC) in approving its report, *Advancing Technology for America's Transportation Future*, also approved the making available of certain materials used in the study process, including detailed, specific subject matter papers prepared or used by the study's Task Groups and/or Subgroups. These Topic Papers were working documents that were part of the analyses that led to development of the summary results presented in the report's Executive Summary and Chapters.

These Topic Papers represent the views and conclusions of the authors. The National Petroleum Council has not endorsed or approved the statements and conclusions contained in these documents, but approved the publication of these materials as part of the study process.

The NPC believes that these papers will be of interest to the readers of the report and will help them better understand the results. These materials are being made available in the interest of transparency.

Yield Projections for Major US Field Crops and Potential Biomass Crops

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Project Summary

I. Introduction

This report summarizes the literature on potential yields for three major commodity crops in the Midwest United States (corn, soybeans, and wheat), corn stover, and switchgrass and Miscanthus, two perennial grasses currently receiving attention as potential feedstocks for cellulosic ethanol production in the near future. Using literature on expected yield increases, we provide projections for each crop out to 2030 and 2050 under various market scenarios and conditions. Yet, as Fisher et al. (2009) note "projecting crop yields, especially 40 years ahead, is fraught with uncertainty" (pg. 3). Therefore, although our projections out to 2050 are based on previous literature and historical data, they need to be considered in the context from which they are derived including modeling limitations and assumptions.

In their evaluation of global- and country-level crop yields, Fisher et al. (2009) find that the answer to whether there is potential for yields gains to meet growing food, feed, and fuel demand or whether we are nearing a "technological plateau" depends heavily on which yield projections are assumed. If global cereal yields remain on 1960-2009 linear trends, production will not be sufficient to meet growing demand and result in significant commodity price increases. Yet, an increase of only 0.4% in yield growth rates can reverse the expected price impacts (Fisher et al., 2009). Also, given the shortage of land that can be economically transitioned into food and feed production without major environmental degradation, increasing productivity (i.e. yields) on current (non-erodible) cropland will be a key determinant in meeting future food and feed demands (GHI, 2009).

In this report, we provide a summary of the recent literature on crop yields, growth rates, and point estimates for corn, soybeans, wheat, corn stover, switchgrass, Miscanthus and other biomass crops. We also provide a limited summary of the literature on other crops such as hay, world cereal trends, sorghum, sugar cane and rice. From literature estimates of yield trends and growth rates, we provide forecasts for 2030 and 2050 yields above observed 2009 NASS yield values for commodity crops and above assumed baseline values for biomass crops. Given the sheer quantity of information on crop and biomass feedstock yields, we discuss only select studies within the text and provide the remaining information in summary tables. We conclude the report with a discussion of several constraining factors that may limit crop yield growth potential.

II. Summary of the Literature

In this section, we summarize literature on crop yield trends, growth rates, and point estimates for corn, soybeans, wheat, hay, corn stover, switchgrass, Miscanthus, and other biomass crops. Crop yields have seen continual increases over the past half century through breeding of improved cultivars, better crop management practices including increased and efficient use of fertilizer, or favorable weather conditions (Crosbie et al., 2006; Tannura et al., 2008a, 2008b; Fischer et al., 2009). Despite increases in crop yields in most regions of the world, large yield gaps still exist between developed and developing countries. Since many drivers of crop production are outside farmers control (e.g. climate condition and to some extent soil and site characteristics), the yield gap may never be completely erased even with transmission of farming technology and management practices between developed and developing countries (Fischer et al., 2009). Although we provide estimates for other regions of the world in our summary tables, our discussion will focus on yield projections for the U.S. and primarily the Midwest.

Corn

Over the past half century, corn has shown a gradual increase in yield and is expected to continue rising with the introduction of new biotechnology and favorable climate impacts in major corn producing areas. According to a report by the Global Harvest Initiative (2009), coarse grains could see eight to ten fold increases in developing country yields while food grains could see two to three fold increases. Table 1 provides a (non-comprehensive) summary of the literature on corn yields, yield trends, and yield growth rates. Based on the information from these studies (i.e. trends and growth rates), we project corn yield estimates out to 2050 under the different model assumptions using 2009 U.S. and state-level yield data reported by the National Agricultural Statistics Service (NASS). These projections and the underlying assumptions are provided in Table 2.

[Table 1]

[Table 2]

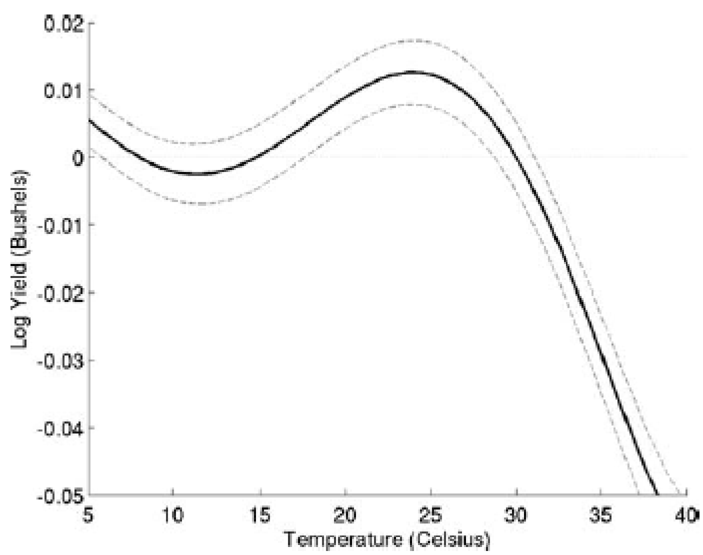
Rosburg et al. (2011 WP) use U.S. and state-level corn data between 1960-2009 to project U.S. and state-level corn yields out to 2030. Using statistical tests for structural break identification, Rosburg et al. (2011 WP) identify potential short-run yield trends and growth rates. Using a linear trend model for U.S. corn production, the long-run U.S. corn yield trend is 1.92 bushels per acre over the 1970-2009 period and structural tests for a short-run trend were not statistically significant. Using an autoregressive model (current yield modeled as a function of past yield values) the U.S. 1970-2009 growth rate is 1.62%. Rosburg et al. (2011) found evidence of a significant structural break at 1999 using the autoregressive model which resulted in a short-run trend of 1.85% for U.S. average corn yield. Assuming the historical linear trend or growth rates hold through 2030, Rosburg et al. estimated that U.S. average corn yield could reach between 205 and 242 bushels per acre by 2030. Extending the trends and growth rates to 2050 would result in U.S. average corn yields between 243 and 349 bushels per acre. Rosburg et al. (2011) also provided state-specific estimates which are summarized in Tables 13 and 14.

Tweeten and Thompson (2008) analyze a similar period but focus only on the long-run trend between 1961 and 2007. Using a linear model, Tweeten and Thompson (2008) find a long-run U.S. corn yield trend around 1.83 bushels per acre. If this trend persists to 2030 and 2050 beyond the 2009 observed U.S. corn yield value (164.7 bushels per acre), yields are projected to reach 203 and 240 bushels per acre, respectively. These results are comparable to the U.S. long-run estimates from Rosburg et al. (2011). Fischer et al. (2009) project slightly higher U.S. corn yields relative to the linear results by Tweeten and Thompson (2008) and Rosburg et al. (2011) but lower than the autoregressive results by Rosburg et al. (2011). Fischer et al. (2009) expected U.S. corn yields to grow around 1.5% relative to 2008 values. If this growth rate holds through 2030 and 2050, the U.S. corn yield would reach 214 and 288 bushels per acre, respectively. A December 2008 report by the Biomass Research and Development Initiative (BRDi) assumed a lower annual corn yield growth rate of 1.23%. Assuming the lower growth rate form the BRDi report continues beyond observed 2009 U.S. average corn yield, U.S. corn yield would reach 213 bushels per acre by 2030 and 272 bushels per acre by 2050.

Perlack et al. (2005) discuss several different corn yield scenarios in their "Billion Ton Study." Although the historical trend between 1965 and 2000 is 1.7 bushels per acre in the U.S. (cite Dobermann et al., 2002) and the USDA uses 1.8 bushels per acre for projections, both trends result in lower yield predictions compared to the FAO (2003) corn yield growth rate of 1.2% per year. Assuming the FAO corn yield growth rate holds relative to the 2009 observed yield, U.S. corn yield would reach 212 bushels per acre by 2030 and 269 bushels per acre by 2050. On the other hand, if the USDA trend of 1.8 bushels per acre persists relative to 2009, U.S. corn yield would reach only 202 and 238 bushels per acre in 2030 and 2050, respectively. English et al. (2010) report the USDA baseline values for expected corn yield growth rates between 2009 and 2018 of 1.23% but assume corn grows at a slower rate during the 2019 to 2026 period at 1.13%. Assuming the USDA baseline values and maintaining the 1.13% growth rate out to 2030 and 2050, U.S. corn yield would reach 210 bushels per acre in 2030 and 263 bushels per acre in 2050.

Several recent studies have tried to separate out the impact on corn yields from improved climate characteristics (e.g. temperature and precipitation) and technological yield growth (Tannura et al., 2008a, 2008b; Yu, 2010 Presentation; Schlenker and Roberts, 2006; Huang and Khanna, 2010). Schlenker and Roberts (2006) find that U.S. corn yields are increasing with temperature up to 25° C and identify 30° C as the "threshold temperature" where negative yield impacts begin to occur (see Figure 1). Precipitation and yield were found to have an inverted U relationship with highest yield achieved at 26 inches. Tanurra et al. (2008a, 2008b) consider the relationship between weather, technology, and corn yields in Illinois, Indiana, and Iowa between 1960 and 2007. Yields were found to be significantly affected by June and July precipitation and July and August temperatures (Tanurra et al., 2008a). More importantly, the impact of a shift to better climate characteristics was not equivalent to the impact of a decrease in climate characteristics. An unfavorable weather period had a larger impact on yields compared to a deviation towards favorable weather. Tanurra et al. (2008a) provide corn yield projections based on the 1960-2007 yield trend in Illinois and a hypothesized yield trend with increased biotechnology. Assuming the 1960-2007 yield trend of 1.7 bushel per acre extends between 2008 and 2030, Tannura et al. (2008a) estimate that Illinois corn yield would reach around 200 bushels per acre (210 if use 2009 Illinois yield reported in NASS). If biotechnology increases this trend to 3 bushels per acre between 2008 and 2030, yield would reach 225 bushels per acre by 2030 (237 if use 2009 Illinois yield reported in NASS). Similarly, if we apply the estimated Iowa yield trend reported by Tannura et al. (2008a) of 2.1 bushels per acre to the 2009 Iowa corn yield reported by NASS (182 bushels per acre), Iowa could reach 226 bushels per acre by 2030 and 268 bushels per acre by 2050.

Figure 1 – Nonlinear Relationship between Temperature and Corn Yields



Notes: Figure displays the impact of a given temperature for a twenty-four-hour period of the growing season on yearly log yields. The curve is relative to a temperature of 8°C. The 95% confidence interval after adjusting for spatial correlation is added as dashed lines.

Source: Schlenker and Roberts (2006)

Soybeans

Soybeans have potential to significantly aid in meeting global food, feed, and biofuel demand. Fischer et al. (2009) note that soybeans are the "fastest growing crop, especially in Latin America" and according to a report by the Global Harvest Initiative (2009), oilseeds have potential for high future yield growth in developing countries with possible four to five fold increases. Similar to our section on corn yield estimates, we provide estimates from the literature for several regions of the world in our summary tables but focus on yield projections for the U.S. and primarily the Midwest in our discussion.

Table 3 provides a (non-comprehensive) summary of the literature on soybean yields, yield trends, and yield growth rates. Based on the information from these studies (i.e. trends and growth rates), we project soybean yield estimates out to 2050 under the different model assumptions using NASS 2009 U.S. and state-level yield data. These projections and the underlying assumptions are provided in Table 4.

[Table 3]

[Table 4]

Based on the approach used by Rosburg et al. (2011 WP), we project U.S. and state-level soybean yields out to 2030 and 2050 using a linear trend model. The long-run (1960-2009) U.S. soybean trend is 0.4 bushels per acre. Structural break tests identified a break in the soybean yield trend at 1985 with an increase in yield trend to 0.44 over the latter period. Assuming these trends persist until 2030 (2050), U.S. soybean yield would reach 52 (60) bushels per acre using the long-run trend and 53 (62) bushels per acre using the short-run trend. Projections for major soybean producing states can be found in Table 15.

Tweeten and Thompson (2008) also analyze the long run soybean yield trend over a similar time period (1961-2007). Based on their linear model results, Tweeten and Thompson (2008) estimate a long-run U.S. soybean yield trend around 0.41 bushels per acre, similar to the long run results using the method proposed by Rosburg et al. (2011). If the trend estimated by Tweeten and Thompson (2008) persists beyond the 2009 observed NASS yield value to 2030 and 2050, soybean yields are projected to reach 53 and 61 bushels per acre, respectively. English et al. (2010) find similar results assuming the USDA baseline growth rate between 2009-2008 (0.99%) and a slightly lower growth rate over the 2019 to 2026 period (0.93%). Assuming the baseline growth rates hold over this period and extending the 2019-2026 growth rate to 2030 (2050), soybean yields would reach 54 (65) bushels per acre. Fisher et al. (2009) estimate a higher growth rate for post-2008 soybean yield at 1.3%. Applying this growth rate to the 2009 U.S. soybean yield reported by NASS (44 bushels per acre), soybean yields would reach 58 bushels per acre in 2030 and 75 bushels per acre in 2050. The December 2010 BRDi report assumed an annual yield growth rate between the values reported by English et al. (2010) and Fisher et al. (2009) of 1.04%.

Huang and Khanna (2010) find a much lower yield trend of 0.29 bushels per pace based on 1994 to 2007 data which falls within the increasing yield trend range reported by McCarl et al. (2008) of 0.14-0.43 bushels per acre. If the yield trend reported by Huang and Khanna (2010) extends to 2030 and 2050 above the observed 2009 U.S. soybean yield, soybean yield will only reach 50 bushels per acre in 2030 and 56 bushels per acre in 2050.

In their analysis of the relationship between weather, technology, and crop yields in Illinois, Indiana, and Iowa between 1960 and 2006, Tanurra et al. (2008b) found a soybean yield trend of 0.43-0.44 bushels per acre for Illinois, 0.47-0.49 bushels per acre for Indiana, and 0.46-0.49 bushels per acre for Iowa. Extending these yield trends out to 2030 (2050) from observed 2009 state-level yields, soybean yields are projected around 55 (64), 59 (69), and 61 (70-71) bushels per acre for Illinois, Indiana, and Iowa.

Wheat

Wheat production is allocated on a significant portion of U.S. crop land (53.6 million acres planted in 2010) but only around two-thirds of the land allocated to corn (88.2 million acres in 2010) and soybeans (77.4 million acres in 2010). Therefore, the literature on wheat production has not been as comprehensive as the literature n expected corn and soybean production, especially in the Midwest. Table 5 provides a (non-comprehensive) summary of the literature on wheat yields, yield trends, and yield growth rates. Based on the information from these studies (i.e. trends and growth rates), we project wheat yield estimates out to 2050 under the different model assumptions using NASS 2009 U.S. and state-level yield data. These projections and the underlying assumptions are provided in Table 6.

[Table 5]

[Table 6]

Based on the approach used by Rosburg et al. (2011 WP), we project U.S. and state-level wheat yields out to 2030 and 2050 using a linear trend model. The long-run (1960-2009) U.S. soybean trend is 0.61 bushels per acre. Structural break tests identified a break in the soybean yield trend at 1985 with a decrease in yield trend to 0.53 over the latter period. Assuming these trends persist until 2030 (2050), U.S. soybean yield would reach 57 (70) bushels per acre using the long-run trend and 56 (66) bushels per acre using the short-run trend. Projections for major wheat producing states can be found in Table 16.

Huang and Khanna (2010) find a similar wheat yield trend to the long-run trend from the Rosburg et al. (2011) approach. Using a linear model and data between 1994 and 2007, Huang and Khanna (2010) find a U.S. wheat yield trend of 0.65 bushels per acre which lies within the range reported by McCarl et al. (2008) of 0.43-0.71 bushels per acre using 1960-2007 data. If the yield trend reported by Huang and Khanna (2010) extends to 2030 and 2050 above the observed 2009 U.S. wheat yield, wheat yield would reach 58 bushels per acre in 2030 and 71 bushels per acre in 2050. Wheat yield projections using the rates reported in English et al. (2010) are similar to the projections from the lower bound reported by McCarl et al. (2008). Assuming the USDA growth rate between 2009-2008 (0.85%) and a slightly higher growth rate over the 2019 to 2026 period (0.88%) holds through 2030 and 2050, wheat yields would reach 53 and 64 bushels per acre. Tweeten and Thompson (2008) find a linear trend estimate that lies below the range reported by McCarl et al. (2008). Using 1961-2007 data, Tweeten and Thompson (2008) find a U.S. wheat yield trend of 0.386 bushels per acre. If this lower yield trend persists to 2030 and 2050, wheat yields would only reach 53 and 60 bushels per acre, respectively.

Biomass Crops – Stover, Switchgrass, and Miscanthus

Although a large body of literature exists on biomass yield estimates, there is a lack of literature on estimated yield growth rates or trends. Projecting biomass yields is difficult to the uncertainty regarding technological advancements in the near and distant future and environmental uncertainties. Given the uncertainly perennial grass production for commercial level biofuel production, Jain et al. (2010) suggests using a ± 10% sensitivity range for switchgrass and miscanthus yields. Table 7, 8, and 9 provide a (non-comprehensive) summary of the literature on corn stover, switchgrass, and miscanthus yields, yield trends, and yield growth rates. Table 10 provides a yield estimates for other biomass crops found in the literature.

[Table 7]

[Table 8]

[Table 9]

[Table 10]

For the few studies which report growth rates and trends for biomass crops, we project yield projections based on assumed baseline or "starting" values. These projections and the underlying assumptions are provided in Table 10.

[Table 11]

English et al. (2010) report switchgrass yield projections for U.S. regions in 2010, 2020 and 2025. The authors also report potential annual breeding gains of 5% for all regions. Using their projected 2010 value and assuming the 5% annual breeding gains holds through 2030, switchgrass yields could reach between 9 and 16 tons per acre by 2030 with highest yields expected in the Corn Belt and Appalacia regions. Although we provide projected yield estimates if the 5% annual breeding gains continue through 2050, it is highly unlikely that biotechnology can maintain this rate of breeding gains over the long-run. Similarly, Marshall and Sugg (2010) report region-specific switchgrass yield estimates for 2008 and assume an annual yield growth rate of 2% up to 2015. Assuming the 2008 yield ranges from Marshall and Sugg (2010) and a 2% annual growth rate holds through 2030, switchgrass yields would range between 5 and 10 bushels per acre in 2030 with highest yields in the Delta and Appalachia regions. The yield growth assumptions from both English et al. (2010) and Marshall and Sugg (2010) fall within the potential switchgrass growth rate range reported by McLaughlin and Kszos (2005) of 1-5%.

Smeets et al. (2009) report 2030 switchgrass and Miscanthus yields based on a 1.5% growth rate in Poland, Hungary, United Kingdom, Italy, and Lithuania. Based on 2004 yield estimates, switchgrass yields are projected to range between 9.4 and 12 tons per acre in 2030 while miscanthus yields are expected to range between 9.4 and 15 tons per acre.

Other crops

With a global agricultural market, the ability to meet the growing food, feed, and fuel demand will also depend on technological growth in agricultural production other regions of the world. Table 12 provides a limited summary of the literature of major crops in other regions beyond the Midwest United States.

[Table 12]

III. Concluding Remarks

This report has summarized recent literature on crop yields, growth rates, and point estimates for corn, soybeans, wheat, corn stover, switchgrass, Miscanthus, and other biomass crops. We also provided a limited summary of the literature on other crops such as hay, world cereal trends, sorghum, sugar cane and rice. From the literature estimates, we provided yield forecasts based on 2009 NASS yield values or assumed baseline values market scenarios and conditions. Yet, as Fischer et al. (2009) note "projections are only just that, and the overall results are quite sensitivity to the assumptions" (pg. 13). Therefore, although our projections out to 2050 are based on previous literature and historical data, they need to be considered in the context from which they are derived including modeling limitations and assumptions. Tweeten and Thompson also assert caution when using relatively short-run trends noting "it is hazardous, however, to let an interpretation from 3-4 recent years to take precedence over the 47-year trend" (pg. 14).

Although crop yields in general have seen continual increases over the past half century, it is important to recognize the potential limitations to future yield growth. Growth in agricultural productivity will require significant financial investment in research and development. Yield and ultimately food, feed, and fuel supply may be limited by hesitancy to fund or adopt biotechnology crops and therefore could be hindered by political or social resistance to new technologies. Even with significant investment in agricultural technology, there is a lag around 10 to 15 years between initial research investment and crop supply impacts (Fischer et al., 2009).

A stumbling block for global increases in agricultural production, especially in developing countries, is the lack of infrastructure and institutional support for irrigation expansion (Tweeten and Thompson, 2008). Currently, large areas (China, South Asia, Middle East, and North Africa) are “extracting groundwater or river water for irrigation at unsustainable levels” (pg. 6).

Another constraining factor to meet growing demand for food and feed crops is the ability to maintain high agricultural output despite the large amount of cropland lost each year due to soil erosion, overgrazing, water logging, salinization, urbanization, etc. Estimates of agricultural land lost due to degradation range between 5 and 18.75 million hectares per year (IFPRI, Tweeten and Thompson, 2008; Myers, 1997). Tweeten and Thompson (2008) conclude that the “world will need another Brazilian *cerrado* every four to 18 years to compensate for cropland losses from degradation and (to a much smaller extent) urbanization” (pg. 8). A report by the Global Harvest Institute(2009) notes that any remaining land not currently in agricultural production, forested, or subject to severe erosion or desertification is likely to be extremely costly to prepare for agricultural production and therefore is unlikely to be an economically feasible transition. Therefore, given current yield trends and growth rates, agricultural production is expected to continue increasing in the near future but economic and social limitations may hinder the ability to meet growing food, feed, and biofuel feedstock demand.

Supplementary Tables

Table 1 – Corn Literature

Table 1 – Literature Estimates of Corn Yields, Yield Trends, and Yield Growth Rates						
Source	**Year**	**Value**	**Unit**	**Level**	**Location**	**Assumptions/Details**
BRDI (2008b)	03-07	4.2	t/ac	Avg yield		Olympic average
		1.23%		Yield growth		2016 baseline projected annual yield growth rate
Chen et al. (2010)	2022	11	tDM/ha	Yield		BAU scenario - no biofuel policies Equivalent to 21% increase (starting value of 9)
de Vries et al (2010)		8.2	mt/ha	Avg yield	US	Average based on reviewed source publications
English et al. (2010)	2009-18	1.23%		Yield growth		USDA baseline
	2019-25	1.13%		Yield growth		USDA baseline extended from last 3 years
Fischer et al. (2009)		1.6%		Yield growth	World	Global annual yield growth
	1996-07	36	Kg/ha	Yield trend	Kenya	Prior to 2008 problems; equivalent to 2.1% growth rate
	`Current’	206	Kg/ha	Yield	Iowa	Progress accelerated around 1990; equivalent to 2% growth in farm yield
	`Current’	17	Mt/ha	Potential yield	Iowa	Evidence from farmer contests
	`Current’	1-1.5%		PY growth	Iowa	Evidence from breeder’s trials
	Post 2008	2.1%		FY growth	Kenya	FY rate of change relative to 2008; based on 12 years only
	Post 2008	2.6%		FY growth	Brazil	FY rate of change relative to 2008
	Post 2008	2.0%		FY growth	Iowa	FY rate of change relative to 2008
	Post 2008	1.5%		FY growth	USA	FY rate of change relative to 2008
	Post 2008	1%		PY growth	Iowa	PY rate of change relative to 2008; based on comparison of trials and contests
	Post 2008	0.8%		FY growth	S.S. Africa	FY rate of change relative to 2008; Assume area increases
	Post 2008	1%		FY growth	China	FY rate of change relative to 2008; Area growth of 1.4%
	Post 2008	2%		FY growth	Egypt	FY rate of change relative to 2008
Gallagher et al. (2003a)		139	bu/ac	Yield	IL	
		129	bu/ac	Yield	IN	
		137	bu/ac	Yield	IA	
		134	bu/ac	Yield	KS	
		118	bu/ac	Yield	MN	

		117	bu/ac	Yield	MO	
		126	bu/ac	Yield	NE	
		125	bu/ac	Yield	OH	
		90	bu/ac	Yield	SD	
		104	bu/ac	Yield	WI	
Hertel et al. (2009)		0.25		Elasticity		Yield (own price) elasticity used in analysis
		335	bu/ha	Yield		Baseline coarse grain yield
Huang and Khanna (2010)	77-07	0.15		Elasticity	US	Yield elasticity; yield impact from dollar increase
	77-07	0.22-0.76		Elasticity	US	Literature review of yield elasticity
	77-07	0.5	bu/ac	Yield impact	US	Yield response to 1% increase in irrigated acres
	77-07	0.002	bu/ac	Yield impact	US	Yield response to extra corn acre planted on acreage under substitute crop in previous year within the county
	77-07	-0.00066	bu/ac	Yield impact	US	Yield response to extra corn acre planted on marginal acreage within county
	94-07	2.30-2.92	bu/ac	Yield trend	US	Yield trend - increasing at an accelerating rate
		Inverted U			US	Relationship between yields and growing degree days
	80-93	Inverted U			US	Yield over time (rate of increase declining over this period)
	77-07	0.82		Ratio	US	Ratio of marginal to average yields over 1997-2007 period
IFPRI	To 2050	0.9%		Yield growth	World	Averaged for irrigated and rain-fed production; cited by Fischer et al. (2009)
Karlen (2010)	2008	9.71	Mg/ha	Avg yield	IA, MN, NE, PA, SC, SD	Average grain yield at moisture content of 155 g/kg
	2008	3.9-14.8	Mg/ha	Yield	IA, MN, NE, PA, SC, SD	Range in grain yield
Keeney (2010)		0.47-0.82		Ratio		Ratio of marginal to average yields in the literature (cited in Huang and Khanna, 2010)
Kim and Dale (2005)	2005	7.05	dt/ha	Avg yield		Cited in BRDI (2008a)
Kucharik and Serbin (2008)		-13%			WI	Yield impact from a 1° increase in summer temp
McCarl et al. (2008)	94-07	1.88	bu/acre	Yield trend	US	Yield trend (cited in Huang and Khanna, 2010)
McLaughlin and Kszos (2005)		0.7-1.2%		Yield growth		Past 70 years; cited in BRDI (2008a)
Parker et al. (2010)	2016	14.50%		Yield	West	Yield projection for 2015/2016 relative to 2006/2007
Perlack et al. (2005)	65-00	1.7	bu/ac	Yield trend	US	Dobermann et al. (2002)
		1.8	bu/ac	Yield trend	US	Value used by USDA for projections

	2020	173	bu/ac	Yield	US	Using USDA trend (1.8 bu/acre)
	2043	207	bu/ac	Yield	US	Using USDA trend (1.8 bu/acre)
	"Current"	1.2%	bu/ac	Yield growth	US	"Current" crop yield rate (FAO, 2003)
		300	bu/ac	Yield	Corn Belt	Corn yield simulation model from University of Nebraska (Arkebauer et al., 2004); irrigated and rain fed region
Schlenker and Roberts (2006)	50-04	12.0-25	°C		US	Temperature range with increasing yield
		30	°C		US	Threshold temperature – harmful to yield above
		26	inches		US	Precipitation level with highest yield
		Inverted U			US	Yield & precipitation relationship; Peaks at 26 inches
Tannura et al. (2008a)	60-07	2	bu/ac	Yield trend	IL	Estimate separate effects of weather and technology (account for breaks in trend)
	60-07	1.7	bu/ac	Yield trend	IN	Estimate separate effects of weather and technology (account for breaks in trend)
	60-07	2.1	bu/ac	Yield trend	IA	Estimate separate effects of weather and technology (account for breaks in trend)
	60-95	1.8	bu/ac	Yield trend	IL	
	60-95	1.8	bu/ac	Yield trend	IN	
	60-95	1.9	bu/ac	Yield trend	IA	
	96-07	2	bu/ac	Yield trend	IL	
	96-07	1.8	bu/ac	Yield trend	IN	
	96-07	2.1	bu/ac	Yield trend	IA	
Tannura et al. (2008b)	60-06	1.68	bu/ac	Yield trend	IL	Linear trend only
	60-06	1.65	bu/ac	Yield trend	IN	Linear trend only
	60-06	1.9	bu/ac	Yield trend	IA	Linear trend only
	60-06	1.92	bu/ac	Yield trend	IL	Modified Thompson model (precip and temp)
	60-06	1.76	bu/ac	Yield trend	IN	Modified Thompson model (precip and temp)
	60-06	2.04	bu/ac	Yield trend	IA	Modified Thompson model (precip and temp)
Tweeten and Thompson (2008)	61-07	1.8	Bu/acre	Yield trend	World	Historic corn yield trend
	2025	1.01%		Yield growth	USA	Annual percent increase based on linear model
	2050	0.81%		Yield growth	USA	Annual percent increase based on linear model
	2025	1.18%		Yield growth	USA	Annual percent increase based on log-log model
	2050	0.98%		Yield growth	USA	Annual percent increase based on log-log model
Yu (2010) (presentation)	80-08	9%		Yield growth	IL	State average

	80-08	12%		Yield growth	IN	State average
	80-08	12%		Yield growth	IA	State average
	80-08	4%		Yield growth	MI	State average
	80-08	5%		Yield growth	MN	State average
	80-08	12%		Yield growth	MO	State average
	80-08	7%		Yield growth	OH	State average
	80-08	5%		Yield growth	WI	State average
	90-02	1.48%		Yield growth	IL	Correct trend estimates
	90-02	1.56%		Yield growth	IN	Correct trend estimates
	90-02	1.87%		Yield growth	IA	Correct trend estimates
	90-02	2.13%		Yield growth	MN	Correct trend estimates
	90-02	1.79%		Yield growth	MO	Correct trend estimates
	90-02	0.76%		Yield growth	OH	Correct trend estimates

Table 2 – Corn Projections

Table 2 – Corn Yield Projections							
Source	**Location**	**Assumption**	**2010**	**2020**	**2030**	**2040**	**2050**
BRDI (2008b)	US	1.23% annual yield growth applied to 2009 US value (164.70 bu/acre)	166.73	188.41	212.91	240.59	271.88
English et al. (2010)	US	2009-2018 growth (1.23%) and 2019-2026 growth (1.13%) applied to 2009 US value (164.7 bu/ac); Assume 2019-2026 growth (1.13%) for 2027-2050	166.73	188.03	210.40	235.42	263.41
Fischer et al. (2009)	US	Post 2008 growth rate (1.5%) applied to 2008 US value (153.9 bu/ac)	158.55	184.01	213.55	247.83	287.62
McCarl et al. (2008)	US	1994-2007 trend (1.88 bu/ac) applied to 2009 US value (164.7 bu/ac)	166.58	185.38	204.18	222.98	241.78
McLaughlin and Kszos (2005)	US	0.7% annual yield growth applied to 2009 US value (164.70 bu/acre)	165.85	177.84	190.68	204.46	219.23
	US	1.2% annual yield growth applied to 2009 US value (164.70 bu/acre)	166.68	187.79	211.58	238.39	268.59
Perlack et al. (2005)	US	1965-2000 trend of 1.7 bu/acre applied to 2009 US value (164.70 bu/acre)	166.40	183.40	200.40	217.40	234.40
	US	1.8 bu/acre trend applied to 2009 US value (164.70 bu/acre)	166.50	184.50	202.50	220.50	238.50
	US	Reported values using USDA trend (1.8 bu/acre)	--	173.00	--	207 (2043)	--
	US	FAO (2003) 1.2% annual trend applied to 2009 US value (164.70 bu/acre)	166.68	187.79	211.58	238.39	268.59
Rosburg et al. (2011)	US	1970-09 linear trend (1.92 bu/yr) applied to 2009 US value (164.70 bu/acre)	166.62	185.82	205.02	224.22	243.42
	US	1970-09 AR growth rate (1.62%) applied to 2009 US value (164.70 bu/acre)	167.37	196.55	230.81	271.05	318.30
	US	1999-09 AR growth rate (1.85%) applied to 2009 US value (164.70 bu/acre)	167.75	201.50	242.03	290.73	349.22
	Iowa	1970-09 linear trend (2.12 bu/yr) applied to 2009 Iowa value (182 bu/acre)	184.12	205.32	226.52	247.72	268.92
	Iowa	1995-09 linear trend (3.63 bu/yr) applied to 2009 Iowa value (182 bu/acre)	185.63	221.95	258.28	294.60	330.92
	Iowa	1974-09 AR growth rate (1.96%) applied to 2009 Iowa value (182 bu/acre)	185.57	225.32	273.59	332.20	403.36
	Iowa	1999-09 AR growth rate (2.01%) applied to 2009 Iowa value (182 bu/acre)	185.66	226.54	276.42	337.28	411.55
	Illinois	1970-09 linear trend (1.93 bu/yr) applied to 2009 Illinois value (174 bu/acre)	175.93	195.23	214.53	233.83	253.13
	Illinois	1995-09 linear trend (3.86 bu/yr) applied to 2009 Illinois value (174 bu/acre)	177.86	216.51	255.15	293.79	332.44
	Illinois	1970-09 AR growth rate (1.56%) applied to 2009 Illinois value (174 bu/acre)	176.71	206.30	240.84	281.16	328.23
	Illinois	1999-09 AR growth rate (2.12%) applied to 2009 Illinois value (174 bu/acre)	177.69	219.16	270.32	333.41	411.24
	Others	See Tables 13 and 14 for other state-level results	--	--	--	--	--
Tannura et al. (2008a)	Illinois	1960-07 and 1996-07 trend (2 bu/acre) applied to 2009 Illinois value	176.00	196.00	216.00	236.00	256.00
	Indiana	1960-07 trend (1.7 bu/acre) applied to 2009 Indiana value (171 bu/acre)	172.70	189.70	206.70	223.70	240.70
	Indiana	1996-07 trend (1.8 bu/acre) applied to 2009 Indiana value (171 bu/acre)	172.80	190.80	208.80	226.80	244.80
	Iowa	1960-07 and 1996-07 trend (2.1 bu/acre) applied to 2009 Iowa value	184.10	205.10	226.10	247.10	268.10
	Illinois	1960-07 trend (1.7 bu/acre) forecasted over 2008-2030			~200		

	Illinois	1960-07 trend (1.7 bu/acre) applied to 2009 Illinois value (174 bu/acre)	175.70	192.70	209.70	226.70	243.70
	Illinois	Assume 3 bu/year trend from biotechnology applied to 2008-2030			~225		
	Illinois	Assume 3 bu/year trend from biotechnology applied to 2009 Illinois value (174 bu/acre)	177.00	207.00	237.00	267.00	297.00
Tannura et al. (2008b)	Illinois	1960-07 trend (1.68 bu/acre) applied to 2009 Illinois value (174 bu/acre)	175.68	192.48	209.28	226.08	242.88
	Illinois	1960-07 modified trend (1.92 bu/acre) applied to 2009 Illinois value (174 bu/acre)	175.92	195.12	214.32	233.52	252.72
	Indiana	1960-07 trend (1.65 bu/acre) applied to 2009 Indiana value (171 bu/acre)	172.65	189.15	205.65	222.15	238.65
	Indiana	1960-07 modified trend (1.76 bu/acre) applied to 2009 Indiana value (171 bu/acre)	172.76	190.36	207.96	225.56	243.16
	Iowa	1960-07 trend (1.9 bu/acre) applied to 2009 Iowa value (182 bu/acre)	183.90	202.90	221.90	240.90	259.90
	Iowa	1960-07 modified trend (2.04 bu/acre) applied to 2009 Iowa value (182 bu/acre)	184.04	204.44	224.84	245.24	265.64
Tweeten and Thompson (2008)	US	1961-2007 trend (1.83 bu/ac) applied to 2009 US value (164.7 bu/ac)	166.53	184.83	203.13	221.43	239.73
Yu (2010) presentation	Illinois	1990-02 yield trend (1.48%) applied to 2009 Illinois value (174 bu/acre)	176.58	204.52	236.89	274.37	317.80
	Indiana	1990-02 yield trend (1.56%) applied to 2009 Indiana value (171 bu/acre)	173.67	202.74	236.69	276.31	322.57
	Iowa	1990-02 yield trend (1.87%) applied to 2009 Iowa value (182 bu/acre)	185.40	223.14	268.56	323.23	389.02
	Minnesota	1990-02 yield trend (2.13%) applied to 2009 Minnesota value (174 bu/acre)	177.71	219.40	270.88	334.43	412.89
	Missouri	1990-02 yield trend (1.79%) applied to 2009 Missouri value (153 bu/acre)	155.74	185.97	222.07	265.19	316.67
	Ohio	1990-02 yield trend (0.76%) applied to 2009 Ohio value (174 bu/acre)	175.32	189.11	203.99	220.03	237.34

Table 3 – Soybean Literature

Table 3 – Literature Estimates of Soybean Yields, Yield Trends, and Yield Growth Rates						
Source	Year	Value	Unit	Level	Location	Assumptions/Details
BRDI (2008b)	03-07	1.3	t/ac	Avg yield		Olympic average
BRDI (2008b)		1.04%		Yield growth		2016 baseline projected annual yield growth rate
de Vries et al (2010)		2.6	mt/ha	Avg yield	US	Average based on reviewed source publications
English et al. (2010)	09-18	0.99%		Yield growth		USDA baseline
	2019-25	0.93%		Yield growth		USDA baseline extended from last 3 years
Fischer et al. (2009)	Post 2008	1.8%		FY growth	Brazil	FY rate of change relative to 2008; area growth 4.4%
	Post 2008	1.3%		FY growth	US	FY rate of change relative to 2008; area growth 1.5%
Huang and Khanna (2010)		Inverted U			US	Relationship between yields and growing degree days
	77-07	0.66		Elasticity	US	Yield elasticity - impact from dollar increase in crop price
	77-07	0.9	bu/acre	Impact	US	Yield response to 1% increase in irrigated acres
	77-07	Insignificant	bu/acre	Impact	US	Yield response to extra soybean acre planted on acreage under substitute crop in previous year within the county
	77-07	Insignificant	bu/acre	Impact	US	Yield response to extra soybean acre planted on marginal acreage within county
	94-07	0.29	bu/acre	Yield trend	US	Yield trend
	80-93	0.23	bu/acre	Yield trend	US	Soybean yield trend (constant increase rate over period)
Kucharik and Serbin (2008)		-16%			WI	Yield impact from a 1° increase in summer temp
McCarl et al. (2008)	60-07	0.14-0.43	bu/acre	Yield trend	US	Ever-increasing yield trend (Huang and Khanna, 2010)
Parker et al. (2010)	2016	-4.20%		Yield	West	Yield projection for 2015/2016 relative to 2006/2007
Tannura et al. (2008b)	60-06	0.43	bu/acre	Yield trend	IL	Linear trend only
	60-06	0.47	bu/acre	Yield trend	IN	Linear trend only
	60-06	0.46	bu/acre	Yield trend	IA	Linear trend only
	60-06	0.44	bu/acre	Yield trend	IL	Modified Thompson model (precip and temp)
	60-06	0.48	bu/acre	Yield trend	IN	Modified Thompson model (precip and temp)
	60-06	0.49	bu/acre	Yield trend	IA	Modified Thompson model (precip and temp)
Tweeten and Thompson (2008)	61-07	0.4	bu/acre	Yield trend	World	Historic corn yield trend
	61-07	0.41	bu/acre	Yield trend	US	Historic yield trend (derived from Annex Table 1)
	2025	0.8%		Yield growth	US	Annual percent increase based on linear model
	2050	0.67%		Yield growth	US	Annual percent increase based on linear model

	2025	1.2%		Yield growth	US	Annual percent increase based on semi-log model
	2050	1.2%		Yield growth	US	Annual percent increase based on semi-log model

Table 4 – Soybean Projections

Table 4 – Soybean Yield Projections

Source	Location	Assumption	2010	2020	2030	2040	2050
BRDI (2008b)	US	1.04% annual yield growth applied to 2009 US value (44 bu/acre)	44.46	49.30	54.68	60.64	67.25
English et al. (2010)	US	2009-2018 growth (0.99%) and 2019-2026 growth (0.93%) applied to 2009 US value (44 bu/ac); Assume 2019-2026 growth (0.93%) for 2027-2050	44.44	48.98	53.73	58.94	64.66
Fischer et al. (2009)	US	Post 2008 growth (1.3%) applied to 2008 value (39.7 bu/acre)	40.74	46.36	52.75	60.02	68.29
	US	Post 2008 growth (1.3%) applied to 2009 value (44 bu/acre)	44.57	50.72	57.71	65.67	74.72
Huang and Khanna (2010)	US	1994-07 linear trend (0.29 bu/ac) applied to 2009 US value (44 bu/acre)	44.29	47.19	50.09	52.99	55.89
McCarl et al. (2008)	US	1960-07 low linear trend (0.14 bu/ac) applied to 2009 US value (44 bu/acre)	44.14	45.54	46.94	48.34	49.74
	US	1960-07 high linear trend (0.43 bu/ac) applied to 2009 US value (44 bu/acre)	44.43	48.73	53.03	57.33	61.63
Rosburg et al. (2011) approach	US	1960-09 linear trend (0.4 bu/yr) applied to 2009 US value (44 bu/acre)	44.40	48.38	52.36	56.34	60.32
	US	1985-09 linear trend (0.44 bu/yr) applied to 2009 US value (44 bu/acre)	44.44	48.87	53.30	57.73	62.15
	Iowa	1960-09 linear trend (0.46 bu/yr) applied to 2009 Iowa value (51 bu/acre)	51.46	56.08	60.69	65.31	69.93
	Iowa	1985-09 linear trend (0.49 bu/yr) applied to 2009 Iowa value (51 bu/acre)	51.49	56.42	61.34	66.26	71.18
	Illinois	1960-09 linear trend (0.40 bu/yr) applied to 2009 Illinois value (46 bu/acre)	46.40	50.43	54.46	58.48	62.51
	Illinois	1985-09 linear trend (0.39 bu/yr) applied to 2009 Illinois value (46 bu/acre)	46.39	50.25	54.11	57.97	61.83
	Others	See Table 15 other states and more results	--	--	--	--	--
Tannura et al. (2008b)	Illinois	1960-06 trend (0.43 bu/acre) applied to 2009 Illinois value (46 bu/acre)	46.43	50.73	55.03	59.33	63.63
	Illinois	1960-06 modified trend (0.44 bu/acre) applied to 2009 Illinois value	46.44	50.84	55.24	59.64	64.04
	Indiana	1960-06 trend (0.47 bu/acre) applied to 2009 Indiana value (49 bu/acre)	49.47	54.17	58.87	63.57	68.27
	Indiana	1960-06 modified trend (0.48 bu/acre) applied to 2009 Indiana value	49.48	54.28	59.08	63.88	68.68
	Iowa	1960-06 trend (0.46 bu/acre) applied to 2009 Iowa value (51 bu/acre)	51.46	56.06	60.66	65.26	69.86
	Iowa	1960-06 modified trend (0.49 bu/acre) applied to 2009 Iowa value	51.49	56.39	61.29	66.19	71.09
Tweeten and Thompson (2008)	US	1961-2007 trend (0.41 bu/ac) applied to 2009 US value (44 bu/ac)	44.41	48.51	52.61	56.71	60.81

Table 5 - Wheat Literature

Table 5 – Literature Estimates of Wheat Yields, Yield Trends, and Yield Growth Rates						
Source	Crop	Year	Value	Unit	Level	Assumptions/Details
BRDI (2008b)	Wheat Straw		1	t/acre	Yield	Assumption
Chen et al. (2010)	Wheat Straw		0.2676	t/acre	Yield	Estimated based on grain-to-residue ratios
Chen et al. (2010)	Wheat Straw		0.6	tDM/ha	Yield	Average yield (Use grain-to-residue ratios and moisture content)
English et al. (2010)	Wheat	2009-18	0.85%		Yield growth	USDA baseline
English et al. (2010)	Wheat	2019-25	0.88%		Yield growth	USDA baseline extended from last 3 years
Hettenhaus (2006)	Wheat Straw		40-45	bu/ac	Yield	Average dry land yield (need about 20 bu to be left for erosion)
Huang and Khanna (2010)	Wheat	80-93	Inverted U		Yield	Yield over time (rate of increase in yields declined over this period)
Huang and Khanna (2010)	Wheat	77-07	0.43		Elasticity	Yield elasticity from impact of one dollar increase in crop price
Huang and Khanna (2010)	Wheat	77-07	0.76		Ratio	Ratio of marginal to average yields over 1997-2007 period
Huang and Khanna (2010)	Wheat	94-07	0.65	bu/ac	Yield trend	
Huang and Khanna (2010)	Wheat		U-shape			Relationship between yield and growing degree days
Huang and Khanna (2010)	Wheat	97-07	-0.0003	bu/ac	Yield impact	Yield response to additional acre at the county level
Keeney (2010)	Wheat		0.67-0.90		Ratio	Ratio of marginal to average yields found in the literature (cited in Huang and Khanna, 2010)
Kim and Dale (2005)	Wheat Straw	2005	1.35	dt/ha	Yield	Cited in BRDI (2008a)
McCarl et al. (2008)	Wheat	60-07	0.43-0.71	bu/ac	Yield trend	Ever-increasing yield trend (cited in Huang and Khanna, 2010)
Perlack et al. (2002)	Wheat	88-00	1.70%		Yield growth	Source: Wheat Improvement Center in Mexico City (2002)
Perlack et al. (2002)	Wheat	77-88	1.30%		Yield growth	Source: Wheat Improvement Center in Mexico City (2002)
Perlack et al. (2002)	Wheat	2010-20	1.30%		Yield growth	USDA predicted rate for next 10 years
Tweeten and Thompson (2008)	Wheat	1961-07	0.4	bu/ac	Yield trend	World historical yield trend
Tweeten and Thompson	Wheat	1961-07	0.386	bu/ac	Yield trend	U.S. historic yield trend (derived from Annex Table 1)

Table 6 – Wheat Projections

Table 6 – Wheat Yield Projections							
Source	Location	Assumption	2010	2020	2030	2040	2050
English et al. (201)	US	2009-2018 growth (0.85%) and 2019-2026 growth (0.88%) applied to 2009 US value (44.5 bu/ac); Assume 2019-2026 growth (0.88%) for 2027-2050	44.88	48.87	53.35	58.23	63.56
Huang and Khanna (2010)	US	1994-2007 linear trend (0.65 bu/yr) applied to 2009 US value (44.5 bu/ac)	45.15	51.65	58.15	64.65	71.15
McCarl et al. (2008)	US	1960-2007 LT low value (0.43 bu/ac) applied to 2009 US value (44.5 bu/ac)	44.93	49.23	53.53	57.83	62.13
	US	1960-2007 LT high value (0.71 bu/ac) applied to 2009 US value (44.5 bu/ac)	45.21	52.31	59.41	66.51	73.61
Perlack et al. (2002)	US	1988-2000 yield growth (1.7%) applied to 2009 US value (44.5 bu/ac)	45.26	53.57	63.40	75.04	88.82
Rosburg et al. (2011) approach	US	2010-2020 assumed annual yield growth (1.3%) applied to 2009 US value (44.5 bu/ac) and extended to 2050	45.08	51.29	58.37	66.41	75.57
	US	1960-2009 LT (0.61 bu/yr) applied to 2009 US value (44.5 bu/ac)	45.11	51.22	57.33	63.44	69.54
	US	1985-2009 LT (0.53 bu/yr) applied to 2009 US value (44.5 bu/ac)	45.03	50.31	55.60	60.88	66.17
	ND	1960-2009 LT (0.27 bu/yr) applied to 2009 ND value (44.8 bu/ac)	45.07	47.82	50.56	53.30	56.05
	ND	1995-2009 LT (0.84 bu/yr) applied to 2009 ND value (44.8 bu/ac)	45.64	54.08	62.51	70.94	79.37
	KS	1960-2009 LT (0.33 bu/yr) applied to 2009 Kansas value (42 bu/ac)	42.33	45.61	48.90	52.18	55.46
	KS	1997-2009 LT (-0.75 bu/yr) applied to 2009 Kansas value (42 bu/ac)	41.25	33.78	26.31	18.84	11.36
		See Table 16 for other states and more results	--	--	--	--	--
Tweeten and Thompson (2008)	US	1961-2007 trend (0.386 bu/ac) applied to 2009 US value (44.5 bu/ac)	44.89	48.75	52.61	56.47	60.33

Table 7 – Stover Literature

Table 7 – Literature Estimates of Corn Stover Yields, Yield Trends, and Yield Growth Rates					
Source	Year	Value	Unit	Location	Assumptions/Details
Atchison and Hettenhaus (2003)		2-3.8	t/ac		Erosion protection (70% removal)
Atchison and Hettenhaus (2003)		0-2.6	t/ac		130 bu/acre yield
Atchison and Hettenhaus (2003)		0-3.6	t/ac		170 bu/acre yield
Atchison and Hettenhaus (2003)		0-4.3	t/ac		200 bu/acre yield
BRDI (2008b)		3	t/ac		Assuming a removal rate of 47-82% depending on feedstock, region, soil type and environmental constraints
BRDI (2008b)	2016	1.23%			2016 baseline projected annual yield growth rate
Brechbill and Tyner (2008a)		1.62	t/ac	Indiana	Bale
Brechbill and Tyner (2008a)		2.23	t/ac	Indiana	Rake and Bale
Brechbill and Tyner (2008a)		2.98	t/ac	Indiana	Shred, Rake and Bale
Chen et al. (2010)		0.67	t/ac		No till; Estimated based on grain-to-residue ratios
Chen et al. (2010)		1.5	tDM/ha		Average yield under no-till (Use grain-to-residue ratios and moisture content)
Duffy and Nanhou (2002)		1.5, 3, 4, and 6	t/ac	S. Iowa	Four scenarios assumptions
Edwards (2007)		2.4	t/ac	Iowa	
Gallagher et al. (2003a)		5613	lb/acre	Illinois	Stover yield consistent with corn yield assumed in model (139 bu/acre)
Gallagher et al. (2003a)		5063	lb/acre	Indiana	Stover yield consistent with corn yield assumed in model (129 bu/acre)
Gallagher et al. (2003a)		5489	lb/acre	Iowa	Stover yield consistent with corn yield assumed in model (137 bu/acre)
Gallagher et al. (2003a)		5312	lb/acre	Kansas	Stover yield consistent with corn yield assumed in model (134 bu/acre)
Gallagher et al. (2003a)		4549	lb/acre	Minnesota	Stover yield consistent with corn yield assumed in model (118 bu/acre)
Gallagher et al. (2003a)		4505	lb/acre	Missouri	Stover yield consistent with corn yield assumed in model (117 bu/acre)
Gallagher et al. (2003a)		4956	lb/acre	Nebraska	Stover yield consistent with corn yield assumed in model (126 bu/acre)
Gallagher et al. (2003a)		4883	lb/acre	Ohio	Stover yield consistent with corn yield assumed in model (125 bu/acre)
Gallagher et al. (2003a)		3125	lb/acre	SD	Stover yield consistent with corn yield assumed in model (90 bu/acre)
Gallagher et al. (2003a)		3826	lb/acre	WI	Stover yield consistent with corn yield assumed in model (104 bu/acre)
Hettenhaus (2006)		140-200+	bu/ac	Dry land	Average dry land yield
Huang et al. (2009)		2.54	t/ac	Minnesota	Produced
James et al. (2010)		1.6	t/ac	S. Michigan	Calculated based on Walters and Yang (2008)
Jiang and Swinton (2008)		2.925	t/ac	Corn Belt	Produced (150 bu/acre)
Jiang and Swinton (2008)		1.46	t/ac	Corn Belt	Harvested (50% collection)

Karlen (2010)	2008	0-7	Mg/ha	IA, MN, NE, PA, SC, SD	Range over 6 sites with 3 rates of harvest (0%, 50%, 90%)
Karlen (2010)	2008	3.4-4.9	Mg/ha	IA, MN, NE, PA, SC, SD	Average harvestable stover (corresponds to 39% and 59% of stover produced)
Khanna (2008)		2.4-4	t/ac	Illinois	Produced
Khanna (2008)		1.8-1.9	t/ac	Illinois	Delivered
Khanna and Dhungana (2007)		2.02	t/ac	Illinois	Soil tolerance
Kim and Dale (2005)	2005	2.38	dt/ha		Cited in BRDI (2008)
Lang (2002)		3.5	t/ac		Produced (125 bu/acre)
Lang (2002)		3.92	t/ac		Produced (140 bu/acre)
Lang (2002)		4	t/ac		Produced (>140 bu/acre)
Perlack and Turhollow (2002)		1.1	t/ac		
Prewitt et al. (2007)		0.8-2.2	t/ac	Kentucky	Field trial collected yield (12 acres)
Quick (2003)		4.2	t/ac	Iowa	150 bu/acre yield (Produced)
Quick (2003)		2.94	t/ac	Iowa	150 bu/acre yield (Removable)
Schechinger and Hettenhaus (2004)		1.25-1.5	t/ac	IA and WI	Collected (trial)
Sokhansanj and Turhollow (2002)		3.6	t/ac	Midwest	Produced
Sokhansanj and Turhollow (2002)		1.5	t/ac	Midwest	Delivered
Vadas et al. (2008)		2.31	t/ac	Wisconsin	Normal (corn only)
Vadas et al. (2008)		2.99	t/ac	Wisconsin	High (corn only)

Table 8 – Switchgrass Literature

Table 8 – Literature Estimates of Switchgrass Yields, Yield Trends, and Yield Growth Rates							
Source	Strain	Year	Value	Unit	Level	Location	Assumptions/Details
Berdahl et al. (2005)	CIR		0.97-4.27	t/ac	Yield	ND	Field average yield
Berdahl et al. (2005)	Dacotah		1.11-4.22	t/ac	Yield	ND	Field average yield
Berdahl et al. (2005)	Eight cultivars		2.23	t/ac	Yield	SD to NE	Farm-level 5 year average, Northern SD to Southern NE
Berdahl et al. (2005)	Multiple		1.12-4.1	t/ac	Yield	ND	Mean field average yield
Berdahl et al. (2005)	ND3743		0.91-3.92	t/ac	Yield	ND	Field average yield
Berdahl et al. (2005)	OK NU-2		0.89-4.18	t/ac	Yield	ND	Field average yield
Berdahl et al. (2005)	Shawnee		1.06-4.5	t/ac	Yield	ND	Field average yield
Berdahl et al. (2005)	Sunburst		1.43-5.57	t/ac	Yield	ND	Field average yield
Berdahl et al. (2005)	Trailblazer		1.15-4.88	t/ac	Yield	ND	Field average yield
Berdahl et al. (2005)	Summer		1.18-4.38	t/ac	Yield	ND	Field average yield
Bouton (2002)	Alamo		6.0	t/ac	Yield	AL	Average harvested yield
Bouton (2002)	Kanlow		5.9	t/ac	Yield		Average harvest, plot trials
BRDI (2008b)			4.2-10.3	t/ac	Yield	14 states	Range from literature
Brechbill and Tyner (2008a)	CIR		5	t/ac	Yield	IN	Constant production over 10 years
Brummer et al. (2001)			1.52	t/ac	Yield	IA	Commercial scale
Cassida et al. (2005b)	Alamo		8.80	t/ac	Yield	TX	4 years, (3.0x6.1m) plots, College Station
Cassida et al. (2005b)	Alamo		4.77	t/ac	Yield	LA	3 years, (3.0x6.1m) plots, Clinton
Cassida et al. (2005b)	Alamo		4.85	t/ac	Yield	TX	4 years, (3.0x6.1m) plots, Stephenville
Cassida et al. (2005b)	Alamo		8.69	t/ac	Yield	TX	3 years - (3.0x6.1m) plots, Dallas
Cassida et al. (2005b)	Alamo		7.47	t/ac	Yield	AR	3 years - (3.0x6.1m) plots, Hope
Cassida et al. (2005b)	Caddo		2.42	t/ac	Yield	TX	4 years, (3.0x6.1m) plots, College Station
Cassida et al. (2005b)	Caddo		0.50	t/ac	Yield	LA	3 years, (3.0x6.1m) plots, Clinton
Cassida et al. (2005b)	Caddo		2.23	t/ac	Yield	TX	4 years, (3.0x6.1m) plots, Stephenville
Cassida et al. (2005b)	Caddo		2.70	t/ac	Yield	TX	3 years - (3.0x6.1m) plots, Dallas
Cassida et al. (2005b)	Caddo		3.30	t/ac	Yield	AR	3 years - (3.0x6.1m) plots, Hope
Cassida et al. (2005b)	NL931		6.32	t/ac	Yield	TX	4 years, (3.0x6.1m) plots, College Station
Cassida et al. (2005b)	NL931		4.15	t/ac	Yield	LA	3 years, (3.0x6.1m) plots, Clinton
Cassida et al. (2005b)	NL931		4.76	t/ac	Yield	TX	4 years, (3.0x6.1m) plots, Stephenville

Cassida et al. (2005b)	NL931		7.89	t/ac	Yield	TX	3 years - (3.0x6.1m) plots, Dallas
Cassida et al. (2005b)	NL931		6.74	t/ac	Yield	AR	3 years - (3.0x6.1m) plots, Hope
Cassida et al. (2005b)	NL942		7.20	t/ac	Yield	TX	4 years, (3.0x6.1m) plots, College Station
Cassida et al. (2005b)	NL942		4.75	t/ac	Yield	LA	3 years, (3.0x6.1m) plots, Clinton
Cassida et al. (2005b)	NL942		5.44	t/ac	Yield	TX	4 years, (3.0x6.1m) plots, Stephenville
Cassida et al. (2005b)	NL942		8.39	t/ac	Yield	TX	3 years - (3.0x6.1m) plots, Dallas
Cassida et al. (2005b)	NL942		7.70	t/ac	Yield	AR	3 years - (3.0x6.1m) plots, Hope
Cassida et al. (2005b)	NU942		2.60	t/ac	Yield	TX	4 years, (3.0x6.1m) plots, College Station
Cassida et al. (2005b)	NU942		1.09	t/ac	Yield	LA	3 years, (3.0x6.1m) plots, Clinton
Cassida et al. (2005b)	NU942		3.16	t/ac	Yield	TX	4 years, (3.0x6.1m) plots, Stephenville
Cassida et al. (2005b)	NU942		3.52	t/ac	Yield	TX	3 years - (3.0x6.1m) plots, Dallas
Cassida et al. (2005b)	NU942		4.62	t/ac	Yield	AR	3 years - (3.0x6.1m) plots, Hope
Cassida et al. (2005b)	SL931		9.54	t/ac	Yield	TX	4 years, (3.0x6.1m) plots, College Station
Cassida et al. (2005b)	SL931		4.81	t/ac	Yield	LA	3 years, (3.0x6.1m) plots, Clinton
Cassida et al. (2005b)	SL931		5.03	t/ac	Yield	TX	4 years, (3.0x6.1m) plots, Stephenville
Cassida et al. (2005b)	SL931		8.49	t/ac	Yield	TX	3 years - (3.0x6.1m) plots, Dallas
Cassida et al. (2005b)	SL931		8.90	t/ac	Yield	AR	3 years - (3.0x6.1m) plots, Hope
Cassida et al. (2005b)	SL932		8.48	t/ac	Yield	TX	4 years, (3.0x6.1m) plots, College Station
Cassida et al. (2005b)	SL932		4.65	t/ac	Yield	LA	3 years, (3.0x6.1m) plots, Clinton
Cassida et al. (2005b)	SL932		6.09	t/ac	Yield	TX	4 years, (3.0x6.1m) plots, Stephenville
Cassida et al. (2005b)	SL932		8.35	t/ac	Yield	TX	3 years - (3.0x6.1m) plots, Dallas
Cassida et al. (2005b)	SL932		8.10	t/ac	Yield	AR	3 years - (3.0x6.1m) plots, Hope
Cassida et al. (2005b)	SL941		7.72	t/ac	Yield	TX	4 years, (3.0x6.1m) plots, College Station
Cassida et al. (2005b)	SL941		5.17	t/ac	Yield	LA	3 years, (3.0x6.1m) plots, Clinton
Cassida et al. (2005b)	SL941		5.68	t/ac	Yield	TX	4 years, (3.0x6.1m) plots, Stephenville
Cassida et al. (2005b)	SL941		7.76	t/ac	Yield	TX	3 years - (3.0x6.1m) plots, Dallas
Cassida et al. (2005b)	SL941		7.75	t/ac	Yield	AR	3 years - (3.0x6.1m) plots, Hope
Cassida et al. (2005b)	SU941		2.94	t/ac	Yield	TX	4 years, (3.0x6.1m) plots, College Station
Cassida et al. (2005b)	SU941		0.81	t/ac	Yield	LA	3 years, (3.0x6.1m) plots, Clinton
Cassida et al. (2005b)	SU941		2.60	t/ac	Yield	TX	4 years, (3.0x6.1m) plots, Stephenville
Cassida et al. (2005b)	SU941		4.14	t/ac	Yield	TX	3 years - (3.0x6.1m) plots, Dallas

Cassida et al. (2005b)	SU941		4.01	t/ac	Yield	AR	3 years - (3.0x6.1m) plots, Hope
Ceres (May 2009)			10	t/ac	Yield		Highest average yield variety across multiple trial locations
Ceres (May 2009)			19	t/ac	Yield	CA	Highest yielding variety across multiple trial locations
Chen et al. (2010)		05-06	3.8	t/ac	Yield	US	Simulated from MISCANMOD (2005-2006 average delivered yield)
Chen et al. (2010)		05-06	8.5	tDM/ha	Yield		Average delivered yield from MISCANMOD
Comis (2006)			5-6	t/ac	Yield	Corn Belt	Review; Western Corn Belt
Comis (2006)			1-4	t/ac	Yield	ND	Review
Comis (2006)			7-16	t/ac	Yield	Southeast	
De La Torre Ugarte et al. (2003)			4.9	t/ac	Yield	Northeast	POLYSIS assumptions (CT, NH, NJ, MA, ME, PA, RI, VT)
De La Torre Ugarte et al. (2003)			5.8	t/ac	Yield	App	POLYSIS assumptions (DE, KY, MD, NC, TN, VA, WV)
De La Torre Ugarte et al. (2003)			6.0	t/ac	Yield	Corn Belt	POLYSIS assumptions (IA, IL, IN, MO, OH)
De La Torre Ugarte et al. (2003)			4.8	t/ac	Yield	Lake States	POLYSIS assumptions (MI, MN, WI)
De La Torre Ugarte et al. (2003)			5.5	t/ac	Yield	Southeast	POLYSIS assumptions (AL, AR, FL, GA, LA, MS, SC)
De La Torre Ugarte et al. (2003)			4.3	t/ac	Yield	S. Plains	POLYSIS assumptions (CO, KS, NE, OK, TX)
De La Torre Ugarte et al. (2003)			3.5	t/ac	Yield	N. Plains	POLYSIS assumptions (MT, ND, SD, WY)
Duffy (2007)	--		4	t/ac	Yield	IA	
English et al. (2010)			5%	t/ac	Yield growth		Annual breeding gains; Cited Hellwinckel and De La Torre Ugarte, (2005)
English et al. (2010)		2010	4.87	t/ac	Yield	Northeast	Base
English et al. (2010)		2020	7.3	t/ac	Yield	Northeast	10 year projection
English et al. (2010)		2025	9.7	t/ac	Yield	Northeast	20 year projection
English et al. (2010)		2010	5.84	t/ac	Yield	App	Base
English et al. (2010)		2020	8.8	t/ac	Yield	App	10 year projection
English et al. (2010)		2025	11.7	t/ac	Yield	App	20 year projection
English et al. (2010)		2010	5.98	t/ac	Yield	Corn Belt	Base
English et al. (2010)		2020	9	t/ac	Yield	Corn Belt	10 year projection
English et al. (2010)		2025	12	t/ac	Yield	Corn Belt	20 year projection
English et al. (2010)		2010	4.8	t/ac	Yield	Lake States	Base

English et al. (2010)		2020	7.2	t/ac	Yield	Lake States	10 year projection
English et al. (2010)		2025	9.6	t/ac	Yield	Lake States	20 year projection
English et al. (2010)		2010	5.49	t/ac	Yield	Southeast	Base
English et al. (2010)		2020	8.2	t/ac	Yield	Southeast	10 year projection
English et al. (2010)		2025	11	t/ac	Yield	Southeast	20 year projection
English et al. (2010)		2010	4.3	t/ac	Yield	S. Plains	Base
English et al. (2010)		2020	6.5	t/ac	Yield	S. Plains	10 year projection
English et al. (2010)		2025	8.6	t/ac	Yield	S. Plains	20 year projection
English et al. (2010)		2010	3.47	t/ac	Yield	N. Plains	Base
English et al. (2010)		2020	5.2	t/ac	Yield	N. Plains	10 year projection
English et al. (2010)		2025	6.9	t/ac	Yield	N. Plains	20 year projection
Felix and Tilley (2009)			9.9	mt/ha	Yield		Moisture content of 13.5%
Fike et al. (2006a)	Alamo, Kanlow		7.05	t/ac	Yield	Southeast	Avg, 2.4x6-8m plots - KY, NC, TN, VA, WV
Fike et al. (2006a)	CIR, Shelter		5.62	t/ac	Yield	Southeast	Avg, 2.4x6-8m plots - KY, NC, TN, VA, WV
Fike et al. (2006a)	Mix		6.33	t/ac	Yield	Southeast	Avg, 2.4x6-8m plots - KY, NC, TN, VA, WV
Fike et al. (2006a)	Mix		4.64-8.5	t/ac	Yield range	Southeast	2.44x6-8m plots - KY, NC, TN, VA, WV
Fike et al. (2006b)	Alamo		4.8-9.8	t/ac	Yield	Southeast	1 cut, 2.4x6-8m plots - KY,NC,TN,VA, WV
Fike et al. (2006b)	Alamo		6.0-10.0	t/ac	Yield	Southeast	2 cut, 2.4x6-8m plots - KY,NC,TN,VA, WV
Fike et al. (2006b)	CIR		3.9-7.3	t/ac	Yield	Southeast	1 cut, 2.4x6-8m plots - KY,NC,TN,VA, WV
Fike et al. (2006b)	CIR		5.8-9.5	t/ac	Yield	Southeast	2 cut, 2.4x6-8m plots - KY,NC,TN,VA, WV
Fike et al. (2006b)	Kanlow		5.4-9.5	t/ac	Yield	Southeast	1 cut, 2.4x6-8m plots - KY,NC,TN,VA, WV
Fike et al. (2006b)	Kanlow		6.0-9.5	t/ac	Yield	Southeast	2 cut, 2.4x6-8m plots - KY,NC,TN,VA, WV
Fike et al. (2006b)	Shelter		3.7-6.8	t/ac	Yield	Southeast	1 cut, 2.4x6-8m plots - KY,NC,TN,VA, WV
Fike et al. (2006b)	Shelter		4.9-9.1	t/ac	Yield	Southeast	2 cut, 2.4x6-8m plots - KY,NC,TN,VA, WV
Gibson and Barnhart (2007)			1-4	t/ac	Yield	South Iowa	Field trials
Gibson and Barnhart (2007)			2-6.4	t/ac	Yield	Iowa	Plot trials, Central Iowa
Graham et al. (1995)		2000	4.2	dt/acre	Yield	N.Central	Yield scenario
Graham et al. (1995)		2005	4.8	dt/acre	Yield	N.Central	Yield scenario
Graham et al. (1995)		2020	6.0	dt/acre	Yield	N.Central	Yield scenario
Graham et al. (1995)		2000	3.7	dt/acre	Yield	North East	Yield scenario
Graham et al. (1995)		2005	4.3	dt/acre	Yield	North East	Yield scenario

Graham et al. (1995)		2020	5.3	dt/acre	Yield	North East	Yield scenario
Graham et al. (1995)		2000	5.1	dt/acre	Yield	S. Central	Yield scenario
Graham et al. (1995)		2005	5.9	dt/acre	Yield	S. Central	Yield scenario
Graham et al. (1995)		2020	7.4	dt/acre	Yield	S. Central	Yield scenario
Graham et al. (1995)		2000	6.0	dt/acre	Yield	South East	Yield scenario
Graham et al. (1995)		2005	3.9	dt/acre	Yield	South East	Yield scenario
Graham et al. (1995)		2020	8.6	dt/acre	Yield	South East	Yield scenario
Heaton et al. (2004a)	--		4.46	t/ac	Yield		Peer-reviewed articles
Huang et al. (2009)	Alamo		4.9	t/ac	Yield	MN	Assumption; cropland and grassland
Jain et al. (2010)	CIR	2003-07	4.4 - 6.9	t/ac	Peak yield	Midwest	Estimated average peak yield
Jain et al. (2010)	CIR		6.6	t/ac	Yield	Midwest	Average observed peak yields
Jain et al. (2010)	CIR		6.8	t/ac	Yield	Midwest	Average modeled yields
Jain et al. (2010)	CIR		3.75-4.2	t/ac	Yield	Midwest	Farm-gate yield (annualized yield after harvest and storage losses)
Jain et al. (2010)	CIR		3.6-17.8	t/ac	Yield range	Midwest	Range in estimated peak yield
Jain et al. (2010)			±10%				Variation used in biomass baseline crop yields for sensitivity analysis
Jain et al. (2010)			9.4-8.4	tDM/ha	Yield		Farm-gate yield for Low cost - high cost scenarios (annualized yield after losses during harvest and storage)(10 year life)
James et al. (2010)			4	t/ac	Yield	MI	Assumption for Southern Michigan; adjusted below MW region average
Jiang and Swinton (2008)			3.628	t/ac	Yield	Corn belt	Assumption
Khanna (2008)	--		2.3-2.5	t/ac	Yield	IL	Delivered field trial yield
Khanna and Dhungana (2007)	--		2.58	t/ac	Yield	IA and IL	Field trials
Khanna et al. (2008)	--		3.13	t/ac	Yield	IL	MISCANMOD; Delivered yield (yrs 3-10)
Khanna et al. (2008)	--		4.2	t/ac	Peak yield	IL	MISCANMOD; Peak yield
Khanna et al. (2008)	--		21.74	t/ac	Yield	IL	MISCANMOD; 10 year PV
Kiniry et al. (2005)	Alamo		5.5	t/ac	Yield	LA	3 years, 3-9.5 ha plots, Clinton
Kiniry et al. (2005)	Alamo		7.7	t/ac	Yield	AR	3 years, 3-9.5 ha plots, Hope
Kiniry et al. (2005)	Alamo		10	t/ac	Yield	TX	3 years, 3-9.5 ha plots, College Station
Kiniry et al. (2005)	Alamo		6.6	t/ac	Yield	TX	7 years, 3-9.5 ha plots, Stephenville
Kiniry et al. (2005)	Alamo		8.3	t/ac	Yield	TX	3 years, 3-9.5 ha plots, Dallas

Kszos et al. (2002)	Alamo		3.47	t/ac	Yield	N. Plains	Small plots
Kszos et al. (2002)	Alamo		4.3	t/ac	Yield	S. Plains	Small plots
Kszos et al. (2002)	Multiple		5.98	t/ac	Yield	Corn belt	Plot trial yield (small plots)
Kszos et al. (2002)	Mixture		4.8	t/ac	Yield	Lake states	Plot trial yield (small plots)
Kszos et al. (2002)	Mixture		5.5	t/ac	Yield	Southeast	Plot trial yield (small plots)
Kszos et al. (2002)	Mixture		5.84	t/ac	Yield	App	Plot trial yield (small plots)
Kszos et al. (2002)	Mixture		4.87	t/ac	Yield	North East	Plot trial yield (small plots)
Lemus et al. (2002)			4	t/ac	Yield	IA	Plot trial yield (small plots)
Lewandowski et al. (2003)			7.14	t/ac	Yield	South, Mid-Atlantic	Average over 19 blocks
Lewandowski et al. (2003)			9.8	t/ac	Max Yield	South, Mid-Atlantic	Best over 19 blocks
Lewandowski et al. (2003)	Alamo		11.6	t/ac	Yield	AL	One cut - (1.5x6.1m) plot
Lewandowski et al. (2003)	Alamo		15.4	t/ac	Yield	AL	Two cut - (1.5x6.1m) plot
Lewandowski et al. (2003)	Alamo		5.9	t/ac	Yield	TX	One cut - (1.5x6.1m) plot
Lewandowski et al. (2003)	Alamo		5.4	t/ac	Yield	U. South	One cut - (1.5x6.1m) plot
Lewandowski et al. (2003)	CIR		4.2	t/ac	Yield	AL	One cut - (1.5x6.1m) - plot
Lewandowski et al. (2003)	CIR		4.6	t/ac	Yield	AL	Two cut - (1.5x6.1m) - plot
Lewandowski et al. (2003)	CIR		2.4	t/ac	Yield	TX	One cut - (1.5x6.1m) - plot
Lewandowski et al. (2003)	CIR		4.2	t/ac	Yield	U. South	One cut - (1.5x6.1m) - plot
Lewandowski et al. (2003)	CIR		4.7	t/ac	Yield	Britain	3-6 years (average yield)
Lewandowski et al. (2003)	Kanlow		8.3	t/ac	Yield	AL	One cut, (1.5x6.1m) plot
Lewandowski et al. (2003)	Kanlow		10.3	t/ac	Yield	AL	Two cut, (1.5x6.1m) plot
Lewandowski et al. (2003)	Kanlow		4.5	t/ac	Yield	TX	One cut, (1.5x6.1m) plot
Lewandowski et al. (2003)	Kanlow		5.5	t/ac	Yield	U. South	One cut, (1.5x6.1m) plot
Lewandowski et al. (2003)	Kanlow		5	t/ac	Yield	Britain	3-4 years (average yield)
Marshall and Sugg (2010)		2008	3.5-6.5	t/ac	Yield	App	Calibrated 2008 values
Marshall and Sugg (2010)		2008	5.16-6.4	t/ac	Yield	Corn belt	Calibrated 2008 values
Marshall and Sugg (2010)		2008	3.8-6.5	t/ac	Yield	Delta	Calibrated 2008 values
Marshall and Sugg (2010)		2008	4.5-6.0	t/ac	Yield	Lake States	Calibrated 2008 values
Marshall and Sugg (2010)		2008	3.0	t/ac	Yield	Mtn States	Calibrated 2008 values
Marshall and Sugg (2010)		2008	4.8-6.0	t/ac	Yield	N. Plains	Calibrated 2008 values

Marshall and Sugg (2010)		2008	3.2-6.2	t/ac	Yield	Northeast	Calibrated 2008 values
Marshall and Sugg (2010)		2008	3.5-6.3	t/ac	Yield	S. Plains	Calibrated 2008 values
Marshall and Sugg (2010)		2008	4.4-6.5	t/ac	Yield	Southeast	Calibrated 2008 values
Marshall and Sugg (2010)		>2008	2%		Yield growth	US	
Marshall and Sugg (2010)			5.5-21.6	T/ha/yr	Yield	US	Cite McLaughlin et al., 2005
Marshall and Sugg (2010)		2008	7.8-14.5	MT/ha	Yield	App	Used to calibrate crop growth values
Marshall and Sugg (2010)		2008	11.6-14.3	MT/ha	Yield	Corn Belt	Used to calibrate crop growth values
Marshall and Sugg (2010)		2008	8.5-14.5	MT/ha	Yield	Delta	Used to calibrate crop growth values
Marshall and Sugg (2010)		2008	10.1-13.3	MT/ha	Yield	Lake States	Used to calibrate crop growth values
Marshall and Sugg (2010)		2008	6.73	MT/ha	Yield	Mtn States	Used to calibrate crop growth values
Marshall and Sugg (2010)		2008	10.8-13.4	MT/ha	Yield	N. Plains	Used to calibrate crop growth values
Marshall and Sugg (2010)		2008	7.2-13.9	MT/ha	Yield	North East	Used to calibrate crop growth values
Marshall and Sugg (2010)		2008	7.9-14.1	MT/ha	Yield	S. Plains	Used to calibrate crop growth values
Marshall and Sugg (2010)		2008	9.8-14.6	MT/ha	Yield	Southeast	Used to calibrate crop growth values
Marshall and Sugg (2010)		2008-15	2%		Yield growth		Growth rate up to 2015 (base: 2008)
McLaughlin and Kszos (2005)			1.0-5.0%		Yield growth		No time reference (cited in BRDI, 2008a)
McLaughlin and Kszos (2005)	Alamo	98-01	5.4	t/ac	Yield	IA	One cut (average)
McLaughlin and Kszos (2005)	Alamo	98-01	7.8	t/ac	Max Yield	IA	One cut (best)
McLaughlin and Kszos (2005)	Alamo	94-01	5.8	t/ac	Yield	AL	One cut (average)
McLaughlin and Kszos (2005)	Alamo	96-01	7.2	t/ac	Yield	GA	One cut (average)
McLaughlin and Kszos (2005)	Alamo	89-01	10.3	t/ac	Yield	AL	Two cut (average)
McLaughlin and Kszos (2005)	Alamo	94-01	7.2	t/ac	Yield	AL	Two cut (average)
McLaughlin and Kszos (2005)	Alamo	94-01	15.4	t/ac	Max Yield	AL	One cut (best)
McLaughlin and Kszos (2005)	Alamo	89-01	15.4	t/ac	Max Yield	AL	Two cut (best)
McLaughlin and Kszos (2005)	Alamo	94-01	13.6	t/ac	Max Yield	AL	Two cut (best)
McLaughlin and Kszos (2005)	Alamo	95-00	6	t/ac	Yield	TX	One cut (average)
McLaughlin and Kszos (2005)	Alamo	95-00	7.2	t/ac	Yield	TX	One cut (average)
McLaughlin and Kszos (2005)	Alamo	98-01	8.5	t/ac	Yield	TX, AR, LA	One cut (average)
McLaughlin and Kszos (2005)	Alamo	95-00	11	t/ac	Max Yield	Texas	One cut (best)
McLaughlin and Kszos (2005)	Alamo	95-00	8.8	t/ac	Max Yield	Texas	One cut (best)
McLaughlin and Kszos (2005)	Alamo	92-01	6.2	t/ac	Yield	App	One cut (average) - VA, TN, WV, KY, NC

McLaughlin and Kszos (2005)	Alamo	92-01	7	t/ac	Yield	App	Two cut (average) - VA, TN, WV, KY, NC
McLaughlin and Kszos (2005)	Alamo	92-01	12.2	t/ac	Max Yield	App	One cut (best) - VA, TN, WV, KY, NC
McLaughlin and Kszos (2005)	Alamo	92-01	11.3	t/ac	Max Yield	App	Two cut (best) - VA, TN, WV, KY, NC
McLaughlin and Kszos (2005)	CIR	99-01	7.3	t/ac	Yield	NE	One cut (average)
McLaughlin and Kszos (2005)	Kanlow	99-01	9.2	t/ac	Yield	NE	One cut (average)
McLaughlin and Kszos (2005)	Kanlow	98-01	5.8	t/ac	Yield	IA	One cut (average)
McLaughlin and Kszos (2005)	Kanlow	94-01	5.2	t/ac	Yield	AL	One cut (average)
McLaughlin and Kszos (2005)	Kanlow	96-01	7	t/ac	Yield	GA	One cut (average)
McLaughlin and Kszos (2005)	Kanlow	89-01	8.12	t/ac	Yield	AL	Two cut (average)
McLaughlin and Kszos (2005)	Kanlow	94-01	6.9	t/ac	Yield	AL	Two cut (average)
McLaughlin and Kszos (2005)	Kanlow	94-01	11	t/ac	Max yield	AL	One cut (best)
McLaughlin and Kszos (2005)	Kanlow	96-01	10.3	t/ac	Max yield	GA	One cut (best)
McLaughlin and Kszos (2005)	Kanlow	92-01	6.2	t/ac	Yield	App	One cut (average), VA, TN, WV, KY, NC
McLaughlin and Kszos (2005)	Kanlow	92-01	10.4	t/ac	Max yield	App	One cut (best) - VA, TN, WV, KY, NC
McLaughlin and Kszos (2005)	Rockwell	00-01	4.2	t/ac	Yield	KS	Field average yield; One cut (2000-2001)
McLaughlin and Kszos (2005)	Shelter	00-01	4.2	t/ac	Yield	KS	One cut (average)
McLaughlin and Kszos (2005)	Sunburst	00-01	4.9	t/ac	Yield	ND	One cut (average)
McLaughlin and Kszos (2005)	Sunburst	00-01	6.2	t/ac	Yield	ND	One cut (best)
McLaughlin and Kszos (2005)	Trailblazer	00-01	4.4	t/ac	Yield	ND	One cut (average)
McLaughlin and Kszos (2005)	Trailblazer	00-01	5.4	t/ac	Yield	ND	One cut (best)
McLaughlin et al. (2002)			4.2	t/ac	Yield	US	US average
Monti et al. (2009)	Alamo		3.8-6.7	t/ac	Yield	Italy	3 experiments on losses
Mooney et al. (2009)	Alamo		3.8-7.89	t/ac	Yield	TN	Plot trials with varying seed and nitrogen applications - 10 year average
Mooney et al. (2009)	Alamo		10.2	t/ac	Max Yield	TN	Plot trials with varying seed and nitrogen applications - 1 year max
Muir et al (2001)	Alamo		10	t/ac	Max Yield	TX	1 year max, 9.1x9.1m plots, Stephenville
Muir et al (2001)	Alamo		6.5	t/ac	Yield	TX	Mean, 9.1x9.1m plots, Stephenville (168 kg N per ha)
Muir et al (2001)	Alamo		4.8	t/ac	Yield	TX	Mean, 5x6m plots, Beevile (168 kg N per ha)
Nelson et al. (2006)			2.5-5.9	t/ac	Yield	KS	SWAT model predicted yields - 0-200 lbs/acre N, Northeast Kansas
Nelson et al. (2006)			4.6	t/ac	Yield	KS	SWAT model predicted yields - 100 lbs/acre

							N , NE Kansas
Ocumpaugh et al. (2003)	Alamo		1.2-9.0	t/ac	Yield	Texas	One-cut (5 locations, 4 years)
Ocumpaugh et al. (2003)	Alamo		1.3-8.6	t/ac	Yield	Texas	Two-cut (5 locations, 4 years)
Parrish et al. (2003)	Alamo, Kanlow	94-96	6.6	t/ac	Yield	Southeast	One cut (1994-1996)
Parrish et al. (2003)	Alamo, Kanlow	94-96	7.3	t/ac	Yield	Southeast	Two cut (1994-1996)
Parrish et al. (2003)	Alamo, Kanlow	97-01	7.0	t/ac	Yield	Southeast	One cut (1997-2001)
Parrish et al. (2003)	Alamo, Kanlow	97-01	6.8	t/ac	Yield	Southeast	Two cut (1997-2001)
Parrish et al. (2003)	Alamo, Kanlow	94-01	6.8	t/ac	Yield	Southeast	One cut (1994-2001)
Parrish et al. (2003)	Alamo, Kanlow	94-01	7.0	t/ac	Yield	Southeast	Two cut (1994-2001)
Parrish et al. (2003)	CIR, Shelter	94-96	4.8	t/ac	Yield	Southeast	One cut (1994-1996), plot average yield
Parrish et al. (2003)	CIR, Shelter	94-96	6.7	t/ac	Yield	Southeast	Two cut (1994-1996), plot average yield
Parrish et al. (2003)	CIR, Shelter	97-01	5.3	t/ac	Yield	Southeast	One cut (1997-2001), plot average yield
Parrish et al. (2003)	CIR, Shelter	97-01	6.5	t/ac	Yield	Southeast	Two cut (1997-2001), plot average yield
Parrish et al. (2003)	CIR, Shelter	94-01	5.1	t/ac	Yield	Southeast	One cut (1994-2001), plot average yield
Parrish et al. (2003)	CIR, Shelter	94-01	6.6	t/ac	Yield	Southeast	Two cut (1994-2001), plot average yield
Perrin et al. (2008)	Multiple		1.7-2.7	t/ac	Yield range	SD to NE	5 year range; commercial scale, Northern SD to Southern NE
Perrin et al. (2008)	Multiple		3.12	t/ac	Yield	SD to NE	10 year average; commercial scale, Northern SD to Southern NE
Perrin et al. (2008)	Multiple		2.6-3.5	t/ac	Yield range	SD to NE	10 year range, commercial scale, Northern SD to Southern NE
Popp and Hogan (2007)			0	t/ac	Yield	AR	Assumption for first year
Popp and Hogan (2007)			3	t/ac	Yield	AR	Assumption for second year
Popp and Hogan (2007)			5	t/ac	Yield	AR	Assumption for years 3-12
Pyter et al. (2007)	CIR		2.2	t/ac	Yield	IL	3 year average, Northern Illinois
Pyter et al. (2007)	CIR		5.2	t/ac	Yield	IL	3 year average, Central Illinois
Pyter et al. (2007)	CIR		2.7	t/ac	Yield	IL	3 year average, Southern Illinois
Reijnders (2010)			4.46-6.69	t/ac	Yield		Previous research (commercial, good soil)
Reynolds et al. (2000)	Alamo	93-97	8.9	t/ac	Yield	TN	2 cut average, 4 plots - 2x7m, Knoxville
Reynolds et al. (2000)	CIR	93-97	8.7	t/ac	Yield	TN	2 cut average, 4 plots - 2x7m, Knoxville
Reynolds et al. (2000)	Kanlow	93-97	8.2	t/ac	Yield	TN	2 cut average, 4 plots - 2x7m, Knoxville
Reynolds et al. (2000)	6	93-97	5-9	t/ac	Yield range	TN	1 cut range, 4 plots - 2x7m, Knoxville
Reynolds et al. (2000)	6	93-97	6.8-10.3	t/ac	Yield range	TN	2 cut range, 4 plots - 2x7m, Knoxville

Reynolds et al. (2000)	NC-1	93-97	8.1	t/ac	Yield	TN	2 cut average, 4 plots - 2x7m, Knoxville
Reynolds et al. (2000)	NC-2	93-97	7.8	t/ac	Yield	TN	2 cut average, 4 plots - 2x7m, Knoxville
Reynolds et al. (2000)	Shelter	93-97	8.1	t/ac	Yield	TN	2 cut average, 4 plots - 2x7m, Knoxville
Sanderson (2008)			2.7	t/ac	Yield	PA	2 cut mean, 9x15m plots, Rock Springs
Sanderson (2008)	CIR		2.8	t/ac	Yield	PA	2 cut , 9x15m plots, Rock Springs
Sanderson (2008)	CIR		3.2	t/ac	Yield	PA	3 cut mean, 9x15m plots, Rock Springs
Sanderson (2008)	Mix		3.2	t/ac	Yield	PA	3 cut mean, 9x15m plots, Rock Springs
Sanderson (2008)	Shawnee		2.7	t/ac	Yield	PA	2 cut average, 9x15m plots, Rock Springs
Sanderson (2008)	Shawnee		3.2	t/ac	Yield	PA	3 cut mean, 9x15m plots, Rock Springs
Sanderson (2008)	Trailblazer		3.1	t/ac	Yield	PA	3 cut, 9x15m plots, Rock Springs
Sanderson (2008)	Trailblazer		2.6	t/ac	Yield	PA	2 cut , 9x15m plots, Rock Springs
Schmer et al. (2006)	Multiple		0.5-3.2	t/ac	Yield range	Plains	Mean, 7.4 - 33 acres, (NE, SD, ND)
Schmer et al. (2006)	Multiple		0-6.4	t/ac	Yield	Plains	Range, 7.4 - 33 acres, (NE, SD, ND)
Shinners et al. (2006)			3.6-8.9	t/ac	Yield	US	Previous research
Shinners et al. (2006)	Shawnee		2.3-4	t/ac	Yield	North	Plot Yield – Northern US
Smeets et al. (2009)		2004	6.7	t/ac	Yield	Poland	2004 Assumption (80% of *Miscanthus*)
Smeets et al. (2009)		2004	7.1	t/ac	Yield	Hungary	2004 Assumption (80% of *Miscanthus*)
Smeets et al. (2009)		2004	5.4	t/ac	Yield	UK	2004 Assumption (80% of *Miscanthus*)
Smeets et al. (2009)		2004	9	t/ac	Yield	Italy	2004 Assumption (80% of *Miscanthus*)
Smeets et al. (2009)		2004	5.8	t/ac	Yield	Lithuania	2004 Assumption (80% of *Miscanthus*)
Smeets et al. (2009)		2004-30	1.50%		Yield growth		Assumption
Smeets et al. (2009)		2030	9.4	t/ac	Yield	Poland	2030 Assumption (1.5% increase/year)
Smeets et al. (2009)		2030	9.8	t/ac	Yield	Hungary	2030 Assumption (1.5% increase/year)
Smeets et al. (2009)		2030	7.6	t/ac	Yield	UK	2030 Assumption (1.5% increase/year)
Smeets et al. (2009)		2030	12	t/ac	Yield	Italy	2030 Assumption (1.5% increase/year)
Smeets et al. (2009)		2030	8	t/ac	Yield	Lithuania	2030 Assumption (1.5% increase/year)
Taliaferro (2002)	Alamo		1.6	t/ac	Yield	KS	3 year mean - (6"x22") plots
Taliaferro (2002)	Alamo		2.8	t/ac	Yield	AR	3 year mean - (6"x22") plots
Taliaferro (2002)	Alamo		2.8	t/ac	Yield	OK	3 year mean - (6"x22") plots
Taliaferro (2002)	Alamo		2.8	t/ac	Yield	VA	3 year mean - (6"x22") plots
Taliaferro (2002)	Kanlow		1.4	t/ac	Yield	KS	3 year mean - (6"x22") plots

Taliaferro (2002)	Kanlow		2.9	t/ac	Yield	AR	3 year mean - (6"x22") plots
Taliaferro (2002)	Kanlow		2.8	t/ac	Yield	OK	3 year mean - (6"x22") plots
Taliaferro (2002)	Kanlow		2.5	t/ac	Yield	VA	3 year mean - (6"x22") plots
Thomason et al. (2005)	Kanlow		5.8	dt/acre	Yield	OK	One cut per year (Average dm)
Thomason et al. (2005)	Kanlow		5.56	dt/acre	Yield	OK	Two cuts per year (Average dm)
Thomason et al. (2005)	Kanlow		7.3	dt/acre	Yield	OK	Three cuts per year (Average dm)
Thomason et al. (2005)	Kanlow		16.4	t/ac	Max yield	OK	Max yield (2 harvests)
Tiffany et al. (2006)			2-4	t/ac	Yield	N. Plains	Assumption
Vadas et al. (2008)			4.00	t/ac	Yield	WI	Normal; large field plots
Vadas et al. (2008)			5.80	t/ac	High Yield	WI	High; large field plots
Vogel et al. (2002)	CIR		4.7-5	t/ac	Yield	NE	Plot trial yield
Vogel et al. (2002)	CIR		5.2-5.6	t/ac	Yield	IA	Plot trial yield
Walsh (2008)	Alamo		15.4	t/ac	Max yield	AL	Max one year
Walsh (2008)	Alamo		5.35-6.9	t/ac	Yield	18 sites	Field level (VA, WV, TN, KY, NC, GA, AL, TX, AR, LA, ND, SD, IA)
Walsh (2008)	Kanlow		5.2-6.9	t/ac	Yield	18 sites	Field level (VA, WV, TN, KY, NC, GA, AL, TX, AR, LA, ND, SD, IA)
Wang et al. (2009)		2007	3, 6, 9	t/ac	Yield	TN	Scenarios; Sensitivity of delivered cost to switchgrass yield - East Tennessee

Table 9 – Miscanthus Literature

Table 9 – Literature Estimates of Miscanthus Yields, Yield Trends, and Yield Growth Rates						
Source	Year	Value	Unit	Level	Location	Assumptions/Details
Allen (2008)		7.2-8	t/acre	Yield		New Miscanthus cultivar (`Amuri') from Mendel; early starter and early maturing (October/November); winter hardy
Allen (2008)		8.0-10.0	t/acre	Yield		New Miscanthus cultivar (`Nagara') from Mendel; late maturing (March/April); winter hardy
Chen et al. (2010)	05-06	11.6	t/acre	Yield	US	Simulated from MISCANMOD (2005-2006 average delivered yield)
Chen et al. (2010)	05-06	26	tDM/ha	Yield		Average delivered yield from MISCANMOD
Christian et al. (2008)		5.71	t/acre	Yield	EU	14 year field trial; Hertfordshire
Christian et al. (2008)		3.43-11.73	t/acre	Yield	EU	14 year field trial; Hertfordshire
Clifton-Brown and Lewandowski (2002)		0.85	t/acre	Yield	Germany	Year 1 Average over 15 genotypes; southern Germany
Clifton-Brown and Lewandowski (2002)		1.34	t/acre	Max yield	Germany	Year 1 Max; southern Germany
Clifton-Brown and Lewandowski (2002)		2.8	t/acre	Yield	Germany	Year 2 Average; southern Germany
Clifton-Brown and Lewandowski (2002)		4.3	t/acre	Max yield	Germany	Year 2 Max; southern Germany
Clifton-Brown and Lewandowski (2002)		7.6	t/acre	Yield	Germany	Year 3 Average; southern Germany
Clifton-Brown and Lewandowski (2002)		11.4	t/acre	Max yield	Germany	Year 3 Max; southern Germany
Clifton-Brown et al. (2001)	1997	0.85	t/acre	Yield	Europe	First year average (1997 planting) - (Sweden, Denmark, England, Germany, and Portugal)
Clifton-Brown et al. (2001)	1997	2.6	t/acre	Max yield	Portugal	First year max (1997 planting)
Clifton-Brown et al. (2001)	1997	0.16	t/acre	Min yield	Sweden	Frist year min (1997 planting)
Clifton-Brown et al. (2001)	1997	3.8	t/acre	Avg yield	Europe	Second year average (1997 planting) - (Sweden, Denmark, England, Germany, and Portugal)
Clifton-Brown et al. (2001)	1997	12	t/acre	Max yield	Portugal	Second year max (1997 planting)
Clifton-Brown et al. (2001)	1997	18.2	t/acre	Max yield	Portugal	Third year max (1997 planting)
Clifton-Brown et al. (2004)		9.6	t/acre	Yield	Sweden	Peak (autumn) - mean 3 most productive genotypes
Clifton-Brown et al. (2004)		7.5	t/acre	Yield	Denmark	Peak (autumn) - mean 3 most productive genotypes
Clifton-Brown et al. (2004)		7.9	t/acre	Yield	England	Peak (autumn) - mean 3 most productive genotypes

Clifton-Brown et al. (2004)		11.8	t/acre	Yield	Germany	Peak (autumn) - mean 3 most productive genotypes
Clifton-Brown et al. (2004)		17.2	t/acre	Yield	Portugal	Peak (autumn) - mean 3 most productive genotypes
Clifton-Brown et al. (2004)		5.8	t/acre	Yield	Sweden	Delayed (late winter/early spring) - mean 3 most productive genotypes
Clifton-Brown et al. (2004)		4.3	t/acre	Yield	Denmark	Delayed (late winter/early spring) - mean 3 most productive genotypes
Clifton-Brown et al. (2004)		5.5	t/acre	Yield	England	Delayed (late winter/early spring) - mean 3 most productive genotypes
Clifton-Brown et al. (2004)		8.9	t/acre	Yield	Germany	Delayed (late winter/early spring) - mean 3 most productive genotypes
Clifton-Brown et al. (2004)		11.6	t/acre	Yield	Portugal	Delayed (late winter/early spring) - mean 3 most productive genotypes
Heaton et al. (2004a)		10	t/acre	Yield		Peer-reviewed articles
Heaton et al. (2004b)		13.36	t/acre	Projection	Illinois	Mean
Heaton et al. (2004b)		10.93-17.81	t/acre	Projection	Illinois	Range
Heaton et al. (2008)		13.2	t/acre	Yield	Illinois	3 year state average
Heaton et al. (2008)		17	t/acre	Yield	Illinois	3 year state average max
Jain et al. (2010)	03-07	3.3-21.3	t/acre	Peak yield	Midwest	Estimated average peak yield in Midwestern states
Jain et al. (2010)		16.6	t/acre	Yield	Midwest	Average observed peak yields
Jain et al. (2010)		19	t/acre	Yield	Midwest	Average modeled yields
Jain et al. (2010)		0-27.7	t/acre	Yield range	Midwest	Range in estimated peak yield
Jain et al. (2010)		6.3-8.6	t/acre	Yield	Midwest	Farm-gate yield (annualized yield after harvest and storage losses)
Jain et al. (2010)		19.2-14.1	tDM/ha	Yield		Farm-gate yield for (low cost - high cost) scenarios; Annualized yield after losses during harvest and storage; 15 year life
Jain et al. (2010)		±10%				Variation used in sensitivity analysis of biomass baseline crop yields
James et al. (2010)		10	t/acre	Yield	Michigan	Assumption; Southern Michigan; adjusted below Illinois average
Kahle et al. (2001)	94-96	6.6-14.9	t/acre	Yield	Germany	Above ground biomass (4-9 year old stands)
Kahle et al. (2001)	94-96	5.2	t/acre	Yield	Germany	Mean harvested yield (4-9 year old stands)
Khanna (2008)		12-18	t/acre	Yield	Illinois	Potential
Khanna (2008)		8.1-8.5	t/acre	Yield	Illinois	Delivered
Khanna and Dhungana (2007)		8.9	t/acre	Simulation	Illinois	

Khanna et al. (2008)		14.5	t/acre	Yield	Illinois	Average yield
Khanna et al. (2008)		12-17	t/acre	Yield range	Illinois	
Khanna et al. (2008)		125.7	t/acre	Yield	Illinois	20 year PV
Lewandowski et al. (2000)		0.9-19.6	t/acre	Yield range	Europe	High end irrigated
Lewandowski et al. (2000)		4.5-11.15	t/acre	Yield	Europe	Autumn yields without irrigation
Lewandowski et al. (2003)		4.5-13.4	t/acre	Yield	European	
Lewandowski et al. (2003)		2.2-6.7	t/acre	Yield	Denmark	
Lewandowski et al. (2003)		1.8-13.4	t/acre	Yield	Germany	
Lewandowski et al. (2003)		4.5-6.7	t/acre	Yield	Britain	
Lewandowski et al. (2003)		5.8-8.5	t/acre	Yield	Switzerland	
Lewandowski et al. (2003)		9.8	t/acre	Yield	Austria	
Lewandowski et al. (2003)		6.2-15.2	t/acre	Yield	Spain	
Lewandowski et al. (2003)		11.6-19.6	t/acre	Yield	Greece	
Lewandowski et al. (2003)		12.5	t/acre	Yield	Turkey	
Lewandowski et al. (2003)		13.4-14.3	t/acre	Yield	Italy	
Pyter et al. (2007)		9.8	t/acre	Yield	Illinois	3 year average - Northern Illinois
Pyter et al. (2007)		15.5	t/acre	Yield	Illinois	3 year average - Central Illinois
Pyter et al. (2007)		15.8	t/acre	Yield	Illinois	3 year average - Southern Illinois
Pyter et al. (2007)		14.1	t/acre	Yield	Illinois	One year (end of third growing season) - Urbana
Reijnders (2010)		4.46-5.8	t/acre	Yield		Previous research (large scale commercial; good soil)
Smeets et al. (2009)	2004	8.5	t/acre	Yield	Poland	
Smeets et al. (2009)	2004	8.9	t/acre	Yield	Hungary	
Smeets et al. (2009)	2004	6.7	t/acre	Yield	UK	
Smeets et al. (2009)	2004	11.2	t/acre	Yield	Italy	
Smeets et al. (2009)	2004	7.6	t/acre	Yield	Lithuania	
Smeets et al. (2009)	2004-30	1.50%		Yield growth	Europe	Poland, Hungary, UK, Italy, Lituania
Smeets et al. (2009)	2030	12	t/acre	Yield	Poland	2030 (1.5% increase/year)
Smeets et al. (2009)	2030	12	t/acre	Yield	Hungary	2030 (1.5% increase/year)
Smeets et al. (2009)	2030	9.4	t/acre	Yield	UK	2030 (1.5% increase/year)
Smeets et al. (2009)	2030	15	t/acre	Yield	Italy	2030 (1.5% increase/year)
Smeets et al. (2009)	2030	10.3	t/acre	Yield	Lithuania	2030 (1.5% increase/year)

Stampfl et al. (2007)		7.2-7.4	t/acre	Yield	Lithuania	Modeled harvestable yield
Stampfl et al. (2007)		6.2-3.4	t/acre	Yield	Latvia	Modeled harvestable yield
Stampfl et al. (2007)		6.6-9.4	t/acre	Yield	France	Several different regions
Stampfl et al. (2007)		7.5-8.9	t/acre	Yield	Poland	Several different regions
Stampfl et al. (2007)		4.7	t/acre	Yield	Denmark	Several different regions
Vargas et al. (2002)	1996	3.4	t/acre	Yield	Denmark	1996 (drought year) - four year old crop
Vargas et al. (2002)	1997	5.9	t/acre	Yield	Denmark	1997 - four year old crop

Table 10 – Other Biomass Crops Literature

Table 10 – Literature Estimates for Other Biomass Crops

Source	Crop	Year	Value	Unit	Level	Assumptions/Details
Swayze (2007 pres)	Biomass	2007	5	t/ac	Yield	Example
Swayze (2007 pres)	Biomass	Future	15	t/ac	Yield	Example
BRDI (2008b)	Cellulosic crops	2022	4.6	t/ac	Yield	Cropland biomass source only - Reference
BRDI (2008b)	Cellulosic crops	2022	5.2	t/ac	Yield	Cropland biomass source only - High yield
BRDI (2008b)	Cellulosic crops	2022	4.6	t/ac	Yield	Cropland and forestland biomass source - Reference
BRDI (2008b)	Cellulosic crops	2022	5.2	t/ac	Yield	Cropland and forestland biomass source - High yield
BRDI (2008b)	Cellulosic crops	2022	4.7	t/ac	Yield	Cropland, forestland biomass and import source - Reference
BRDI (2008b)	Cellulosic crops	2022	5.4	t/ac	Yield	Cropland, forestland biomass and import source - High yield
de Vries et al (2007)	Energy crops	2000	0.7		MF	Management factor (MF) used to represents technological progress (drives yield change)
de Vries et al (2007)	Energy crops	2050	1.3-1.5		MF	Management factor (MF) used to represents technological progress (drives yield change)
Banowetz et al. (2008)	Creeping Red Fescue		2.2-3.36	t/ac	Yield	PNW, County-scale
Banowetz et al. (2008)	Perennial Ryegrass		3.4-4.1	t/ac	Yield	PNW, County-scale
Banowetz et al. (2008)	Tall Fescue		4.13-6.2	t/ac	Yield	PNW, County-scale
James et al. (2010)	Mixed Grasses		3.5	t/ac	Yield	Assumption; Adjusted below SG yield; Southern Michigan
James et al. (2010)	Mixed grasses		0.5	t/ac	Yield	Southern Michigan
Perlack et al. (2002)	Perennial crops		8	dt/ha	Yield	High-yield scenario
Perlack et al. (2002)	Perennial crops	"Current"	4.2	t/ac	Yield	Level attainable today
James et al. (2010)	Prairie grasses		2.1	t/ac	Yield	Assumption; Southern Michigan
James et al. (2010)	Prairie Mix		2.14	t/ac	Yield	Used Tilman et al. (2006) values; Southern Michigan

Kim and Dale (2005)	Rice straw	2005	2.041	dt/ha	Yield	Cited in BRDI (2008a)
Kim and Dale (2005)	Sorghum straw	2005	1.42	dt/ha	Yield	Cited in BRDI (2008)
Hettenhaus (2006)	Soybean stubble					Similar to quantity per acre as straw from dryland cereal grains

Table 11 – Biomass Projections

Table 11 – Biomass Crop Yield Projections								
Source	Crop	Location	Assumption	2010	2020	2030	2040	2050
English et al. (2010)	SG	Northeast	Reported 2010, 2020, 2025 values	4.87	7.30	9.7 (2025)	--	--
	SG	Northeast	5% annual growth rate; use 4.87 for starting 2010 value	4.87	7.93	12.92	21.05	34.28
	SG	App	Reported 2010, 2020, 2025 values	5.84	8.80	11.7 (2025)	--	--
	SG	App	5% annual growth rate; use 5.87 for starting 2010 value	5.84	9.56	15.57	25.37	41.32
	SG	Corn Belt	Reported 2010, 2020, 2025 values	5.98	9.00	12 (2025)	--	--
	SG	Corn Belt	5% annual growth rate; use 5.98 for starting 2010 value	5.98	9.74	15.87	25.85	42.10
	SG	Lake States	Reported 2010, 2020, 2025 values	4.80	7.20	9.6 (2025)	--	--
	SG	Lake States	5% annual growth rate; use 7.80 for starting 2010 value	4.80	7.82	12.74	20.75	33.79
	SG	Southeast	Reported 2010, 2020, 2025 values	5.49	8.20	11 (2025)	--	--
	SG	Southeast	5% annual growth rate; use 5.49 for starting 2010 value	5.49	8.94	14.57	23.73	38.65
	SG	S. Plains	Reported 2010, 2020, 2025 values	4.30	6.50	8.6 (2025)	--	--
	SG	S. Plains	5% annual growth rate; use 4.3 for starting 2010 value	4.30	7.00	11.41	18.58	30.27
	SG	N. Plains	Reported 2010, 2020, 2025 values	3.47	5.20	6.9 (2025)	--	--
	SG	N. Plains	5% annual growth rate; use 3.47 for starting 2010 value	3.47	5.65	9.21	15.00	24.43
Graham et al. (1995)	SG	N. Central	Reported 2020 value	--	6.00	--	--	--
	SG	Northeast	Reported 2020 value	--	5.30	--	--	--
	SG	S. Central	Reported 2020 value	--	7.40	--	--	--
	SG	Southeast	Reported 2020 value	--	8.60	--	--	--
Marshall and Sugg (2010)	SG	App	2% annual growth rate following 2008 value (up 2015) - start with 2008 low value reported (3.5 t/ac); extend to 2050	3.64	4.44	5.41	6.60	8.04
	SG	App	2% annual growth rate following 2008 value - start with 2008 high value reported (6.5 t/ac); extend to 2050	6.76	8.24	10.05	12.25	14.93
	SG	Corn Belt	2% annual growth rate following 2008 value - start with 2008 low value reported (5.16 t/ac); extend to 2050	5.37	6.54	7.98	9.72	11.85
	SG	Corn Belt	2% annual growth rate following 2008 value - start with 2008 high value	6.66	8.12	9.89	12.06	14.70

			reported (6.4 t/ac); extend to 2050					
	SG	Delta States	2% annual growth rate following 2008 value - start with 2008 low value reported (3.8 t/ac); extend to 2050.	3.95	4.82	5.87	7.16	8.73
	SG	Delta States	2% annual growth rate following 2008 value - start with 2008 high value reported (6.5 t/ac); extend to 2050	6.76	8.24	10.05	12.25	14.93
	SG	Lake States	2% annual growth rate following 2008 value - start with 2008 low value reported (4.5 t/ac); extend to 2050	4.68	5.71	6.96	8.48	10.34
	SG	Lake States	2% annual growth rate following 2008 value - start with 2008 high value reported (6.0 t/ac); extend to 2050	6.24	7.61	9.28	11.31	13.78
	SG	Mtn States	2% annual growth rate following 2008 value - start with 2008 value reported (3.0 t/ac); extend to 2050	3.12	3.80	4.64	5.65	6.89
	SG	N. Plains	2% annual growth rate following 2008 value - start with 2008 low value reported (4.8 t/ac); extend to 2050	4.99	6.09	7.42	9.05	11.03
	SG	N. Plains	2% annual growth rate following 2008 value - start with 2008 high value reported (6.0 t/ac); extend to 2050	6.24	7.61	9.28	11.31	13.78
	SG	Northeast	2% annual growth rate following 2008 value - start with 2008 low value reported (3.2 t/ac); extend to 2050	3.33	4.06	4.95	6.03	7.35
	SG	Northeast	2% annual growth rate following 2008 value - start with 2008 high value reported (6.2 t/ac); extend to 2050	6.45	7.86	9.59	11.68	14.24
	SG	S. Plains	2% annual growth rate following 2008 value - start with 2008 low value reported (3.5 t/ac); extend to 2050	3.64	4.44	5.41	6.60	8.04
	SG	S. Plains	2% annual growth rate following 2008 value - start with 2008 high value reported (6.3 t/ac); extend to 2050	6.55	7.99	9.74	11.87	14.47
	SG	Southeast	2% annual growth rate following 2008 value - start with 2008 low value reported (4.4 t/ac); extend to 2050	4.58	5.58	6.80	8.29	10.11
	SG	Southeast	2% annual growth rate following 2008 value - start with 2008 high value reported (6.5 t/ac); extend to 2050	6.76	8.24	10.05	12.25	14.93
McLaughlin and Kszos (2005)	SG	US	1% growth rate - use a value of 4 t/ac in 2008 (4 t/ac arbitrary value)	4.08	4.51	4.98	5.50	6.08
	SG	US	2% growth rate - use a value of 4 t/ac in 2008 (4 t/ac arbitrary value)	4.16	5.07	6.18	7.54	9.19
	SG	US	3% growth rate - use a value of 4 t/ac in 2008 (4 t/ac arbitrary value)	4.24	5.70	7.66	10.30	13.84
	SG	US	4% growth rate - use a value of 4 t/ac in 2008 (4 t/ac arbitrary value)	4.33	6.40	9.48	14.03	20.77
	SG	US	5% growth rate - use a value of 4 t/ac in 2008 (4 t/ac arbitrary value)	4.41	7.18	11.70	19.06	31.05
Smeets et al. (2009)	SG	Poland	2030 reported value (based on 1.5% growth rate)	--	--	9.40	--	--
	SG	Hungary	2030 reported value (based on 1.5% growth rate)	--	--	9.80	--	--
	SG	UK	2030 reported value (based on 1.5% growth rate)	--	--	7.60	--	--
	SG	Italy	2030 reported value (based on 1.5% growth rate)	--	--	12.00	--	--
	SG	Lithuania	2030 reported value (based on 1.5% growth rate)	--	--	8.00	--	--

	SG	Poland	1.5% growth rate (2004-2030) - use a value of 6.7 t/ac in 2004 and extend to 2050	7.33	8.50	9.87	11.45	13.29
	SG	Hungary	1.5% growth rate (2004-2030) - use a value of 7.1 t/ac in 2004 and extend to 2050	7.76	9.01	10.46	12.13	14.08
	SG	UK	1.5% growth rate (2004-2030) - use a value of 5.4 t/ac in 2004 and extend to 2050	5.90	6.85	7.95	9.23	10.71
	SG	Italy	1.5% growth rate (2004-2030) - use a value of 9 t/ac in 2004 and extend to 2050	9.84	11.42	13.25	15.38	17.85
	SG	Lithuania	1.5% growth rate (2004-2030) - use a value of 5.8 t/ac in 2004 and extend to 2050	6.34	7.36	8.54	9.91	11.50
	Misc	Poland	2030 reported value (based on 1.5% growth rate)	--	--	12.00	--	--
	Misc	Hungary	2030 reported value (based on 1.5% growth rate)	--	--	12.00	--	--
	Misc	UK	2030 reported value (based on 1.5% growth rate)	--	--	9.40	--	--
	Misc	Italy	2030 reported value (based on 1.5% growth rate)	--	--	15.00	--	--
	Misc	Lithuana	2030 reported value (based on 1.5% growth rate)	--	--	10.30	--	--
	Misc	Poland	1.5% growth rate (2004-2030) - use a value of 8.5 t/ac in 2004 and extend to 2050	9.29	10.79	12.52	14.53	16.86
	Misc	Hungary	1.5% growth rate (2004-2030) - use a value of 8.9 t/ac in 2004 and extend to 2050	9.73	11.29	13.11	15.21	17.65
	Misc	UK	1.5% growth rate (2004-2030) - use a value of 6.7 t/ac in 2004 and extend to 2050	7.33	8.50	9.87	11.45	13.29
	Misc	Italy	1.5% growth rate (2004-2030) - use a value of 11.2 t/ac in 2004 and extend to 2050	12.25	14.21	16.49	19.14	22.22
	Misc	Lithuana	1.5% growth rate (2004-2030) - use a value of 7.6 t/ac in 2004 and extend to 2050	8.31	9.64	11.19	12.99	15.07
Jain et al. (2010)	Misc	US	±10% sensitivity range					
	SG	US	±10% sensitivity range					
BRDI (2008b)	Stover	US	1.23% baseline projected annual yield growth (2016)					

Table 12 – Other Crop Literature

Table 12 – Other Crop Yield Estimates						
Source	Crop	Year	Value	Unit	Level	Assumptions/Details
Parker et al. (2010)	Canola	2016	14.90%		Projection	Yield projection for 2015/2016 relative to 2006/2007; West
Fischer et al. (2009)	Cereals	1960-09	1960-09	43	World	Global cereal yield trend over past 5 decades (low variability)
Fischer et al. (2009)	Cereals	1960	1960	3.2%	World	Yield growth rate
Fischer et al. (2009)	Cereals	2000	2000	1.5%	World	Yield growth rate (fell since 1960)
Fischer et al. (2009)	Cereals	2050	2050	0.8%	World	Projection based on linear trend to 2050
Fischer et al. (2009)	Cereals	1991-09	1991-09	2.5%	Latin America	Best yield performance in world since 1991
Fischer et al. (2009)	Cereals	1991-09	1991-09	1.2-1.3%	Sub-Saharan Africa, S & SE Asia	Worst yield performances in world since 1991
GHI (2009)	Cereals	2001	2.4-2.5	mt/ha	SE Asia	Regional cereal yield; cite IFPRI Impact Projections (2001)
GHI (2009)	Cereals	2001	3	mt/ha	East Asia	Regional cereal yield; cite IFPRI Impact Projections (2001)
GHI (2009)	Cereals	2001	5.4-5.5	mt/ha	S.S. Africa	Regional cereal yield; cite IFPRI Impact Projections (2001)
GHI (2009)	Cereals	2001	1..4	mt/ha	Latin Amer	Regional cereal yield; cite IFPRI Impact Projections (2001)
GHI (2009)	Cereals	2001	3.6-3.7	mt/ha	W. Asia/ N. Africa	Regional cereal yield; cite IFPRI Impact Projections (2001)
GHI (2009)	Cereals	2001	2.5-2.6	mt/ha	Developing	Developing world; cite IFPRI Impact Projections (2001)
GHI (2009)	Cereals	2001	3.0-3.1	mt/ha	Developed	Developed world; cite IFPRI Impact Projections (2001)
GHI (2009)	Cereals	2001	3.9-4.0	mt/ha	SE Asia	Regional cereal yield; cite IFPRI Impact Projections (2001)
IFPRI	Cereals	Until 2050	1%		World	Cereal growth rate to 2050; cited by Fischer et al. (2009)
Rosegrant et al. (2008)	Cereals	To 2050	37	Kg/ha	World	Average annual absolute yield gain; cited in Fischer et al. (2009)
Tweeten and Thompson (2008)	Cereals	To 2050	43	Kg/ha	World	Linear yield trend; Cited by Fischer et al. (2009)
Tweeten and Thompson (2008)	Cereals	2025	1.04%		World	Predicted percent increase in 2025 from linear model
Tweeten and Thompson (2008)	Cereals	2050	0.83%		World	Predicted percent increase in 2050 from linear model
Tweeten and Thompson (2008)	Cereals	2025	0.87%		World	Predicted percent increase in 2025 from quadratic model
Tweeten and Thompson (2008)	Cereals	2050	0.62%		World	Predicted percent increase in 2050 from quadratic model
de Vries et al (2007)	Food crops	2050	0.78-0.82		MF	Management factor (MF) used to represents technological progress (drives yield change)
de Vries et al (2007)	Food crops	2100	0.86-0.89		MF	Management factor (MF) used to represents technological progress (drives yield change)
BRDI (2008b)	Grain sorghum	2003-07	1.8	t/ac	Yield	Olympic average

BRDI (2008b)	Grain sorghum		0.65%		Yield growth	2016 baseline projected annual yield growth rate
Rosburg et al. (2011) approach	Hay	2009-50			State-level	See Table 17 for State-level Hay Projections in the U.S.
English et al. (2010)	Oats	2009-18	0.65%		Yield growth	USDA baseline
English et al. (2010)	Oats	2019-25	0.61%		Yield growth	USDA baseline extended from last 3 years
Hertel et al. (2009)	Oilseeds		-1.20%		Yield impact	Yield change from increase in US corn ethanol production from 6.6 gigaliters to 56.7 gigaliters per year
Hertel et al. (2009)	Other crops		-1.30%		Yield impact	Yield change from increase in US corn ethanol production from 6.6 gigaliters to 56.7 gigaliters per year
Hertel et al. (2009)	Other grains		-0.43%		Yield impact	Yield change from increase in US corn ethanol production from 6.6 gigaliters to 56.7 gigaliters per year
English et al. (2010)	Rice	2009-18	1.06%		Yield growth	USDA baseline
English et al. (2010)	Rice	2019-25	0.79%		Yield growth	USDA baseline extended from last 3 years
Reijnders (2010)	Sorghum		16.41	t/ac	Yield	Previous research (large scale commercial; good soil)
Reijnders (2010)	Sorghum		16.41	t/ac	Yield	Previous research (large scale commercial; good soil)
English et al. (2010)	Sorghum	2009-18	0.16%		Yield growth	USDA baseline
English et al. (2010)	Sorghum	2019-25	0.16%		Yield growth	USDA baseline extended from last 3 years
BRDI (2008b)	Sugarcane	2003-07	32.7	t/ac	Yield	Olympic average
BRDI (2008b)	Sugarcane		0.32%		Yield growth	2016 baseline projected annual yield growth rate
Hertel et al. (2009)	Sugarcane		0.40%		Yield impact	Yield change from increase in US corn ethanol production from 6.6 gigaliters to 56.7 gigaliters per year
Kim and Dale (2005)	Sugarcane	2005	21	dt/ha	Yield	Cited in BRDI (2008)

Table 13 – Corn Yield Linear Trend Estimates (Rosburg et al., 2011)

Table 13 – State Linear Trend Model Corn Yield Forecasts from Rosburg et al. (2011)												
	Iowa			**Illinois**			**Nebraska**				**Indiana**	
	LR – US & State	**SR - State**	**SR - USAR**	**LR - US**	**SR - State**	**SR - USAR**	**LR - US**	**LR - State**	**SR - State**	**SR - USAR**	**LR - US**	**SR - USAR**
Year	1970-2009	1995-2009	1999-2009	1970-2009	1995-2009	1999-2009	1970-2009	1974-2009	1993-2009	1999-2009	1970-2009	1999-2009
Trend	2.12	3.63	3.36	1.93	3.86	3.51	2.01	2.08	3.10	3.98	1.81	2.95
2009	182.00	182.00	182.00	174.00	174.00	174.00	178.00	178.00	178.00	178.00	171.00	171.00
2010	184.12	185.63	185.36	175.93	177.86	177.51	180.01	180.08	181.10	181.98	172.81	173.95
2020	205.37	221.95	219.00	195.19	216.51	212.60	200.14	200.83	212.13	221.80	190.94	203.50
2030	226.61	258.28	252.64	214.45	255.15	247.69	220.26	221.58	243.16	261.62	209.07	233.05
2040	247.85	294.60	286.27	233.71	293.79	282.78	240.38	242.33	274.19	301.44	227.20	262.59
2050	269.09	330.92	319.91	252.97	332.44	317.87	260.51	263.08	305.22	341.25	245.32	292.14
	Minnesota				**South Dakota**				**Kansas**			
	LR - US	**LR - State**	**SR - State**	**SR - USAR**	**LR - US**	**LR - State**	**SR - State**	**SR - USAR**	**LR - US**	**LR - State**	**SR - State**	**SR - USAR**
Year	**1970-2009**	**1974-2009**	**1988-2009**	**1999-2009**	**1970-2009**	**1977-2009**	**1994-2009**	**1999-2009**	**1970-2009**	**1988-2009**	**2000-2009**	**1999-2009**
Trend	2.31	2.55	3.36	2.55	2.29	2.29	2.41	2.93	1.39	0.28	2.15	1.20
2009	174.00	174.00	174.00	174.00	151.00	151.00	151.00	151.00	155.00	155.00	155.00	155.00
2010	176.31	176.55	177.36	176.55	153.29	153.29	153.41	153.93	156.39	155.28	157.15	156.20
2020	199.36	202.02	210.97	202.00	176.15	176.24	177.55	183.20	170.34	158.04	178.60	168.20
2030	222.41	227.49	244.58	227.45	199.01	199.19	201.68	212.47	184.29	160.80	200.05	180.20
2040	245.47	252.96	278.19	252.91	221.87	222.14	225.81	241.75	198.23	163.56	221.51	192.20
2050	268.52	278.43	311.79	278.36	244.73	245.09	249.94	271.02	212.18	166.32	242.96	204.20
	Ohio		**Wisconsin**		**Missouri**		**Michigan**		**Texas**			
	LR - US	**SR - USAR**	**LR – US & State**	**SR - USAR**	**LR - US**	**SR - USAR**	**LR - US**	**SR - USAR**	**LR - US**	**LR - State**	**SR - USAR**	
Years	**1970-2009**	**1999-2009**	**1970-2009**	**1999-2009**	**1970-2009**	**1999-2009**	**1970-2009**	**1999-2009**	**1970-2009**	**1971-2009**	**1999-2009**	
Trend	1.72	3.23	1.62	1.17	1.89	3.40	1.71	2.50	1.11	1.01	1.01	
2009	174.00	174.00	153.00	153.00	153.00	153.00	148.00	148.00	130.00	130.00	130.00	
2010	175.72	177.23	154.62	154.17	154.89	156.40	149.71	150.50	131.11	131.01	131.01	
2020	192.89	209.50	170.85	165.90	173.75	190.40	166.83	175.50	142.20	141.06	141.10	
2030	210.06	241.77	187.07	177.63	192.62	224.40	183.94	200.50	153.29	151.11	151.19	
2040	227.24	274.05	203.30	189.35	211.49	258.40	201.06	225.50	164.38	161.17	161.28	
2050	244.41	306.32	219.52	201.08	230.36	292.40	218.17	250.50	175.47	171.22	171.37	
	North Dakota				**Kentucky**		**Colorado**				**Pennsylvania**	
	LR - US	**LR - State**	**SR - State**	**SR - USAR**	**LR - US**	**SR - USAR**	**LR - US**	**LR - State**	**SR - State**	**SR - USAR**	**LR - US**	**SR - USAR**

Years	1970-2009	1973-2009	1998-2009	1999-2009	1970-2009	1999-2009	1970-2009	1971-2009	1992-2009	1999-2009	1970-2009	1999-2009
Trend	1.82	1.94	0.69	0.47	1.84	3.28	1.24	1.20	0.69	1.13	1.14	5.29
2009	115.00	115.00	115.00	115.00	165.00	165.00	153.00	153.00	153.00	153.00	143.00	143.00
2010	116.82	116.94	115.69	115.47	166.84	168.28	154.24	154.20	153.69	154.13	144.14	148.29
2020	135.07	136.38	122.58	120.20	185.21	201.10	166.64	166.20	160.61	165.40	155.57	201.20
2030	153.31	155.81	129.47	124.93	203.59	233.92	179.05	178.20	167.52	176.67	166.99	254.11
2040	171.56	175.24	136.35	129.65	221.97	266.74	191.45	190.21	174.43	187.95	178.42	307.02
2050	189.80	194.68	143.24	134.38	240.35	299.55	203.85	202.21	181.35	199.22	189.85	359.93

Table 14 – Corn Yield Autoregressive Estimates (Rosburg et al., 2011)

Table 14 – State Autoregressive Model Corn Yield Forecasts from Rosburg et al. (2011)

	Iowa - AR(4)			**Illinois - AR(4)**		**Nebraska - AR(2)**			**Minnesota - AR(4)**			
	LR - US	**LR - State**	**SR – State & USAR**	**LR - US**	**SR – State & USAR**	**LR – US & State**	**SR - State**	**SR - USAR**	**LR - US**	**LR - State**	**SR - State**	**SR - USAR**
Year	**1970-2009**	**1974-2009**	**1999-2009**	**1970-2009**	**1999-2009**	**1970-2009**	**1993-2009**	**1999-2009**	**1970-2009**	**1971-2009**	**1981-2009**	**1999-2009**
Rate	**1.51%**	**1.96%**	**2.01%**	**1.56%**	**2.12%**	**1.76%**	**2.18%**	**2.08%**	**1.71%**	**1.89%**	**1.84%**	**1.27%**
2009	182.00	182.00	182.00	174.00	174.00	178.00	178.00	178.00	174.00	174.00	174.00	174.00
2010	184.75	185.56	185.66	176.71	177.69	181.13	181.87	181.71	176.98	177.29	177.21	176.20
2020	214.69	225.28	226.53	206.28	219.13	215.56	225.55	223.33	209.68	213.79	212.70	199.80
2030	249.49	273.50	276.41	240.79	270.25	256.54	279.71	274.49	248.43	257.80	255.31	226.57
2040	289.92	332.05	337.26	281.07	333.29	305.32	346.89	337.37	294.34	310.88	306.45	256.92
2050	336.90	403.12	411.51	328.10	411.03	363.37	430.19	414.65	348.73	374.88	367.83	291.34
	Indiana - AR(4)			**South Dakota - AR(1)**		**Kansas - AR(1)**		**Ohio - AR(5)**			**Wisconsin - AR(4)**	
	LR - US	**LR - State**	**SR – State & USAR**	**LR - US**	**SR - USAR**	**LR - US**	**SR - USAR**	**LR - US**	**LR - State**	**SR - USAR**	**LR – US & State**	**SR – State & USAR**
Year	**1970-2009**	**1972-2009**	**1999-2009**	**1970-2009**	**1999-2009**	**1970-2009**	**1999-2009**	**1970-2009**	**1972-2009**	**1999-2009**	**1970-2009**	**1999-2009**
Rate	**1.44%**	**1.45%**	**1.88%**	**2.67%**	**2.01%**	**1.76%**	**0.32%**	**1.63%**	**1.62%**	**2.51%**	**1.29%**	**0.87%**
2009	171.00	171.00	171.00	151.00	151.00	155.00	155.00	174.00	176.82	174.00	153.00	153.00
2010	173.46	173.48	174.21	155.03	154.04	157.73	155.50	176.84	179.71	178.37	154.97	154.32
2020	200.08	200.36	209.88	201.74	187.95	187.87	160.57	207.92	211.29	228.65	176.10	168.21
2030	230.79	231.41	252.85	262.52	229.34	223.77	165.82	244.45	248.42	293.09	200.11	183.34
2040	266.21	267.27	304.61	341.61	279.83	266.53	171.23	287.41	292.08	375.69	227.39	199.84
2050	307.07	308.69	366.97	444.54	341.45	317.45	176.82	337.92	343.41	481.58	258.39	217.82
	Missouri - AR(5)		**Michigan - AR(3)**		**Texas - AR(1)**		**North Dakota - AR(2)**			**Kentucky - AR(4)**		
	LR - US	**SR - USAR**	**LR - US**	**SR - USAR**	**LR - US**	**SR - USAR**	**LR - US**	**SR - State**	**SR - USAR**	**LR – US &**	**SR - USAR**	

										State	
Years	**1970-2009**	**1999-2009**	**1970-2009**	**1999-2009**	**1970-2009**	**1999-2009**	**1970-2009**	**1998-2009**	**1999-2009**	**1970-2009**	**1999-2009**
Rate	**1.75%**	**2.34%**	**1.56%**	**1.91%**	**2.50%**	**1.66%**	**1.93%**	**1.09%**	**0.63%**	**1.87%**	**2.25%**
2009	153.00	153.00	148.00	148.00	130.00	130.00	115.00	115.00	115.00	165.00	165.00
2010	155.67	156.57	150.30	150.83	133.25	132.16	117.22	116.25	115.72	168.09	168.71
2020	185.09	197.25	175.42	182.32	170.54	155.80	141.97	129.55	123.16	202.34	210.73
2030	220.08	248.49	204.73	220.39	218.26	183.67	171.95	144.36	131.08	243.58	263.21
2040	261.67	313.05	238.94	266.40	279.34	216.53	208.25	160.87	139.50	293.21	328.77
2050	311.13	394.38	278.86	322.03	357.51	255.26	252.22	179.27	148.47	352.97	410.65

	Colorado - AR(1)		**Pennsylvania - AR(2)**	
	LR - US	**SR - USAR**	**LR - US**	**SR - USAR**
Years	**1970-2009**	**1999-2009**	**1970-2009**	**1999-2009**
Rate	**1.10%**	**0.39%**	**1.20%**	**3.03%**
2009	153.00	153.00	143.00	143.00
2010	154.68	153.60	144.71	147.33
2020	172.52	159.71	162.99	198.58
2030	192.41	166.07	183.57	267.66
2040	214.60	172.68	206.76	360.76
2050	239.35	179.55	232.88	486.26

Table 15 – Soybean Yield Linear Trend Estimates (Rosburg et al., 2011)

Table 15 – State Linear Trend Model Soybean Yield Forecasts following Rosburg et al. (2011)

	Iowa		Illinois		Minnesota			Indiana		Nebraska		
	LR - US	SR - US	LR - US	SR - US	LR - US	SR - State	SR - US	LR - US	SR - US	LR - US	SR - State	SR - US
Year	1960-2009	1985-2009	1960-2009	1985-2009	1960-2009	1994-2009**	1985-2009	1960-2009	1985-2009	1960-2009	1969-2009**	1985-2009
Trend	0.46	0.49	0.40	0.39	0.46	0.04	0.35	0.46	0.47	0.52	0.58	0.72
2009	51.00	51.00	46.00	46.00	40.00	40.00	40.00	49.00	49.00	54.50	54.50	54.50
2010	51.46	51.49	46.40	46.39	40.46	40.04	40.35	49.46	49.47	55.02	55.08	55.22
2020	56.08	56.42	50.43	50.25	45.03	40.41	43.83	54.04	54.18	60.19	60.93	62.39
2030	60.69	61.34	54.46	54.11	49.60	40.79	47.32	58.63	58.89	65.37	66.77	69.56
2040	65.31	66.26	58.48	57.97	54.17	41.16	50.80	63.22	63.61	70.54	72.62	76.74
2050	69.93	71.18	62.51	61.83	58.74	41.54	54.29	67.80	68.32	75.71	78.46	83.91

	Missouri		Ohio		South Dakota		Kansas		Arkansas		
	LR - US	SR - US	LR - US	SR - US	LR - US	SR - US	LR - US	SR - US	LR - US	SR - State	SR - US
Year	1960-2009	1985-2009	1960-2009	1985-2009	1960-2009	1985-2009	1960-2009	1985-2009	1960-2009	2001-2009	1985-2009
Trend	0.34	0.37	0.42	0.36	0.40	0.40	0.34	0.30	0.34	0.44	0.59
2009	43.50	43.50	49.00	49.00	42.00	42.00	44.00	44.00	37.50	37.50	37.50
2010	43.84	43.87	49.42	49.36	42.40	42.40	44.34	44.30	37.84	37.94	38.09
2020	47.25	47.58	53.61	52.99	46.35	46.43	47.77	47.27	41.29	42.36	44.02
2030	50.66	51.29	57.80	56.62	50.30	50.46	51.21	50.24	44.73	46.78	49.94
2040	54.06	54.99	61.99	60.26	54.25	54.48	54.64	53.22	48.18	51.19	55.86
2050	57.47	58.70	66.18	63.89	58.20	58.51	58.07	56.19	51.63	55.61	61.78

	North Dakota		Michigan			Mississippi			Tennessee		
	LR - US	SR - US	LR - US	SR - State	SR - US	LR - US	SR - State	SR - US	LR - US	SR - State	SR - US
Years	1960-2009	1985-2009	1960-2009	1977-2009	1985-2009	1960-2009	2001-2009	1985-2009	1960-2009	1984-2009	1985-2009
Trend	0.39	0.26	0.41	0.32	0.24	0.30	0.59	0.74	0.31	0.42	0.42
2009	30.00	30.00	40.00	40.00	40.00	48.87	48.87	48.87	45.00	45.00	45.00
2010	30.39	30.26	40.41	40.32	40.24	49.17	49.46	49.61	45.31	45.42	45.42
2020	34.34	32.81	44.52	43.54	42.67	52.20	55.38	57.02	48.36	49.66	49.67
2030	38.28	35.37	48.62	46.76	45.09	55.23	61.30	64.43	51.41	53.89	53.91
2040	42.22	37.93	52.73	49.98	47.51	58.26	67.21	71.83	54.46	58.13	58.15
2050	46.16	40.49	56.83	53.20	49.93	61.29	73.13	79.24	57.51	62.36	62.39

	Kentucky		Wisconsin			North Carolina			Louisiana		
	LR - US	SR - US	LR - US	SR - State	SR - US	LR - US	SR - State	SR - US	LR - US	SR - State	SR - US
Years	1960-2009	1985-2009	1960-2009	2000-2009	1985-2009	1960-2009	1984-2009	1985-2009	1960-2009	2001-2009	1985-2009

Trend	0.34	0.44	0.53	0.16	0.23	0.16	0.25	0.26	0.25	0.80	0.63
2009	48.00	48.00	40.00	40.00	40.00	34.00	34.00	34.00	39.00	39.00	39.00
2010	48.34	48.44	40.53	40.16	40.23	34.16	34.25	34.26	39.25	39.80	39.63
2020	51.72	52.86	45.86	41.73	42.53	35.81	36.72	36.87	41.74	47.80	45.90
2030	55.11	57.28	51.19	43.31	44.83	37.45	39.19	39.48	44.23	55.80	52.17
2040	58.49	61.70	56.52	44.88	47.13	39.09	41.67	42.10	46.72	63.80	58.45
2050	61.88	66.12	61.85	46.46	49.43	40.73	44.14	44.71	49.21	71.80	64.72

Table 16 – Wheat Yield Linear Trend Estimates (Rosburg et al., 2011)

Table 16 – State Linear Trend Model Wheat Yield Forecasts following Rosburg et al. (2011)

	North Dakota		Kansas			Montana			South Dakota		
	Long Run	SR - US	Long Run	SR - State	SR - US	Long Run	SR - State	SR - US	Long Run	SR - State	SR - US
Year	**1960-2009**	**1985-2009**	**1960-2009**	**1997-2009**	**1985-2009**	**1960-2009**	**1969-2009**	**1985-2009**	**1960-2009**	**1988-2009**	**1985-2009**
Trend	0.27	0.35	0.33	-0.75	0.26	0.17	0.14	0.23	0.51	0.96	0.80
2009	44.80	44.80	42.00	42.00	42.00	33.30	33.30	33.30	42.90	42.90	42.90
2010	45.07	45.15	42.33	41.25	42.26	33.47	33.44	33.53	43.41	43.86	43.70
2020	47.82	48.66	45.61	33.78	44.86	35.21	34.80	35.81	48.52	53.44	51.69
2030	50.56	52.16	48.90	26.31	47.46	36.94	36.17	38.08	53.63	63.02	59.68
2040	53.30	55.67	52.18	18.84	50.06	38.68	37.54	40.36	58.73	72.61	67.67
2050	56.05	59.17	55.46	11.36	52.66	40.42	38.91	42.64	63.84	82.19	75.66

	Washington			Colorado			Idaho			Texas	
	Long Run	SR - State	SR - US	Long Run	SR - State	SR - US	Long Run	SR - State	SR - US	Long Run	SR - US
Year	**1960-2009**	**1996-2009**	**1985-2009**	**1960-2009**	**1983-2009**	**1985-2009**	**1960-2009**	**1993-2009**	**1985-2009**	**1960-2009**	**1985-2009**
Trend	0.57	-0.53	0.31	0.33	-0.19	-0.15	1.02	-0.02	0.58	0.25	0.10
2009	55.30	55.30	55.30	40.60	40.60	40.60	79.30	79.30	79.30	25.00	25.00
2010	55.87	54.77	55.61	40.93	40.41	40.45	80.32	79.28	79.88	25.25	25.10
2020	61.58	49.51	58.74	44.19	38.54	38.95	90.53	79.08	85.72	27.78	26.11
2030	67.29	44.24	61.87	47.45	36.67	37.45	100.74	78.89	91.55	30.30	27.12
2040	72.99	38.97	65.00	50.71	34.80	35.95	110.95	78.69	97.38	32.82	28.12
2050	78.70	33.70	68.13	53.98	32.93	34.46	121.17	78.50	103.22	35.34	29.13

	Minnesota			Oklahoma			Nebraska			Illinois	
	Long Run	SR - State	SR - US	Long Run	SR - State	SR - US	Long Run	SR - State	SR - US	Long Run	SR - US
Years	**1960-2009**	**1993-2009**	**1985-2009**	**1960-2009**	**1997-2009**	**1985-2009**	**1960-2009**	**1988-2009**	**1985-2009**	**1960-2009**	**1985-2009**
Trend	0.46	1.45	0.60	0.19	-0.68	0.08	0.30	0.52	0.30	0.57	0.58
2009	52.80	52.80	52.80	22.00	22.00	22.00	48.00	48.00	48.00	56.00	56.00
2010	53.26	54.25	53.40	22.19	21.32	22.08	48.30	48.52	48.30	56.57	56.58
2020	57.83	68.77	59.37	24.10	14.57	22.93	51.32	53.71	51.31	62.24	62.35
2030	62.40	83.28	65.34	26.02	7.81	23.77	54.34	58.91	54.32	67.91	68.12
2040	66.97	97.80	71.32	27.93	1.05	24.61	57.36	64.10	57.32	73.59	73.88
2050	71.54	112.31	77.29	29.84	-5.71	25.45	60.38	69.30	60.33	79.26	79.65

	Ohio			Oregon			California			Missouri	
	Long Run	SR - State	SR - US	Long Run	SR - State	SR - US	Long Run	SR - State	SR - US	Long Run	SR - US
Years	**1960-2009**	**1997-2009**	**1985-2009**	**1960-2009**	**1999-2009**	**1985-2009**	**1960-2009**	**1999-2009**	**1985-2009**	**1960-2009**	**1985-2009**
Trend	0.79	0.19	0.79	0.55	1.08	-0.40	1.18	0.74	0.11	0.47	0.53

2009	72.00	72.00	72.00	50.31	50.31	50.31	86.80	86.80	86.80	47.00	47.00
2010	72.79	72.19	72.79	50.87	51.39	49.92	87.98	87.54	86.91	47.47	47.53
2020	80.72	74.05	80.73	56.41	62.14	45.96	99.74	94.89	88.00	52.19	52.80
2030	88.64	75.92	88.67	61.96	72.90	42.00	111.50	102.24	89.09	56.91	58.08
2040	96.56	77.79	96.61	67.50	83.65	38.05	123.27	109.60	90.18	61.63	63.36
2050	104.48	79.66	104.55	73.04	94.41	34.09	135.03	116.95	91.27	66.34	68.64
	Michigan			**Indiana**		**North Carolina**			**Kentucky**		
	Long Run	**SR - State**	**SR - US**	**Long Run**	**SR - US**	**Long Run**	**SR - State**	**SR - US**	**Long Run**	**SR - State**	**SR - US**
Years	**1960-2009**	**1999-2009**	**1985-2009**	**1960-2009**	**1985-2009**	**1960-2009**	**1972-2009**	**1985-2009**	**1960-2009**	**1987-2009**	**1985-2009**
Trend	0.57	0.99	0.58	0.47	0.53	0.47	0.56	0.61	0.75	0.84	1.03
2009	69.00	69.00	69.00	67.00	67.00	49.00	49.00	49.00	57.00	57.00	57.00
2010	69.57	69.99	69.58	67.47	67.53	49.47	49.56	49.61	57.75	57.84	58.03
2020	75.24	79.92	75.35	72.19	72.80	54.16	55.21	55.68	65.23	66.29	68.33
2030	80.91	89.84	81.12	76.91	78.08	58.85	60.85	61.75	72.72	74.74	78.63
2040	86.59	99.77	86.88	81.63	83.36	63.54	66.49	67.81	80.20	83.19	88.93
2050	92.26	109.69	92.65	86.34	88.64	68.23	72.13	73.88	87.68	91.64	99.23

Table 17 – Hay Yield Linear Trend Estimates (Rosburg et al., 2011)

Table 17 – State Linear Trend Model Hay Yield Forecasts following Rosburg et al. (2011)

	Alaska		California			Texas			Missouri		
	Long Run	**SR - US**	**Long Run**	**SR - State**	**SR - US**	**Long Run**	**SR - State**	**SR - US**	**Long Run**	**SR - State**	**SR - US**
Year	**1960-2009**	**1996-2009**	**1960-2009**	**1992-2009**	**1996-2009**	**1960-2009**	**1977-2009**	**1996-2009**	**1960-2009**	**1990-2009**	**1996-2009**
Trend	0.02	0.02	0.04	0.02	0.03	0.01	0.00	0.00	0.01	0.00	0.00
2009	1.15	1.15	5.68	5.68	5.68	1.79	1.79	1.79	2.07	2.07	2.07
2010	1.17	1.17	5.72	5.70	5.71	1.80	1.79	1.79	2.08	2.07	2.07
2020	1.34	1.39	6.12	5.90	5.97	1.94	1.75	1.77	2.14	2.04	2.06
2030	1.51	1.61	6.51	6.10	6.23	2.08	1.72	1.75	2.21	2.02	2.05
2040	1.69	1.83	6.91	6.30	6.49	2.21	1.69	1.72	2.27	1.99	2.05
2050	1.86	2.06	7.31	6.50	6.75	2.35	1.66	1.70	2.34	1.97	2.04

	South Dakota			Kansas			Kentucky			Minnesota	
	Long Run	**SR - State**	**SR - US**	**Long Run**	**SR - State**	**SR - US**	**Long Run**	**SR - State**	**SR - US**	**Long Run**	**SR - US**
Year	**1960-2009**	**1977-2009**	**1996-2009**	**1960-2009**	**2000-2009**	**1996-2009**	**1960-2009**	**1989-2009**	**1996-2009**	**1960-2009**	**1996-2009**
Trend	0.02	0.01	-0.01	0.01	0.03	-0.02	0.02	-0.01	-0.01	0.01	-0.02
2009	2.06	2.06	2.06	2.83	2.83	2.83	2.50	2.50	2.50	2.56	2.56
2010	2.08	2.07	2.05	2.84	2.86	2.81	2.52	2.49	2.49	2.57	2.54
2020	2.27	2.17	1.96	2.97	3.16	2.60	2.68	2.44	2.37	2.70	2.33
2030	2.46	2.27	1.86	3.09	3.46	2.39	2.84	2.38	2.26	2.84	2.12
2040	2.66	2.37	1.77	3.22	3.75	2.18	3.00	2.33	2.14	2.97	1.92
2050	2.85	2.47	1.67	3.35	4.05	1.96	3.16	2.27	2.02	3.10	1.71

	Nebraska			Idaho			Oklahoma			North Dakota	
	Long Run	**SR - State**	**SR - US**	**Long Run**	**SR - State**	**SR - US**	**Long Run**	**SR - State**	**SR - US**	**Long Run**	**SR - US**
Years	**1960-2009**	**2000-2009**	**1996-2009**	**1960-2009**	**1974-2009**	**1996-2009**	**1960-2009**	**1976-2009**	**1996-2009**	**1960-2009**	**1996-2009**
Trend	0.02	0.03	0.00	0.03	0.02	0.01	0.00	-0.01	-0.01	0.01	-0.01
2009	2.31	2.31	2.31	3.66	3.66	3.66	1.64	1.64	1.64	1.77	1.77
2010	2.33	2.34	2.31	3.69	3.68	3.67	1.64	1.63	1.63	1.78	1.76
2020	2.54	2.62	2.35	3.96	3.84	3.72	1.67	1.58	1.56	1.88	1.65
2030	2.76	2.89	2.39	4.23	4.00	3.77	1.70	1.53	1.48	1.97	1.54
2040	2.97	3.17	2.43	4.50	4.16	3.82	1.72	1.47	1.41	2.07	1.44
2050	3.19	3.45	2.47	4.77	4.32	3.87	1.75	1.42	1.33	2.17	1.33

	Montana			Wisconsin			Tennessee			Colorado	
	Long Run	**SR - State**	**SR - US**	**Long Run**	**SR - State**	**SR - US**	**Long Run**	**SR - State**	**SR - US**	**Long Run**	**SR - US**
Years	**1960-2009**	**1983-2009**	**1996-2009**	**1960-2009**	**1997-2009**	**1996-2009**	**1960-2009**	**1989-2009**	**1996-2009**	**1960-2009**	**1996-2009**
Trend	0.01	0.00	-0.01	0.00	-0.04	-0.03	0.02	0.00	-0.01	0.02	-0.02
2009	1.91	1.91	1.91	2.31	2.31	2.31	2.21	2.21	2.21	2.40	2.40

2010	1.92	1.91	1.90	2.31	2.27	2.28	2.23	2.21	2.20	2.42	2.37
2020	2.02	1.94	1.80	2.27	1.87	1.98	2.44	2.24	2.15	2.66	2.16
2030	2.13	1.96	1.71	2.24	1.47	1.68	2.64	2.26	2.10	2.90	1.94
2040	2.23	1.99	1.61	2.21	1.07	1.38	2.85	2.29	2.04	3.13	1.72
2050	2.33	2.01	1.51	2.18	0.67	1.08	3.06	2.31	1.99	3.37	1.50

	Iowa			**Pennsylvania**			**Washington**		
	Long Run	**SR - State**	**SR - US**	**Long Run**	**SR - State**	**SR - US**	**Long Run**	**SR - State**	**SR - US**
Years	**1960-2009**	**1983-2009**	**1996-2009**	**1960-2009**	**1997-2009**	**1996-2009**	**1960-2009**	**1998-2009**	**1996-2009**
Trend	0.02	0.02	0.02	0.01	0.00	0.02	0.05	-0.01	0.00
2009	3.28	3.28	3.28	2.36	2.36	2.36	4.07	4.07	4.07
2010	3.30	3.30	3.30	2.37	2.36	2.38	4.12	4.06	4.07
2020	3.52	3.51	3.47	2.49	2.36	2.57	4.57	3.92	4.09
2030	3.74	3.71	3.64	2.61	2.36	2.77	5.03	3.79	4.11
2040	3.97	3.92	3.81	2.72	2.36	2.97	5.48	3.65	4.12
2050	4.19	4.13	3.98	2.84	2.36	3.16	5.94	3.52	4.14

	Oregon			**Arkansas**		
	Long Run	**SR - State**	**SR - US**	**Long Run**	**SR - State**	**SR - US**
Years	**1960-2009**	**1999-2009**	**1996-2009**	**1960-2009**	**1972-2009**	**1996-2009**
Trend	0.03	0.01	-0.01	0.02	0.01	0.01
2009	3.15	3.15	3.15	2.21	2.21	2.21
2010	3.18	3.16	3.14	2.23	2.22	2.22
2020	3.44	3.26	3.08	2.38	2.36	2.29
2030	3.70	3.37	3.02	2.54	2.50	2.36
2040	3.97	3.47	2.96	2.70	2.64	2.43
2050	4.23	3.57	2.89	2.86	2.78	2.50

References

Aden, A. May 2008. "Biochemical Production of Ethanol from Corn Stover: 2007 State of Technology Model." NREL: Technical Report. NREL/TP-510-43205.

Aden, A., M. Ruth, K. Ibsen, J. Jechura, K. Neeves, J. Sheehan, B. Wallace, L. Montague, A. Slayton, and J. Lukas. June 2002. "Lignocellulosic Biomass to Ethanol Process Design and Economics Utilizing Co-Current Dilute Acid Prehydrolysis and Enzymatic Hydrolysis for Corn Stover." NREL: Technical Report. NREL/TP-510-32438.

Allen, D. January 10, 2008. "Genetic Improvement of Miscanthus at Mendel Biotechnology." Presentation for the 5th 'Annual Bioenergy Feedstocks Symposium. Urbana-Champaign, IL.

America's Energy Future Panel on Alternative Liquid Transportation Fuel (ALTF). 2009. "Liquid Transportation Fuels from Coal and Biomass: Technological Status, Costs, and Environmental Impacts." National Academy of Sciences, National Academy of Engineering and National Research Council. The National Academies Press.

Andrews, S. February 2006. "White Paper: Crop Residue Removal for Biomass Energy Production: Effects on Soils and Recommendations." Soil Quality National Development Team. USDA – Natural Resource Convention Services

Atchison, J. and J. Hettenhaus. March 2003. "Innovative Methods for Corn Stover Collecting, Handling, Storing and Transporting." National Renewable Energy Laboratory. NREL/SR-510-33893. http://www.nrel.gov/docs/fy04osti/33893.pdf

Babcock, B., P. Gassman, M. Jha, and C. King. 2007. "Adoption Subsidies and Environmental Impacts of Alternative Energy Crops." Briefing Paper 07-BP 50, Center for Agriculture and Rural Development (CARD), Iowa State University.

Baker, M., D. Hayes, and B. Babcock. February 2008. "Crop-Based Biofuel Production under Acreage Constraints and Uncertainty." Iowa State University, Center for Agricultural and Rural Development. Working Paper 08-WP 460.

Bangsund, D., E. DeVuyst, and F. Leistritz. August 2008. "Evaluation of Breakeven Farm-Gate Switchgrass Price in South Central North Dakota." Agribusiness and Applied Economics Report No. 632-S. Department of Agribusiness and Applied Economics, North Dakota State University, Fargo, ND. Available online at: http://ageconsearch.umn.edu/bitstream/42253/2/AAE632-S.pdf

Banowetz, G., A. Boateng, J. Steiner, S. Griffith, V. Sethi, and H. El-Nashaar. 2008. "Assessment of Straw Biomass Feedstock Resources in the Pacific Northwest." Biomass and Bioenergy 32:629-634.

Barney, J. and J. DiTomaso. 2010. "Bioclimatic Predictions of Habitat Suitability for the Biofuel Switchgrass in North America under Current and Future Climate Scenarios." Biomass and Bioenergy 34: 124-133.

Berdahl, J., A. Frank, J. Krupinsky, P. Carr, J. Hanson, and H. Johnson. 2005. "Biomass Yield, Phenology, and Survival of Diverse Switchgrass Cultivars and Experimental Strains in Western North Dakota." Agronomy Journal 97:549-555.

Blanco-Canqui, H. 2010. "Energy Crops and Their Implications on Soil and Environment." Agronomy Journal 102(2): 403-419.

Bouton, J. 2002. "Bioenergy Crop Breeding and Production Research in the Southeast." Prepared by Oak Ridge National Laboratory for U.S. Department of Energy Office of Biomass. ORNL/Sub-02-19XSV810C/01.

Biomass Research and Development Institute (BRDI). October 2008. "The Economics of Biomass Feedstocks in the United States: A Review of the Literature." Biomass Research and Development Board.

Biomass Research and Development Institute (BRDI). December 2008. “Increasing Feedstock Production for Biofuels: Economic Drivers, Environmental Implications, and the Role of Research.” Biomass Research and Development Board.

Brechbill, S. and W. Tyner. April 2008a. “The Economics of Biomass Collection, Transportation, and Supply to Indiana Cellulosic and Electric Utility Facilities.” Department of Agricultural Economics, Purdue University. Working Paper #08-03.

Brechbill, S. and W. Tyner. 2008b. “The Economics of Renewable Energy: Corn Stover and Switchgrass.” Department of Agricultural Economics, Purdue University. Purdue Extension ID-404-W.

Brummer, E., C. Burras, M. Duffy, and K. Moore. August 2001. “Switchgrass Production in Iowa: Economic Analysis, Soil Suitability, and Varietal Performance.” Oak Ridge National Laboratory, Bioenergy Feedstock Development Program. Managed by University of Tennessee Battelle LLC.

Brummer, E., C. Burras, M. Duffy, and K. Moore. 2002. “Switchgrass Production in Iowa: Economic analysis, soil suitability, and varietal performance.” ORNL/University of Tennessee, Sept.

Busby, D., R. Little, S. Shaik, A. Martins, F. Epplin, S. Hqang, B. Baldwin, and C. Taliaferro. 2007. “Yield and Production Costs for Three Potential Dedicated Energy Crops in Mississippi and Oklahoma Environments.” Selected Paper for Presentation at the Southern Agricultural Economics Association Annual Meeting, Mobile, Alabama.

Carolan, J., S. Joshi, and B. Dale. 2007. “Technical and Financial Feasibility Analysis of Distributed Bioprocessing Using Regional Biomass Pre-Processing Centers.” Journal of Agricultural & Food Industrial Organization 5(10).

Carpenter, B. and M. Mees. 2008. “Baleage Silage, & Bio-energy, Projected Budgets for 2009.” Agricultural Electronic Bulletin Board, University of Missouri Extension, Columbia, MO. http://agebb.missouri.edu/mgt/budget/forage.htm.

Cassida, K., J. Muir, A. Hussey, J. Read, B. Venuto, and W. Ocumpaugh. 2005b. “Biomass Yield and Stand Characteristics of Switchgrass in South Central U.S. Environments.” Crop Science 45: 673-681.

CERES. May 20, 2009. "Ceres Yield Results: Energy Crop Benefits are Greatly Underestimated." Ceres News Release. http://www.ceres.net/News/NewsReleases/2009/05-20-09-News-Rel.html

Chen, X., H. Huang, M. Khanna, and H. Onal. 2010. “Meeting the Mandate for Biofuels: Implications for Land Use and Food and Fuel Prices.” Paper Selected for Presentation at the AAEA Joint Meetings, Denver, Colorado, July 25-27, 2010.

Christian D., A. Riche, and N. Yates. 2008. “Growth, Yield and Mineral Content of Miscanthus x Giganteus Grown as a Biofuel for 14 Successful Harvests.” Industrial Crops and Products. doi:10.1016/j.indcrop.2008.02.009.

Clifton-Brown, J. and I. Lewandowski. 2002. “Screening Miscanthus Genotypes in Field Trials to Optimal Biomass Yield and Quality in Southern Germany.” European Journal of Agronomy 16:(97-110).

Clifton-Brown, J., I. Lewandowski, B. Andersson, G. Basch, D. Christian, J. Kjeldsen, U. Jorgensen, J. Mortensen, A. Riche, K. Schwarz, K. Tayebi, and F. Teixeira. 2001. “Performance of 15 Miscanthus Genotypes at Five Sites in Europe.” Agronomy Journal 93:1013-1019.

Comis, D. July 2006. “Switching to Switchgrass makes Sense.” ARS. Agriculture Research. Pg 19.

Conway, G. and G. Toenniessen. December 2, 1999. “Feeding the World in the Twenty-First Century.” AgBioWorld. http://www.agbioworld.org/biotech-info/topics/dev-world/feeding.html

Cubbage, F., S. Koesbandana, P. Mac Donagh, R. Rubilar, G. Balmelli, V. Morales Olmos, R. De La Torre, M. Murara, V. Hoefich, H. Kotze, R. Gonzalez, O. Carrero, G. Frey, T. Adams, J. Turner, R. Lord, J. Huang, C. MacIntyre, K.

McGinley, R. Abt, and R. Phillips. 2010. “Global Timber Investments, Wood Costs, Regulations, and Risk.” Biomass and Bioenergy. doi:10.1016/j.biombioe.2010.05.008

Cundiff, J., and W. Harris. 1995. "Maximizing Output-Maximizing Profits," Resource, Feb. (cited in Epplin F. 1996. “Cost of producing and delivering switchgrass biomass to an ethanol conversion facility,” professional paper AEP-246 of Oklahoma Agricultural Experiment Station).

Crosbie, T. M., Eathington, S. R., Johnson, G. R., Sr., Edwards, M., Reiter, R., Stark, S. Mohanty, R. G., Oyervides, M., Buehler, R. E., Walker, A. K., Dobert, R., Delannay, X., Pershing, J. C., Hall, M. A., & Lamkey, K. R. (2006). “Plant breeding: Past, Present, and Future.” In Plant Breeding: The Arnel R. Hallauer International Symposium (pp. 3-50). Blackwell Publishing.

Dawson, L. and R. Boopathy. 2007. “Use of Post-Harvest Sugarcane Residue for Ethanol Production.” Bioresource Technology 98: 1695-1699.

De La Torre Ugarte, D., M. Walsh, H. Shapouri, and S. Slinsky. February 2003. “The Economic Impacts of Bioenergy Crop Production on U.S. Agriculture.” USDA. Agricultural Economic Report Number 816.

De la Torre Ugarte, D., B. English, C. Hellwinckel, T. West, K. Jensen, C. Clark, and R. Menard. November 2009. “Analysis of the Implications of Climate Change and Energy Legislation to the Agricultural Sector.” Department of Agricultural Economics, Institute of Agriculture, The University of Tennessee.

De Vries, B., D. van Vuuren, and M. Hoogwijk. 2007. “Renewable Energy Sources: Their Global Potential for the First-Half of the 21st Century at a Global Level: An Integrated Approach.” Energy Policy 35: 2590-2610.

Deschenes, O. and M. Greenstone. 2007. “The Economic Impacts of Climate Change: Evidence from Agricultural Output and Random Fluctuations in Weather.” The American Economic Review 97(1): 354-385.

Duffy, Mike. December 2007. “Estimated Costs for Production, Storage, and Transportation of Switchgrass.” Iowa State University – University Extension. File: Economics 1-8.

Duffy, M. and V. Nanhou. 2002. “Costs of Producing Switchgrass for Biomass in Southern Iowa.” Trends in New Crops and New Uses, ASHA Press, Alexandria, VA, pp. 267-275.

Edwards, William. December 2007. “Estimating a Value for Corn Stover.” Iowa State University – University Extension. File A1-70.

Elliott, G. 2005. “Communication to the 5th Biennial SRWCOWG Conference Report.” SRWC Newsletter No. 12; ORNL/USDA-FS, March.

Elobeid, A., S. Tokgoz, D.J. Hayes, B.A. Babcock, and C.E. Hart. 2007. “The Long-Run Impact of Corn-Based Ethanol on the Grain, Oilseed, and Livestock Sectors with Implications for Biotech Crops.” AgBioForum 10(1): 11-18.

English, B., D. de la Torre Ugarte, C. Hellwinckel, K. Jensen, R. Menard, T. West, and C. Clark. November 2010. “Implications of Energy and Carbon Policies for the Agriculture and Forestry Sectors.” Department of Agricultural & Resource Economics, Institute of Agriculture, The University of Tennessee. 25x25: America’s Energy Future.

Epplin, F., C. Clark, R. Roberts, and S. Hwang. 2007. “Challenges to the Development of a Dedicated Energy Crop.” American Journal of Agricultural Economics 89(5): 1296-1302.

Erickson, M. and W. Tyner. 2010. “The Economics of Harvesting Corn Cobs for Energy.” BioEnergy. Department of Agricultural Economics, Purdue University. Purdue Extension ID-417-W.

Felix, E. and D. Tilley. 2009. “Integrated Energy, Environmental and Financial Analysis of Ethanol Production from Cellulosic Switchgrass.” Energy 34: 410-436.

Ferland, C. 2001. “Switchgrass for Co-generation Fuel Feasibility.” Center for Agribusiness & Economic Development, University of Georgia. http://www.agecon.uga.edu/~caed/Pubs/switchgrass.html

Fike, J., D. Parrish, D. Wolf, J. Balasko, J. Green Jr., M. Rasnake, J. Reynolds. 2006a. “Long-term Yield Potential of Switchgrass-for-Biofuel Systems.” Biomass and Bioenergy 30:198-206.

Fike, J., D. Parrish, D. Wolf, J. Balasko, J. Green Jr., M. Rasnake, J. Reynolds. 2006b. “Switchgrass Production for the Upper Southeastern USA: Influence of Cultivar and Cutting Frequency on Biomass Yields.” Biomass and Bioenergy 30:207-213.

Fischer, G. August 2009. "World Food and Agriculture to 2030/50: How do Climate Change and Bioenergy Alter the Long-term Outlook for Food, Agriculture and Resource Availability." Paper prepared for the FAO Expert Meeting on "How to Feed the World in 2050." Rome. June 24-26, 2009.

Fischer, R., D. Byerlee, and G. Edmeades. June 2009. "Can Technology Deliver on the Yield Challenge to 2050?" Paper prepared for the FAO Expert Meeting on "How to Feedt the World in 2050." Rome. June 24-26, 2009.

Fox, G., P. Girouard, and Y. Syaukat. 1999. “An Economic Analysis of the Financial Viability of Switchgrass as a Raw Material for Pulp Production in Eastern Ontario.” Biomass and Bioenergy 16: 1-12.

Gallagher, P., M. Dikeman, J. Fritz, E. Wailes, W. Gauther, and H. Shapouri. February 2003. “Biomass from Crop Residues: Cost and Supply Estimates.” Agricultural Economic Report No. 819.

Gallagher, P., W. Dikeman, J. Fritz, E. Wailes, W. Gauthier, and H. Shapouri. April 2003. “Supply and Social Cost Estimates for Biomass from Crop Residues in the United States.” Environmental and Resource Economics 24: 335-358.

Gan, J. and C. Smith. 2006. “Availability of Logging Residues and Their Potential for Electricity Production and Carbon Displacement in the USA.” Biomass and Bioenergy 30: 1011-1020.

Gibson, L. and S. Barnhart. 2007. “Switchgrass.” Iowa State University, University Extension. Department of Agronomy. Crop, Soil, and Environmental Sciences. http://www.extension.iastate.edu/publications/ag200.pdf

Girouard, P., M. Walsh, and D. Becker. 1999. “BIOCOST-Canada: A New Tool to Evaluate the Economic, Energy, and Carbon Budgets of Perennial Energy Crops.” Paper Presented at the Fourth Biomass Conference of the Americas, August 29-September 2, Oakland, C.A. 1999.

Glassner, D., J. Hettenhaus, and T. Schechinger. 1998. “Corn Stover Collection Project.” BioEnergy ’98: Expanding BioEnergy Partnerships.

Graham, R., E. Lichtenberg, V. Roningen, H. Shapouri, and M. Walsh. 1995. “The Economics of Biomass Production in the United States.” http://bioenergy.ornl.gov/papers/bioam95/graham3.html

Graham, R., R. Nelson, J. Sheehan, R. Perlack, and L. Wright. 2007. “Current and Potential U.S. Corn Stover Suppliers.” Agronomy Journal 99: 1-11.

Grant, D., J. Hess, K. Kenney, P. Laney, D. Muth, P. Pryfogle, C. Radtke, and C. Wright. September 2006. “Feasibility of a Producer Owned Ground-Straw Feedstock Supply Sustem for Bioethanol and Other Products.” INL, U.S. Department of Energy National Laboratory. INL/EXT-06-11815.

Green, J. and G. Benson. 2008. “Switchgrass for Biomass for Energy Production: Estimate Revenue. Budgets 87-11 and 87-12. North Carolina State University Cooperative Extension. http://www.ag-econ.ncsu.edu/extension/budgets/switchgrass_energy_87-11.pdf

Hallam, A., I. Anderson, and D. Buxton. 2001. “Comparative Economic Analysis of Perennial, Annual, and Intercrops for Biomass Production.” Biomass and Bioenergy 21: 407-424.

Heaton, E., T. Voight, and S. P. Long. 2004. "A quantitative review comparing the yields of two candidate C4 perennial biomass crops in relation to nitrogen, temperature and water. "Biomass and Bioenergy 27:21-30.

Heaton, E. A., J. Clifton-Brown, T. B. Voight, M. B. Jones, and S. P. Long. 2004. "Miscanthus for renewable energy generation: European Union experience and projections for Illinois." Mitigation and Adaptation Strategies for Global Change 9:433-451.

Heaton, E., F. Dohleman, and S. Long. 2008. "Meeting US Biofuel Goals with Less Land: The Potential of Miscanthus." Global Change Biology 14: 2000-2014.

Hertel, T., A. Golub, A. Jones, M. O'Hare, R. Plevin, and D. Kammen. 2009. "Global Land Use and Greenhouse Gas Emissions Impacts of U.S. Maize Ethanol: The Role of Market-Mediated Responses." Center for Global Trade Analysis (GTAP) Working Paper No. 55.

Hess, J.R., C.T. Wright, and K.L. Kenney. 2007. "Cellulosic Biomass Feedstocks and Logistics for Ethanol Production." Biomass, Bioproducts and Biorefining 1:181-190.

Hettenaus, J. 2006. "Achieving Sustainable Production of Agricultural Biomass for Biorefinery Feedstock." Biotechnology Industry Organization – Industrial and Environmental Section.

Hewitt, T. 2006. "Estimated Costs of One Acre of Grain Sorghum, North Florida." North Florida Research and Education Center, University of Florida, Marianna, FL. http://nfrec.ifas.ufl.edu/programs/enterprise_budgets.shtml#field_crops.

Huang, H. and M. Khanna. 2010. "An Econometric Analysis of U.S. Crop Yield and Cropland Acreage: Implications for the Impact of Climate Change." Selected Paper for Presentation at the Agricultural & Applied Economics Association 2010. AAEA, CAES, & WAEA Joint Annual Meeting, Denver, Colorado, July 25-27, 2010.

Huang, H., S. Ramaswamy, W. Al-Dajani, U. Tschirner, and R. Cairncross. 2009. "Effect of Biomass Species and Plant Size on Cellulosic Ethanol: A Comparative Process and Economic Analysis." Biomass and Bioenergy 33: 234-246.

Jain, A., M. Khanna, M. Erickson, and H. Huang. 2010. "An Integrated Biogeochemical and Economic Analysis of Bioenergy Crops in the Midwestern United States." Global Change Biology Bioenergy 2: 217-234. doi: 10.1111/j.1757-1707.2010.01041.x

James, L., S. Swinton, and K.Thelen. 2010. "Profitability Analysis of Cellulosic Energy Crops." Agronomy Journal 102(2):675-687.

Jenkins, B., R. Williams, N. Parker, P. Tittmann, Q. Hart, M. Gildart, S. Kaffka, B. Hartsough, and P. Dempster. 2009. "Sustainable Use of California Biomass Resources can Help Meet State and National Bioenergy Targets." California Agriculture 63(4).

Jiang, Y. and S. Swinton. September 2008. "Market Interactions, Farmer Choices, and the Sustainability of Growing Advanced Biofuels." Department of Agricultural, Food, and Resource Economics, Michigan State University. Staff Paper 2008-03.

Johnson, J. June 2006. "Technology Assessment of Biomass Ethanol: A Multi-Objective, Life Cycle Approach under Uncertainty." Doctoral Thesis in the Department of Chemical Engineering at the Massachusetts Institute of Technology.

Kahle, P., S. Beuch, B. Boelcke, P. Leinweber, and H. Schulten. 2001. "Cropping of Miscanthus in Central Europe: Biomass Production and Influence on Nutrients and Soil Organic Matter." European Journal of Agronomy 15: 171-184.

Karlen, D. 2010. "Corn Stover Feedstock Trials to Support Predictive Modeling." Global Change Biology Bioenergy 2: 235-247. doi: 10.1111/j.1757-1707.2010.01061.x

Keeney, R. 2010. “Yield Response and Biofuels: Issues and Evidence on the Extensive Margin.” Paper Presented at the Fourth World Congress of Environmental and Resource Economists, Montreal, Canada, June 28 – July 2, 2010.

Keeney, R. and T. Hertel. 2009. “The Indirect Land Use Impacts of United States Biofuel Policies: The Importance of Acreage, Yield, and Bilateral Trade Responses.” The American Journal of Agricultural Economics 91(4): 895-909.

Kerstetter, J., and J. Lyons. 2001. “Wheat Straw for Ethanol Production in Washington: A Resource, Technical, and Economic Assessment.” WSUCEEP201084, Washington State University Cooperative Extension Energy Program.

Khanna, Madhu. 2008. “Cellulosic Biofuels: Are they Economically Viable and Environmentally Sustainable?” Choices 23(3):16-19.

Khanna, Madhu and Basanta Dhungana. November 2007. “Economics of Alternative Feedstocks.” Chapter 8 of “Corn-based Ethanol in Illinois and the U.S.: A Report from the Department of Agricultural and Consumer Economics, University of Illinois.” Department of Agricultural and Consumer Economics, University of Illinois. http://www.farmdoc.uiuc.edu/policy/research_reports/ethanol_report/index.html.

Khanna M, Dhungana B., Clifton-Brown J. June 2008 “Costs of Producing Miscanthus and Switchgrass for Bioenergy in Illinois.” Biomass and Bioenergy 32:482-493.

Kim, S., and B. Dale. 2005. “Life Cycle Assessment of Various Cropping Systems Utilized for Producing Biofuels: Bioethanol and Biodiesel.” Biomass and Bioenergy 29:426-439.

Kiniry, J., K. Cassida, M. Hussey, J. Muir, W. Ocumpaugh, J. Read, R. Reed, M. Sanderson, B. Venuto, and J. Williams. 2005. “Switchgrass Simulation by the ALMANAC model at Diverse Sites in the Southern US.” Biomass and Bioenergy 29:419-425.

Kszos, L., S. McLaughlin, and M. Walsh. 2002. “Bioenergy From Switchgrass: Reducing Production Costs by Improving Yield and Optimizing Crop Management.” Bioenergy 2002, Bioenergy for the Environment, Boise, ID, September 22-26, 2002.

Kucharik, C. and S. Serbin. 2008. “Impacts of Recent Climate Change on Wisconsin Corn and Soybean Yield Trends.” Environmental Research Letters 3 034003.

Kumar, A. and S. Sokhansanj. 2007. “Switchgrass (Panicum vigratum, L.) Delivery to a Biorefinery using Integrated Biomass Supply Analysis and Logistics (IBSAL) Model.” Science Direct. Bioresource Technology 98:1033-1044.

Lambert, D. and J. Middleton. 2010. “Logistical Design of a Regional Herbaceous Crop Residue-Based Ethanol Production Complex.” Biomass and Bioenergy 34:91-100.

Lang, Brian. December 2002. “Estimating the Nutrient Value in Corn and Soybean Stover.” Iowa State University – University Extension. Fact Sheet BL-112.

Larson, J., B. English, C. Hellwinkel, D. de la Torre Ugarte, and M. Walsh. 2005. “A Farm-level Evaluation of Conditions under which Farmers will Supply Biomass Feedstocks for Energy Production.” Selected Paper Prepared for the American Agricultural Economics Associations Annual Meeting, Providence, RI, July 24-27, 2005.

Leistritz, F., D. Senechal, M. Stowers, W. McDonald, C. Saffron, and N. Hodur. August 2006. “Preliminary Feasibility Analysis for an Integrated Biomaterials and Ethanol Biorefinery Using Wheat Straw Feedstock.” Department of Agribusiness and Applied Economics, North Dakota State University. Agribusiness & Applied Economics Report No. 590.

Lemus, R., E. Brummer, K. Moore, N. Molstad, C. Burras, and M. Barker. 2002. “Biomass Yield and Quality of 20 Switchgrass Population sin Southern Iowa, USA.” Biomass and Bioenergy 23: 433-442.

Lewandowski, I., J. Clifton-Brown, J. Scurlock, and W. Huisman. 2000. “Miscanthus: European Experience with a Novel Energy Crop.” Biomass and Bioenergy19: 209-227.

Lewandowski, I., J. Scurlock, E. Lindvall, and M. Christou. 2003. "The Development and Current Status of Perennial Rhizomatous Grasses as Energy Crops in the US and Europe." Biomass and Bioenergy 25:335-361

Mapemba, L., F. Epplin, C. Taliaferro, and R. Huhnke. 2007. "Biorefinery Feedstock Production on Conservation Reserve Program Land." Review of Agricultural Economics 29:227-246.

Mapemba, LD, FM Epplin, RL Huhnke, CM Taliaferro. 2008. "Herbaceous Plant Biomass Harvest and Delivery Cost with Harvest Segmented by Month and Number of Harvest Machines Endogenously Determined." Biomass and Bioenergy. doi:10.1016/j.biombioe.2008.02.003

Marshall, L. and Z. Sugg. April 2010. "Fields of Fuel: Market and Environmental Implications of Switching to Grass for U.S. Transport." World Resources Institute, WRI Policy Note, Energy: Biofuels.

McAloon, A., Taylor, F., Yee, W., Ibsen, K. and R. Wooley. October 2000. "Determining the Cost of Producing Ethanol from Corn Starch and Lignocellulosic Feedstocks." U.S. Department of Agriculture and U.S. Department of Energy. NREL/TP-580-28893.

McCarl, B. X. Villavicencio, and X. Wu. 2008. "Climate Change and Future Analysis: Is Stationary Dying." American Journal of Agricultural Economics 90(50): 1241-1247.

McLaughlin, S. B. and L. A. Kszos. 2005. "Development of Switchgrass (Panicum virgatum) as a Bioenergy Feedstock in the United States." Biomass and Bioenergy 28:515-535.

McLaughlin, S. B., D. G. de la Torre Ugarte, C. T. Garten, Jr., L. R. Lynd, M. A. Sanderson, V. R. Tolbert, and D. D. Wolf. 2002. "High-value Renewable Energy from Prairie Grasses." Environ. Sci. Technol 36:2122-2129.

McLaughlin, S., J. Kiniry, C. Taliaferro, and D. de la Torre Ugarte. 2006. "Projecting Yield and Utilization Potential of Switchgrass as an Energy Crop." Advances in Agronomy 90.

Miller, R. and B. Bender. 2008. "Growth and Yield of Poplar and Willow Hybrids in the Central Upper Peninsula of Michigan," in Biofuels, Bioenergy, and Biproducts from Sustainable Agricultural and Forest Crops: Proceedings of the Short Rotation Crops International Conference, August 19-20, 2008, Bloomington, MN. Editors: R. Zalesny, R. Mitchell, and J. Richardson. Gen. Tech. Rep. NRS-P-31. U.S. Department of Agriculture, Forest Service.

Miranowski, J. and A. Rosburg. 2010a. "An Economic Breakeven Model of Cellulosic Feedstock and Ethanol Conversion with Implied Carbon Pricing." Iowa State University, Department of Economics Working Paper. http://www.econ.iastate.edu/research/working-papers/p10920

Monti, A., S. Fazio, and G. Venturi. 2009. "The Discrepancy between Plot and Field Yields: Harvest and Storage Losses of Switchgrass." Biomass and Bioenergy 33:841-847.

Mooney, D., R. Roberts, B. English, D. Tyler, and J. Larson. 2008. "Switchgrass Production in Marginal Environments: A Comparative Economic Analysis across Four West Tennessee Landscapes." Selected Paper Presented at the 2008 Annual Meeting of the American Agricultural Economics Association (AAEA), July 2008, Orlando, FL.

Mooney, D., R. Roberts, B. English, D. Tyler, and J. Larson. 2009. "Yield and Breakeven Price of 'Alamo' Switchgrass for Biofuels in Tennessee." Agronomy Journal 101(5):1234-1242.

Morrow, W., W. Griffin, and H. Matthews. 2006. "Modeling Switchgrass Derived Cellulosic Ethanol Distribution in the United States." Environmental Science & Technology 40(9).

Muir, J., M. Sanderson, W. Ocumpaugh, R. Jones, and R. Reed. 2001. "Biomass Production of 'Alamo' Switchgrass in Response to Nitrogen, Phosphorus, and Row Spacing. Agronomy Journal 93:896-901.

Nelson, R., J. Ascough, and M. Langemeier. 2006. "Environmental and Economic Analysis of Switchgrass Production for Water Quality Improvement in Northeast Kansas." Journal of Environmental Management79:336-347.

Ocumpaugh, W., M. Hussey, J. Read, J. Muir, F. Hons, G. Evers, K. Cassida, B. Venuto, J. Grichar, and C. Tischler. 2003. “Evaluation of Switchgrass Cultivars and Cultural Methods for Biomass Production in the South Central U.S.” Report for U.S. Department of Energy, Office of Biomass. ORNL/SUB-03-19SXY091C/01.

Parker, N., P. Tittmann, Q. Hart, R. Nelson, K. Skog, A. Schmidt, E. Gray, and B. Jenkins. 2010. “Development of a Biorefinery Optimized Biofuel Supply Curve for the Western United States.” Biomass and Bioenergy doi:10.1016/j.biombioe.2010.06.007

Perez-Verdin, G., D. Grebner, C. Sun, I. Munn, E. Schultz, and T. Matney. 2009. “Woody Biomass Availability for Bioethanol Conversion in Mississippi.” Biomass and Bioenergy 33: 492-503.

Perlack, R. and R. Hess. 2006. “Biomass Resources for Liquid Fuels Production.” 28th Symposium on Biotechnology for Fuels and Chemicals. Nashville, TN, April 30-May 3, 2006.

Perlack, R. and A. Turhollow. 2002. “Assessment of Options for the Collection, Handling, and Transport of Corn Stover.” Oak Ridge National Laboratory. ORNL/TM-2002/44.

Perlack, R. and A. Turhollow. 2003. “Feedstock Cost Analysis of Corn Stover Residues for Further Processing.” Energy 28:1395-1403.

Perlack, R., L. Wright, A. Turhollow, R. Graham, B. Stokes, and D. Erbach. April 2005. “Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply.” U.S. Department of Energy and U.S. Department of Agriculture. Prepared by the Oakridge National Laboratory.

Perrin, R., K. Vogel, M. Schmer, and R. Mitchell. 2008. “Farm-Scale Production Cost of Switchgrass for Biomass.” BioEnergy Research 1: 91-97.

Petrolia, DR. July 2008. “The Economics of Harvesting and Transporting Corn Stover to Fuel Ethanol: A Case Study for Minnesota.” Biomass and Bioenergy 32(7):603-612.

Popp, M. and R. Hogan, Jr. 2007. “Assessment of Two Alternative Switchgrass Harvest and Transport Methods.” Farm Foundation Conference Paper. St. Louis, Missouri, April 12-13.

Prewitt, R. M. Montross, S. Shearer, T. Stombaugh, S. Higgins, S. McNeill, and S. Sokhansanj. 2007. “Corn Stover Availability and Collection Efficiency Using Typical Hay Equipment.” Transactions of the ASABE 50:705-711.

Puttock, G. 1995. “Estimating Cost for Integrated Harvesting and Related Forest Management Activities.” Biomass and Bioenergy 8(2): 73-79.

Pyter, R., T. Voigt, E. Heaton, F. Dohleman, and S. Long. 2007. “Giant Miscanthus: Biomass Crop for Illinois,” in Issues in New Crops and New Uses, J. Janick and A. Whipkey (eds.). ASHS Press, Alexandria, VA.

Quick, G. February 2003. “Single-Pass Corn and Stover Harvesters: Development and Performance.” Proceedings of the International Conference on Crop Harvesting and Processing February 2003. ASAE Publication Number 701P1103e.

Rahmani, M. and A. Hodges. 2006. “Potential Feedstock Sources for Ethanol Production in Florida.” University of Florida – IFAS Extension, FE650.

Reijnders, L. 2010. “Transport Biofuel Yields from Food and Lignocellullosic C4 Crops.” Biomass and Bioenergy 34: 152-155. Short Communication.

Reynolds, J., C. Walker, and M. Kirchner. 2000. “Nitrogen Removal in Switchgrass Biomass Under Two Harvest Systems.” Biomass and Bioenergy 19: 281-286.

Rosburg, A. and J. Miranowski. 2010. "An Introduction to the Biofuel Breakeven Program (BIOBREAK) with an Application to the Cellulosic Ethanol Market." Iowa State University, Department of Economics, Working Paper.

Rosburg, A., J. Miranowksi, and J. Aukayanagul. 2011. “Alleviating Biofuel Land Use and GHG Impacts through Corn Yield Growth.” Iowa State University, Department of Economics Working Paper.

Sanderson, M. 2008. “Upland Switchgrass Yield, Nutritive Value, and Carbon Changes under Grazing and Clipping.” Agronomy Journal 100(3): 510-516.

Sandor, D., R. Wallace, and S. Peterson. April 2008. “Understanding the Growth of the Celluosic Ethanol Industry.” National Renewable Energy Laboratory, Technical Report NREL/TP-150-42120.

Schechinger, T. and J. Hettenhaus. April 2004. “Corn Stover Harvesting: Grower, Custom Operator, and Processor Issues and Answers.” Oak Ridge National Laboratory. ORNL/SUB-04-4500008274-01.

Schlenker, W. and M. Roberts. “Nonlinear Effects of Weather on Corn Yields.” Review of Agricultural Economics 28(3): 391-398.

Schmer, M., K. Vogel, R. Mitchell, L. Moser, K. Eskridge, and R. Perrin. 2006. “Establishment Stand Thresholds for Switchgrass Grown as a Bioenergy Crop.” Crop Science 46:157-161.

Seabra, J., L. Tao, H. Chum, and I. Macedo. 2010. “A Techno-Economic Evaluation of the Effects of Centralized Cellulosic Ethanol and Co-Products Refinery Options with Sugarcane Mill Clustering.” Biomass and Bioenergy. doi:10.1016/j.biombioe.2010.01.042

Sheehan, J., A. Aden, K. Paustian, K. Killian, J. Brenner, M. Walsh, and R. Nelson. 2004. “Energy and Environmental Aspects of Using Corn Stover for Fuel Ethanol.” Journal of Industrial Ecology 7(3-4): 117 - 146.

Shinners, K., G. Boettcher, R. Muck, P. Wimer, and M. Caser. July 2006. “Drying, Harvesting and Storage Characteristics of Perennial Grasses as Biomass Feedstocks.” 2006 ASABE Annual International Meeting. Paper Number: 061012.

Skog, K, J. Barbour, K. Abt, E. Bilek, F. Burch, R. Fight, R. Hugget, P. Miles, E. Reinhardt, and W. Shepperd. 2006. “Evaluation of Silvicultural Treatments and Biomass Use for Reducing Fire Hazard in Western States.” Research Paper FPL-RP-634. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Smeets, E., I. Lewandowski, and A. Faaij. 2009. “The Economical and Environmental Performance of Miscanthus and Switchgrass Production and Supply Chains in a European Setting.” Renewable and Sustainable Energy Reviews 13:1230-1245.

Smith, W., J. Vissage, D. Darr, and R. Sheffield. 2001. “Forest Resources of the United States, 1997.” General Technical Report NC-219. St. Paul, MN: U.S. Dept. of Agriculture, Forest Service, North Central Research Station.

Sohngen, B, Anderson, J., Petrova, S., and Goslee, K. March 2010. “Alder Springs Biomass Removal Economic Analysis.” Report to USFS under #06-JV-11272164-071

Sokhansanj, Shahab and Anthony Turhollow. September 2002. “Baseline Cost for Corn Stover Collection.” Applied Engineering in Agriculture 18(5):525-530.

Sokhansanj, S., S. Mani, S. Tagore, and A. Turhollow. 2010. “Techno-Economic Analysis of using Corn Stover to Supply Heat and Power to a Corn Ethanol Plant – Part 1: Cost of Feedstock Supply Logistics.” Biomass and Bioenergy 34:75-81.

Solomon, B., J. Barnes, and K. Halvorsen. 2007. “Grain and Cellulosic Ethanol: History, Economics, and Energy Policy.” Biomass and Bioenergy 31: 416-425.

Song, F., J. Zhao, and S. Swinton. 2009. “Switching to Perennial Energy Crops under Uncertainty and Costly Reversibility.” Michigan State University, Department of Agricultural, Food, and Resource Economics. Staff Paper 2009-14.

Stampfl, P., J. Clifton-Brown, and M. Jones. 2007. "European-wide GIS-based Modelling System for Quantifying the Feedstock from Miscanthus and the Potential Contribution to Renewable Energy Targets." Global Change Biology 13:2283-2295.

Swayze, S. January 11, 2007. "Biofuels: Growing Energy." Ceres Presentation.

Taliaferro, C. 2002. "Breeding and Selection of New Switchgrass Varieties for Increased Biomass Production." Report for U.S. Department of Energy, Office of Biomass. ORNL/SUB-02-19XSY162C/01.

Tannura, M., S. Irwin, and D. Good. 2008a. "Are Corn Trends Yields Increasing at a Faster Rate?" University of Illinois at Urbana-Champaign, Department of Agricultural and Consumer Economics. Marketing & Outlook Briefs. MOBR 08-02.

Tannura, M., S. Irwin, and D. Good. 2008b. "Weather, Technology, and Corn and Soybeans Yields in the U.S. Corn Belt." University of Illinois at Urbana-Champaign, Department of Agricultural and Consumer Economics. Marketing & Outlook Research Projects. http://www.farmdoc.uiuc.edu/marketing/morr/morr_archive.html

Thomason, W., W. Raun, G. Johnson, C. Taliaferro, K. Freeman, K. Wynn., and R. Mullen. 2005. "Switchgrass Response to Harvest Frequency and Time and Rate of Applied Nitrogen." Journal of Plant Nutrition 27:1199-1226.

Tiffany, D., B. Jordan, E. Dietrich, and B. Vargo-Daggett. June 2006. "Energy and Chemicals form Native Grasses: Production, Transportation and Processing Technologies Considered in the Northern Great Plains." Department of Applied Economics. College of Food, Agricultural and Natural Resource Sciences, University of Minnesota. Staff Paper P06-11.

Tweeten, L. and S. Thompson. December 2009. "Long-term Global Agricultural Output Supply-Demand Balance and Real Farm and Food Prices." Departmet of Agricultural, Environmental, and Development Economics Working Paper. The Ohio State Unversity. AEDE-WP 0044-08.

Tyner, W., S. Brechbill, and D. Perkis. October, 2010. "Cellulosic Ethanol: Feedstocks, Conversion Technologies, Economics, and Policy Options." CRS Report for Congress. Coordinator: Randy Schnepf. R41460.

United States Department of Agriculture, Forest Services. April 2003. "A Strategic Assessment of Forest Biomass and Fuel Reduction Treatments in Western States." http://www.fs.fed.us/research/pdf/Western_final.pdf

United States Department of Agriculture, Forest Services. March 2005. "A Strategic Assessment of Forest Biomass and Fuel Reduction Treatments in Western States." http://www.fs.fed.us/rm/pubs/rmrs_gtr149.pdf

Vadas, P., K. Barneet, and D. Undersander. March 2008. "Economics of Ethanol Prodcution from Alfalfa, Corn and Switchgrass in the Upper Midwest, USA." BioEnergy Research 1:44-55.

Vargas, L., M. Andersen, C. Jensen, and U. Jorgensen. 2002. "Estimation of Leaf Area Index, Light Interception and Biomass Accumulation of Miscanthus Sinensis 'Goliath' from Radiation Measurements." Biomass and Bioenergy 22:1-14.

Vogel, K., J. Brejda, D. Walters, and D. Buxton. 2002. "Switchgrass Biomass Production in the Midwest USA: Harvest and Nitrogen Management." Agronomy Journal 94:413-420.

Wallace, R., K. Ibsen, A. McAloon, and W. Yee. January 2005. "Feasibility Study for Co-Locating and Integrating Ethanol Production Plants from Corn Starch and Lignocelluosic Feedstocks." United States Department of Agriculture and U.S. Department of Energy. NREL/TP-510-37092. USDA-ARS 1935-41000-055-00D.

Walsh, Marie. "Switchgrass." SunGrant BioWeb. Retrieved February 5, 2008. Last update: May 8, 2008. http://bioweb.sungrant.org/Technical/Biomass+Resources/Agricultural+Resources/New+Crops/Herbaceous+Crops/Switchgrass/Default.htm

Wang, C., J. Larson, B. English, and K. Jensen. 2009. "Cost Analysis of Alternative Harvest, Storage and Transportation Methods for Delivering Switchgrass to a Biorefinery from the Farmers' Perspective." Selected paper prepared for presentation at the Southern Agricultural Economics Association Meeting, Atlanta, Georgia. January 31-February 3, 2009.

Western Governors' Association. January 2008. "Transportation Fuels for the Future – Biofuels: Part I." WGA Biofuels Team – Ethanol, Biobutanol and Biomethane.

Wright, L., M. Walsh, M. Downing, et al. 2000. "Biomass Feedstock Research and Development for Multiple Products in the United States." First World Conference and Exhibition on Biomass for Energy and Industry. Sevilla, Spain. Cited in Jenkins et al. (2009).

Wyman, C. 2009. "Biomass Ethanol: Technical Progress, Opportunities, and Commercial Challenges." Annual Review of Energy and the Environment 24: 189-226.

Yu, T. October 4, 2010. "Weather Effects on Trend, Variance and Distribution of Corn Yield." Agricultural Economics Workshop, Department of Economics, Iowa State University.

Additional Information

Table A – Acreage Literature

Table A – Acreage Estimates						
Source	Crop	Year	Value	Unit	Location	Assumption
ALTF (2009)	Biomass	2008	6.0-12	mil acres	US	Acreage values used to derived estimated biomass supply
ALTF (2009)	Biomass	2020	8.0-16	mil acres	US	Acreage values used to derived estimated biomass supply
Parker et al. (2010)	Canola	2016	10.60%		West	Acreage increase projection for 2015/2016 relative to 2006/2007
de la Torre Ugarte et al. (2009)	Corn	2025	90.5	mil acres	USA	Baseline
de la Torre Ugarte et al. (2009)	Corn	2025	89.3	mil acres	USA	Multiple Offsets/RCN
de la Torre Ugarte et al. (2009)	Corn	2025	90.2	mil acres	USA	EPA Lead
English et al. (2010)	Corn	2025	87.91	mil acres	USA	EISA only
English et al. (2010)	Corn	2025	88.18	mil acres	USA	EISA + Renewable Electricity Standard (RES)
English et al. (2010)	Corn	2025	87.75	mil acres	USA	EISA+RES+CPAY (Carbon payment program)
Hertel et al. (2009)	Corn	2001	6	mil hec	USA	Additional land needed with increase in US corn ethanol production from 6.6 gigaliters to 56.7 gigaliters per year
Hertel et al. (2009)	Corn	2001	36	mil hec	USA	Baseline acreage (use 2001 coarse grain yields)
Parker et al. (2010)	Corn	2016	13.60%		West	Acreage increase projection for 2015/2016 relative to 2006/2007
English et al. (2010)	Cotton	2025	8.57	mil acres	USA	EISA only
English et al. (2010)	Cotton	2025	8.54	mil acres	USA	EISA + Renewable Electricity Standard (RES)
English et al. (2010)	Cotton	2025	7.05	mil acres	USA	EISA+RES+CPAY (Carbon payment program)
de la Torre Ugarte et al. (2009)	Energy Crops	2025	49.5	mil acres	USA	Baseline
de la Torre Ugarte et al. (2009)	Energy Crops	2025	76.4	mil acres	USA	Multiple Offsets/RCN
de la Torre Ugarte et al. (2009)	Energy Crops	2025	66.9	mil acres	USA	EPA Lead
English et al. (2010)	Energy Crops	2025	31.02	mil acres	USA	EISA only
English et al. (2010)	Energy Crops	2025	36.21	mil acres	USA	EISA + Renewable Electricity Standard (RES)
English et al. (2010)	Energy Crops	2025	61.79	mil acres	USA	EISA+RES+CPAY (Carbon payment program)
de la Torre Ugarte et al. (2009)	Hay	2025	75.8	mil acres	USA	Baseline
de la Torre Ugarte et al. (2009)	Hay	2025	91	mil acres	USA	Multiple Offsets/RCN
de la Torre Ugarte et al. (2009)	Hay	2025	85	mil acres	USA	EPA Lead
English et al. (2010)	Hay	2025	61.18	mil acres	USA	EISA only
English et al. (2010)	Hay	2025	61.18	mil acres	USA	EISA + Renewable Electricity Standard (RES)

English et al. (2010)	Hay	2025	61.18	mil acres	USA	EISA+RES+CPAY (Carbon payment program)
Bangsund et al. (2008)	Pasture	2025	355.1	mil acres	USA	Baseline
de la Torre Ugarte et al. (2009)	Pasture	2025	318.7	mil acres	USA	Multiple Offsets/RCN
de la Torre Ugarte et al. (2009)	Pasture	2025	334.2	mil acres	USA	EPA Lead
English et al. (2010)	Pasture	2025	372.11	mil acres	USA	EISA only
English et al. (2010)	Pasture	2025	362.74	mil acres	USA	EISA + Renewable Electricity Standard (RES)
English et al. (2010)	Pasture	2025	328.69	mil acres	USA	EISA+RES+CPAY (Carbon payment program)
English et al. (2010)	Intensive Pasture	2025	11.78	mil acres	USA	EISA only
English et al. (2010)	Intensive Pasture	2025	16.58	mil acres	USA	EISA + Renewable Electricity Standard (RES)
English et al. (2010)	Intensive Pasture	2025	32.29	mil acres	USA	EISA+RES+CPAY (Carbon payment program)
de la Torre Ugarte et al. (2009)	Pasture converted	2025	50.1	mil acres	USA	Baseline
de la Torre Ugarte et al. (2009)	Pasture converted	2025	84.3	mil acres	USA	Multiple Offsets/RCN
de la Torre Ugarte et al. (2009)	Pasture converted	2025	68.8	mil acres	USA	EPA Lead
English et al. (2010)	Rice	2025	2.67	mil acres	USA	EISA only
English et al. (2010)	Rice	2025	2.71	mil acres	USA	EISA + Renewable Electricity Standard (RES)
English et al. (2010)	Rice	2025	2.64	mil acres	USA	EISA+RES+CPAY (Carbon payment program)
de la Torre Ugarte et al. (2009)	Soybeans	2025	65.9	mil acres	USA	Baseline
de la Torre Ugarte et al. (2009)	Soybeans	2025	63	mil acres	USA	Multiple Offsets/RCN
de la Torre Ugarte et al. (2009)	Soybeans	2025	62.9	mil acres	USA	EPA Lead
English et al. (2010)	Soybeans	2025	65.17	mil acres	USA	EISA only
English et al. (2010)	Soybeans	2025	64.43	mil acres	USA	EISA + Renewable Electricity Standard (RES)
English et al. (2010)	Soybeans	2025	62.25	mil acres	USA	EISA+RES+CPAY (Carbon payment program)
Parker et al. (2010)	Soybeans	2016	7.90%		West	Acreage increase projection for 2015/2016 relative to 2006/2007
Graham et al. (1995)	Switchgrass		200	mil acres	N. Central	Scenarios: 2000, 2005, 2020
Graham et al. (1995)	Switchgrass		36	mil acres	Northeast	Scenarios: 2000, 2005, 2020
Graham et al. (1995)	Switchgrass		64	mil acres	S. Central	Scenarios: 2000, 2005, 2020
Graham et al. (1995)	Switchgrass		22	mil acres	Southeast	Scenarios: 2000, 2005, 2020
de la Torre Ugarte et al. (2009)	Wheat	2025	52	mil acres	USA	Baseline
de la Torre Ugarte et al. (2009)	Wheat	2025	50.8	mil acres	USA	Multiple Offsets/RCN
de la Torre Ugarte et al. (2009)	Wheat	2025	50.5	mil acres	USA	EPA Lead
English et al. (2010)	Wheat	2025	51.47	mil acres	USA	EISA only
English et al. (2010)	Wheat	2025	49.92	mil acres	USA	EISA + Renewable Electricity Standard (RES)
English et al. (2010)	Wheat	2025	46.45	mil acres	USA	EISA+RES+CPAY (Carbon payment program)

English et al. (2010)	Wood - energy crops	2025	7.72	mil acres	USA	EISA only
English et al. (2010)	Wood - energy crops	2025	9.34	mil acres	USA	EISA + Renewable Electricity Standard (RES)
English et al. (2010)	Wood - energy crops	2025	10.47	mil acres	USA	EISA+RES+CPAY (Carbon payment program)
Graham et al. (1995)	Poplar		177	mil acres	N. Central	Scenarios: 2000, 2005, 2020
Graham et al. (1995)	Poplar		41	mil acres	S. Central	Scenarios: 2000, 2005, 2020
Graham et al. (1995)	Poplar		22	mil acres	Southeast	Scenarios: 2000, 2005, 2020
Graham et al. (1995)	Willow		36	mil acres	Northeast	Scenarios: 2000, 2005, 2020

Table B – Crop Production Literature

Table B – Crop Production Estimates						
Source	Crop	Year	Value	Unit	Location	Assumption
Perlack et al. (2005)	Ag and forest	2030	1366	mil dt/yr	US	Projection
Perlack et al. (2005)	Agriculture	2030	998	mil dt/yr	US	Projection; all other available residues were utilized
Sandor et al. (2008)	Ag residues	2017	23	mil dt/yr		Base case
Sandor et al. (2008)	Ag residues	2017	27	mil dt/yr		Grower payment scenario
Sandor et al. (2008)	Ag residues	2017	52	mil dt/yr		Production subsidy scenario
Sandor et al. (2008)	Ag residues	2017	38	mil dt/yr		Capital cost reduction scenario
Sandor et al. (2008)	Ag residues	2017	72	mil dt/yr		Grower payment + capital cost reduction scenario
Sandor et al. (2008)	Ag residues	2017	106	mil dt/yr		Production subsidy + capital cost reduction scenario
BRDI (2008b)	Barley	05-07	5.7	mil t/yr		03-07 "Olympic Average" yield x 05-07 average acres planted
Sandor et al. (2008)	Biomass	2017	30-146	mil dt/yr		Potential biomass to support cellulosic ethanol production volumes
Sandor et al. (2008)	Biomass	2017	26	mil dt/yr		Base case
Sandor et al. (2008)	Ag & forest residues, SG	2017	26	mil dt/yr		Base case
Sandor et al. (2008)	Ag & forest residues, SG	2017	30	mil dt/yr		Grower payment scenario
Sandor et al. (2008)	Ag & forest residues, SG	2017	66	mil dt/yr		Production subsidy scenario
Sandor et al. (2008)	Ag & forest residues, SG	2017	44	mil dt/yr		Capital cost reduction scenario
Sandor et al. (2008)	Ag & forest residues, SG	2017	95	mil dt/yr		Grower payment + capital cost reduction scenario
Sandor et al. (2008)	Ag & forest residues, SG	2017	146	mil dt/yr		Production subsidy + capital cost reduction scenario
BRDI (2008b)	Corn	05-07	355.2	mil t/yr		03-07 "Olympic Average" yield x 05-07 average acres planted
ALTF (2009)	Energy crops	2008	104	mil t/yr	US	Potential biomass for biofuel; 2/3 of suitable CRP land in dedicated fuel production

ALTF (2009)	Energy crops	2020	164	mil t/yr	US	Biomass that could be produced for biofuel
Hettenhaus (2006)	Feedstock		5.4	mil dt	Corn Belt	Produced (50-mile radius), dry land
Hettenhaus (2006)	Feedstock		1.8	mil dt	Corn Belt	Available with current tillage practice (50-mile radius), dry land
Hettenhaus (2006)	Feedstock		3.6	mil dt	Corn Belt	Available with no-till (50-mile radius), dry land
Hettenhaus (2006)	Feedstock		5.4	mil dt	Corn Belt	Produced (50-mile radius), 50% Irrigated
Hettenhaus (2006)	Feedstock		0.6	mil dt	Corn Belt	Available with current tillage practice (50-mile radius), 50% irrigated
Hettenhaus (2006)	Feedstock		3.6	mil dt	Corn Belt	Available with no-till (50-mile radius), 50% irrigated
Hettenhaus (2006)	Feedstock		5.4	mil dt		Produced (50-mile radius), dry land
Hettenhaus (2006)	Feedstock		0	mil dt		Available with current tillage practice (50-mile radius), dry land
Hettenhaus (2006)	Feedstock		2.1	mil dt		Available with no-till (50-mile radius), dry land
BRDI (2008b)	Forest residues		101	mil t/yr		Cite Perlack et al., 2005
BRDI (2008b)	Grain sorghum	05-07	12.4	mil t/yr		03-07 "Olympic Average" yield x 05-07 average acres planted
Perlack et al. (2005)	Grains	2030	84	mil dt/yr	US	Projection
ALTF (2009)	Hay	2008	15	mil t/yr	US	Estimated amount available for biofuel
ALTF (2009)	Hay	2020	18	mil t/yr	US	Estimated amount available for biofuel
Parker et al. (2010)	Lignocellulosic resources		82.5	dMt	West	Available at $33 per dry Mt (field, forest plot or municipal recovery)
Gan and Smith (2006)	Logging residues		36.2	mil odMt	US	Estimated recoverable (cited BRDI 2008)
Smith et al. (2001)	Logging residues		47	mil odMt	US	Estimated availability (cited BRDI 2008)
Perlack et al. (2005)	Manure, residue, other	2030	106	mil dt/yr	US	Projection; All excess manure used for biofuel
BRDI (2008b)	Municipal soild waste		14	mil t/yr		
Perlack et al. (2005)	Perennial crops	2030	377	mil dt/yr	US	Projection; 75% annual crop recovery if sustainable; 55 mil acres
BRDI (2008b)	Primary mill residues		1.3	mil t/yr		
Gallagher et al. (2003a)	Residues	1997	2130	mil lbs	CO	Total residue production
Gallagher et al. (2003a)	Residues	1997	24518	mil lbs	KS	Total residue production
Gallagher et al. (2003a)	Residues	1997	5471	mil lbs	MN	Total residue production
Gallagher et al. (2003a)	Residues	1997	7622	mil lbs	MT	Total residue production
Gallagher et al. (2003a)	Residues	1997	3447	mil lbs	NE	Total residue production
Gallagher et al. (2003a)	Residues	1997	20464	mil lbs	ND	Total residue production
Gallagher et al. (2003a)	Residues	1997	2825	mil lbs	OK	Total residue production
Gallagher et al. (2003a)	Residues	1997	4563	mil lbs	SD	Total residue production
Gallagher et al. (2003a)	Residues	1997	81040	mil lbs	G. Plains	Total residue production
Gallagher et al. (2003a)	Residues	1997	1223	mil lbs	CO	Net residue supply (total less forage demand)
Gallagher et al. (2003a)	Residues	1997	19433	mil lbs	KS	Net residue supply (total less forage demand)

Gallagher et al. (2003a)	Residues	1997	5470	mil lbs	MN	Net residue supply (total less forage demand)
Gallagher et al. (2003a)	Residues	1997	6896	mil lbs	MT	Net residue supply (total less forage demand)
Gallagher et al. (2003a)	Residues	1997	2098	mil lbs	NE	Net residue supply (total less forage demand)
Gallagher et al. (2003a)	Residues	1997	30343	mil lbs	ND	Net residue supply (total less forage demand)
Gallagher et al. (2003a)	Residues	1997	1174	mil lbs	OK	Net residue supply (total less forage demand)
Gallagher et al. (2003a)	Residues	1997	4405	mil lbs	SD	Net residue supply (total less forage demand)
Gallagher et al. (2003a)	Residues	1997	71042	mil lbs	G. Plains	Net residue supply (total less forage demand)
Perlack et al. (2005)	Residues - crop	2030	428	mil dt/yr	US	Projection; corn, wheat, and other small grain yields increased by 50%
Gallagher et al. (2003b)	Residues - crop	1997	207199	mil lbs	Corn Belt	Net residue production (crop residues)
Gallagher et al. (2003b)	Residues - crop	1997	81040	mil lbs	G. Plains	Net residue production (crop residues)
Gallagher et al. (2003b)	Residues - crop	1997	7377	mil lbs	W. Coast	Net residue production (crop residues)
Gallagher et al. (2003b)	Residues - crop (rice)	1997	10435	mil lbs	Delta	Net residue production (crop residues)
Gallagher et al. (2003b)	Residues - crop (sugar bagasse)	1997	7114	mil lbs	Southeast	Net residue production (crop residues)
Gallagher et al. (2003b)	Residues - crop	1997	313165	mil lbs	US	Net residue production (crop residues); total from all regions
BRDI (2008b)	Soybeans	05-07	91	mil t/yr		03-07 "Olympic Average" yield x 05-07 average acres planted
ALTF (2009)	Stover	2008	76	mil t/yr	US	Estimated amount for biofuel
ALTF (2009)	Stover	2020	112	mil t/yr	US	Estimated amount for biofuel
BRDI (2008b)	Stover	05-07	254	mil dt/yr		Yield per acre x acres planted (2005-2007 average)
Gallagher et al. (2003a)	Stover	1997	52370.5	mil lbs	IL	State yield assumptions in "yields" table
Gallagher et al. (2003a)	Stover	1997	25149.8	mil lbs	IN	State yield assumptions in "yields" table
Gallagher et al. (2003a)	Stover	1997	44741.2	mil lbs	IA	State yield assumptions in "yields" table
Gallagher et al. (2003a)	Stover	1997	9105.7	mil lbs	KS	State yield assumptions in "yields" table
Gallagher et al. (2003a)	Stover	1997	27413.1	mil lbs	MN	State yield assumptions in "yields" table
Gallagher et al. (2003a)	Stover	1997	7403.2	mil lbs	MO	State yield assumptions in "yields" table
Gallagher et al. (2003a)	Stover	1997	22930.8	mil lbs	NE	State yield assumptions in "yields" table
Gallagher et al. (2003a)	Stover	1997	13495.7	mil lbs	OH	State yield assumptions in "yields" table
Gallagher et al. (2003a)	Stover	1997	8295.3	mil lbs	SD	State yield assumptions in "yields" table
Gallagher et al. (2003a)	Stover	1997	10667.66	mil lbs	WI	State yield assumptions in "yields" table
Gallagher et al. (2003a)	Stover	1997	207198.5	mil lbs	Corn Belt	Yield assumptions in "yields" table
Gallagher et al. (2003a)	Stover	1997	52370.5	mil lbs	IL	Net supply for industrial processing (total less forage demand)
Gallagher et al. (2003a)	Stover	1997	25249.8	mil lbs	IN	Net supply for industrial processing (total less forage demand)
Gallagher et al. (2003a)	Stover	1997	42030.2	mil lbs	IA	Net supply for industrial processing (total less forage demand)
Gallagher et al. (2003a)	Stover	1997	4369.4	mil lbs	KS	Net supply for industrial processing (total less forage demand)

Gallagher et al. (2003a)	Stover	1997	27413.1	mil lbs	MN	Net supply for industrial processing (total less forage demand)
Gallagher et al. (2003a)	Stover	1997	2355.9	mil lbs	MO	Net supply for industrial processing (total less forage demand)
Gallagher et al. (2003a)	Stover	1997	15367.7	mil lbs	NE	Net supply for industrial processing (total less forage demand)
Gallagher et al. (2003a)	Stover	1997	13495.7	mil lbs	OH	Net supply for industrial processing (total less forage demand)
Gallagher et al. (2003a)	Stover	1997	7171.3	mil lbs	SD	Net supply for industrial processing (total less forage demand)
Gallagher et al. (2003a)	Stover	1997	8030.8	mil lbs	WI	Net supply for industrial processing (total less forage demand)
Gallagher et al. (2003a)	Stover	1997	197884.4	mil lbs	Corn Belt	Net supply for industrial processing (total less forage demand)
Banowetz et al. (2008)	Straw	2004	6.5	Mt	ID, OR, WA	Production at current yields in excess of conservation needs
Banowetz et al. (2008)	Straw	2004	2.4	Mg/ha	ID, OR, WA	Average density
Banowetz et al. (2008)	Straw	2004	5.87	Mt	ID	Total straw production from cereal grain using 2004 grain yields
Banowetz et al. (2008)	Straw	2004	2.33	Mt	OR	Total straw production from cereal grain using 2004 grain yields
Banowetz et al. (2008)	Straw	2004	6.87	Mt	WA	Total straw production from cereal grain using 2004 grain yields
Banowetz et al. (2008)	Straw	2004	2.34	Mt	ID	Available straw from cereal grain (total - soil residue requirement)
Banowetz et al. (2008)	Straw	2004	0.69	Mt	OR	Available straw from cereal grain (total - soil residue requirement)
Banowetz et al. (2008)	Straw	2004	2.69	Mt	WA	Available straw from cereal grain (total - soil residue requirement)
Banowetz et al. (2008)	Straw	2004	0.11	Mt	ID	Total straw production from grass seed using 2004 harvested acreage
Banowetz et al. (2008)	Straw	2004	1.93	Mt	OR	Total straw production from grass seed using 2004 harvested acreage
Banowetz et al. (2008)	Straw	2004	0.2	Mt	WA	Total straw production from grass seed using 2004 harvested acreage
Banowetz et al. (2008)	Straw	2004	0.04	Mt	ID	Available straw from grass seed (total - soil residue requirement)
Banowetz et al. (2008)	Straw	2004	0.88	Mt	OR	Available straw from grass seed (total - soil residue requirement)
Banowetz et al. (2008)	Straw	2004	0.11	Mt	WA	Available straw from grass seed (total - soil residue requirement)
BRDI (2008b)	Sugarbeets	05-07	31.2	mil t/yr		Yield per acre x total acres planted
BRDI (2008b)	Sugarcane	05-07	30.1	mil t/yr		03-07 "Olympic Average" yield x 05-07 average acres planted
NREL (2008)	Switchgrass	2017	3	mil dt/yr		Base case
NREL (2008)	Switchgrass	2017	3	mil dt/yr		Grower payment scenario
NREL (2008)	Switchgrass	2017	8	mil dt/yr		Production subsidy scenario
NREL (2008)	Switchgrass	2017	4	mil dt/yr		Capital cost reduction scenario
NREL (2008)	Switchgrass	2017	8	mil dt/yr		Grower payment + capital cost reduction scenario
NREL (2008)	Switchgrass	2017	14	mil dt/yr		Production subsidy + capital cost reduction scenario
ALTF (2009)	Wheat & grass straw	2008	15	mil t/yr	US	Estimated amount of feedstock that could be produced for biofuel
ALTF (2009)	Wheat & grass straw	2020	18	mil t/yr	US	Estimated amount of feedstock that could be produced for biofuel
BRDI (2008b)	Wheat straw		58	mil t/yr		Wheat straw yield x acres planted. USDA/ERS (2008) data
ALTF (2009)	Wood	2008	110	mil t/yr	US	Estimated wood feedstock that could be produced for biofuel

ALTF (2009)	Wood	2020	124	mil t/yr	US	Estimated wood feedstock that could be produced for biofuel
BRDI (2008b)	Wood		15	mil t/yr		Conventional sources
Skog et al. (2006)	Wood		13	mil odt/yr	West	Estimated recoverable forest biomass (cited in BRDI 2008a)
USDA Forest Service (2005)	Wood		10.4	mil bdMt/yr	West	Estimated recoverable forest biomass (cited in BRDI 2008a)
Perlack et al. (2005)	Wood	2030	368	mil dt/yr	US	Projected potential feedstocks for biofuel; Forestland biomass
Perlack et al. (2005)	Wood	2030	60	mil dt/yr	US	Projected potential feedstocks for biofuel; fuel treatment operations
Perlack et al. (2005)	Wood	2030	52	mil dt/yr	US	Projected potential feedstocks for biofuel; Fuel wood harvest
Perlack et al. (2005)	Wood	2030	64	mil dt/yr	US	Projected potential feedstocks for biofuel; logging residues
Perlack et al. (2005)	Wood	2030	47	mil dt/yr	US	Projected potential feedstocks for biofuel; urban residues
Perlack et al. (2005)	Wood	2030	145	mil dt/yr	US	Projected potential feedstocks for biofuel; Mill residues

Table C – Stover Supply Cost Estimates

Table C – Stover Supply Cost Estimates

Source	Year	Value	Unit	Assumption
Aden (2008)	2007	46	per t	2007$ cost assumption
Aden et al. (2002)	2002	30	per t	2002$ cost assumption
ALTF (2009)	2008	110	per t	Supplier breakeven (delivered and stored) - baseline value
ALTF (2009)	2020	86	per t	Supplier breakeven (delivered and stored) - baseline value
Brechbill and Tyner (2008a)		39-46	per t	Produce, store and transport 30 miles
Brechbill and Tyner (2008b)		36-49	per t	Average production and transport by farm size and equipment
Carolan et al. (2008)	2007	30	per dt	Assumption (07$)
Gallagher et al. (2003b)	1997	42	per t	Value as livestock feed (97$)
Glassner et al. (1998)		23-94	per ha	Farmer payments
Graham et al. (2007)	2002	33	per Mt	Fieldedge (02$)
Graham et al. (2007)	2002	25-40	per t	Fieldside cost (2002$)
Huang et al. (2009)		56	per dMt	Delivered cost
Khanna (2008)		93-111	per Mt	Breakeven (low-high)
Larson et al. (2005)	77-01	29	per dt	77-01 mean crop price
McAllon et al. (2000)		35	per dt	Assumption
Miranowski and Rosburg (2010)	2007	113	per t	Midwest supplier breakeven (delivered and stored)
Perlack and Turhollow (2002)		44-49	per dt	Collect, store, haul
Perlack and Turhollow (2003)		43-52	per dt	Collect, store, haul (conventional baling)
Petrolia (2008)		60-93	per Mg	Marginal feedstock cost (refinery)

Petrolia (2008)		57	per Mg	Mean marginal feedstocks cost
Sheehan et al. (2004)		46-66	per dMt	First plant to last 10 plants
Sokhansanj et al. (2010)		73-84	per Mg	Delivered cost (bales - chopped)
Tyner et al. (2010)		50-70	per dt	Farm gate
Tyner et al. (2010)	--	50-70	per dt	"Best-Guess" estimates of farmgate costs
Vadas et al. (2008)		22, 33, 44	per Mg	Assumed delivered prices
Wallace et al. (2005)		40	per bdt	
Erickson and Tyner (2010)		40-120	per dt	Cobs only; Range for analysis ($20 intervals)
Rosburg and Miranowski (2010)	2007	113	per t	Midwest supplier breakeven (delivered and stored); from continuous corn
Rosburg and Miranowski (2010)	2007	86	per t	Midwest supplier breakeven (delivered and stored); from continuous corn

Table D – Miscanthus Supply Cost Estimates

Table D – Miscanthus Supply Cost Estimates				
Source	Year	Value	Unit	Assumption
ALTF (2009)	2008	123	per t	Supplier breakeven (delivered and stored) - baseline value
ALTF (2009)	2020	101	per t	Supplier breakeven (delivered and stored) - baseline value
Jain et al. (2010)		53-153	per dMt	Low cost scenario
Jain et al. (2010)		85-234	per dMt	High cost scenario
James et al. (2010)		60	per Mt	Price assumption from literature
James et al. (2010)		198 (178-218)	per Mg	Breakeven price to replace CC (current)
James et al. (2010)		46 (26-66)	per Mg	Breakeven price to replace CC (future)
Khanna (2008)		93-122	per Mt	Breakeven (low-high)
Khanna et al. (2008)		59	per Mt	Breakeven
Miranowski and Rosburg (2010)	2007	141	per t	Midwest supplier breakeven (delivered and stored)
Miranowski and Rosburg (2010)	2007	115	per t	Appalachian supplier breakeven (delivered and stored)
Rosburg and Miranowski (2010)	2007	110	per t	Midwest high quality land supplier breakeven (delivered and stored)
Rosburg and Miranowski (2010)	2007	114	per t	Midwest low quality land supplier breakeven (delivered and stored)
Rosburg and Miranowski (2010)	2007	102	per t	Appalachian supplier breakeven (delivered and stored)
Tyner et al. (2010)		60-80	per Mg	Farm Gate
Tyner et al. (2010)	--	60-80	per t	"Best-Guess" estimates of farmgate costs

Table E – Switchgrass Supply Cost Estimates

Table E – Switchgrass Supply Cost Estimates					
Source	Year	Value	Unit	Location	Assumption
ALTF (2009)	2008	151	per t		Supplier breakeven (delivered and stored) - baseline value
ALTF (2009)	2020	118	per t		Supplier breakeven (delivered and stored) - baseline value
Babcock et al. (2007)		82-110	per t		Breakeven revenue
Babcock et al. (2007)		38	per t		Processor willingness
Baker et al. (2008)		141-165	per t		Long-run results under varying scenarios
Bangsund et al. (2008)		47-76	per t	ND	Production cost
Brechbill and Tyner (2008a)		57-63	per t		Produce, store and transport 30 miles
Brechbill and Tyner (2008b)		58-71	per t		Average production and transport by farm size and equipment
Brummer et al. (2002)		87-111	per Mt		Cropland; range (no storage to collective storage)
Brummer et al. (2002)		76-105	per Mt		Grassland; range (no storage to collective storage)
Carolan et al. (2008)	2007	30	per dt		Assumption (2007$)
Carpenter and Brees (2008)		86	per t	MO	Production Cost
Cundiff and Harris (1995)		51-59	per dMt		Virginia
De la Torre Ugarte et al. (2003)		30-40	per dt		Assumption
Duffy (2007)		114	per t	IA	Production Cost
Duffy and Nanhou (2002)		54-149	per t	IA	Scenarios - range based on assumptions
Epplin et al. (2007)		36-52	per t	TN	Farm-gate cost
Epplin et al. (2007)		49-64	per t	TN	Delivered Cost
Ferland (2001)		60	per t	GA	Production cost
Fox et al. (1999)		30	per Mt		Literature review
Fox et al. (1999)		27-36	per odMt		Average SG production cost (10 years)
Fox et al. (1999)		25-34	per odMt		Average SG production cost (20 years)
Fox et al. (1999)		73-91	per Mt		Price use hardwood fiber value
Girouard et al. (1999)		38-51	per Mt		Production cost (Canada)
Graham et al. (1995)		52-56	per Mt	N. Central	Region
Green and Benson (2008)		61	per t		Production cost - NC (w/o establishment)
Hallam et al. (2001)		31-387	per Mt		Breakeven price
Huang et al. (2009)		89	per dMt		Cropland; Delivered cost
Huang et al. (2009)		77	per dMt		Grassland; delivered cost
Jain et al. (2010)		88-144	per dMt		Low cost scenario

Jain et al. (2010)		118-188	per dMt		High cost scenario
James et al. (2010)		115 (45-184)	per Mg		Breakeven price to replace CC
James et al. (2010)		60	per Mt		Price assumption from literature
Jiang and Swinton (2008)		91-536	per Mg		Supplier breakeven range
Jiang and Swinton (2008)		19-63	per Mg		Processor breakeven range
Johnson (2006)		30-150	per t		Literature review (production cost)
Khanna (2008)		254-278	per Mt		Breakeven (low-high)
Khanna et al. (2008)		98	per dMt		Farm-gate breakeven (annualized)
Kszos et al. (2002)		35	per dt		Farm-gate price assumption
Kumar and Sokhansanj (2007)		37-48	per dMt		Delivered (does NOT include farming cost or extra payment)
Larson et al. (2005)	77-01	30	per dt		77-01 mean crop price
Marshall and Sugg (2010)	2015	60	per dt		Minimum price needed to jump start switchgrass supply
Marshall and Sugg (2010)	2015	100	per dt		Price to support ethanol industry of 70 BGY (need 153 million acres)
Marshall and Sugg (2010)	2015	65	per dt		Price needed to produce 3.5 BGY (needs 8 million acres of SG land)
McLaughlin and Kszos (2005)		44	per Mg		Farm-gate price - delivered
McLaughlin and Kszos (2005)		54	per Mg		Delivered price
McLaughlin et al. (2002)		30-52	per Mg		Assumptions for POLYSIS
McLaughlin et al. (2006)	2013, 2025	33-66	per Mg		Assumptions (2013 & 2025)
Miranowski and Rosburg (2010)	2007	142	per t	Midwest	Midwest supplier breakeven (delivered and stored)
Miranowski and Rosburg (2010)	2007	110	per t	App	Appalachian supplier breakeven (delivered and stored)
Miranowski and Rosburg (2010)	2007	116	per t	South-Central	South-Central supplier breakeven (delivered and stored)
Mooney et al. (2008)	2004	53	per t	TN	04$
Mooney et al. (2009)		36-114	per dt		Literature review
Mooney et al. (2009)		100	per dt		Price to supply 70 MMGY plant
Mooney et al. (2009)		60	per dt		Price needed to jump-start supply
Morrow et al. (2006)		33, 39, 55	per Mt		Scenarios
Nelson et al. (2006)		25-41	per Mg		Field side breakeven cost; Kansas
Perrin et al. (2008)		42-71	per t	ND, SD, NE, OK	Production cost
Perrin et al. (2008)		66	per Mg		Average production cost (5 years, 10 sites)
Popp and Hogan (2007)		53-61	per dt		Production cost including transport and storage loss
Rosburg and Miranowski (2010)	2007	128	per t	Midwest	Midwest high quality land supplier breakeven (delivered and stored)
Rosburg and Miranowski (2010)	2007	121	per t	Midwest	Midwest low quality land supplier breakeven (delivered and stored)

Rosburg and Miranowski (2010)	2007	96	per t	App	Appalachian supplier breakeven (delivered and stored)
Rosburg and Miranowski (2010)	2007	93	per t	South-Central	South-Central supplier breakeven (delivered and stored)
Smith et al. (2001)		90	per Mt		Round bales delivered (50 miles)
Song et al. (2009)		136	per acre		NPV
Tyner et al. (2010)		65-85	per dt		Farm gate
Tyner et al. (2010)	--	65-85	per t		"Best-Guess" estimates of farm-gate costs
Vadas et al. (2008)		33, 66, 99	per Mg		3 assumed delivered prices
Wang et al. (2009)	2007	68-83	per ton	E. TN	Delivered Cost (delivery immediately after harvest)
Wright et al. (2000)		30-70	per dt	Midwest	Cited in Jenkins et al (2009)
Hallam et al. (2001)	1993	55	per t	IA	1993 hay auctions in Iowa - Switchgrass and Bluestem

Table F – Other Crops Supply Cost Estimates

Table F – Supply Cost Estimates for Other Crops

Source	Type	Year	Value	Unit	Assumption
Hallam et al. (2001)	Alfalfa	1993	65	per t	1993 hay auctions in Iowa
Hallam et al. (2001)	Alfalfa		60-63	per MT	Breakeven price
Rosburg and Miranowski (2010)	Alfalfa	2007	113	per t	Midwest supplier breakeven (delivered and stored)
Vadas et al. (2008)	Alfalfa		93	per Mg	Weighted average of leaf meal and stems
Vadas et al. (2008)	Alfalfa hay		88, 121,154	per Mg	3 price scenarios
Seabra et al. (2010)	Bagasse		0	per dt	Assumption
Gallagher et al. (2003b)	Barley	1997	32	per t	Value as livestock feed (97$)
Busby et al. (2007)	Biomass		20-100	per dt	Literature summary
De la Torre Ugarte et al. (2009)	Biomass		49-61	per dt	Maximum
Hess et al. (2007)	Biomass	2002	37	per dry Mt	Delivered cost (02$)
Lambert and Middleton (2010)	Biomass	2007	98 (78-113)	per Mg	Feed value of AFEX-treated biomass (07$)
Lambert and Middleton (2010)	Biomass		21	per Mg	Marginal value to plant
Mapemba et al. (2007)	Biomass		26-44	per ton	1,000 tons per day; Total cost of delivered feedstock from CRP acres; TEXAS
Mapemba et al. (2007)	Biomass		28-49	per ton	2,000 tons per day; Total cost of delivered feedstock from CRP acres; TEXAS
Mapemba et al. (2007)	Biomass		30-58	per ton	4,000 tons per day; Total cost of delivered feedstock from CRP acres; TEXAS
Mapemba et al. (2008)	Biomass		52	per Mg	Delivered cost
Perlack and Hess (2006)	Biomass		>10-40	per dt	Feedstock cost
Solomon et al. (2007)	Biomass		72	per Mg	Feedstock production cost
Western Governors' Report (2008)	Biomass		13-50	per t	Supply curve range

English et al. (2010)	Biomass	2010-25	45	per dt	EISA - Maximum feedstock price
English et al. (2010)	Biomass	2010-25	50	per dt	EISA+RES - Maximum feedstock price
English et al. (2010)	Biomass	2010-25	51	per dt	EISA+RES+CPAY - Maximum feedstock price
Hettenhaus (2006)	Biomass		18-50	per dt	Previous estimates of delivered feedstock costs
Hettenhaus (2006)	Biomass		50	per dt	baseline case
Jenkins et al. (2009)	Biomass		25 to >115	per t	Literature summary
Sandor et al. (2008)	Biomass		20	per dt	Base case
Sandor et al. (2008)	Biomass		22	per dt	Grower payment scenario
Sandor et al. (2008)	Biomass		31	per dt	Production subsidy scenario
Sandor et al. (2008)	Biomass		28	per dt	Capital cost reduction scenario
Sandor et al. (2008)	Biomass		34	per dt	Grower payment + capital cost reduction scenario
Sandor et al. (2008)	Biomass		39	per dt	Production subsidy + capital cost reduction scenario
Parker et al. (2010)	Biomass		20,30,50	per dmt	Range of biomass prices to estimate Western US supply
de la Torre Ugarte et al (2009)	Biomass	2010-25	49	per dt	Baseline - maximum biomass price for low cost feedstock
de la Torre Ugarte et al (2009)	Biomass	2010-25	49	per dt	Multiple offsets - maximum biomass price for low cost feedstock
de la Torre Ugarte et al (2009)	Biomass	2010-25	59	per dt	Multiple offsets/RCN - maximum biomass price for low cost feedstock
de la Torre Ugarte et al (2009)	Biomass	2010-25	61	per dt	Limited Offsets - maximum biomass price for low cost feedstock
de la Torre Ugarte et al (2009)	Biomass	2010-25	60	per dt	EPA led - maximum biomass price for low cost feedstock
De la Torre Ugarte et al. (2003)	Perennials		40	per dt	Competitive price
McLaughlin et al. (2002)	Perennials		40	per dt	Competitive price
Gallagher et al. (2003a)	Residue	1997	14-30	per t	Price at processing plant (97$)
Gallagher et al. (2003b)	Residue	1997	14-30	per t	Value as livestock feed (97$)
James et al. (2010)	Grasses - mix		60	per Mt	Price assumption from literature
James et al. (2010)	Grasses - mix		132 (44-220)	per Mg	Breakeven price (range) to replace continuous corn
James et al. (2010)	Native Prairie		575 (208-942)	per Mg	Breakeven price (range) to replace continuous corn
ALTF (2009)	Prairie mix	2008	127	per t	Supplier breakeven (delivered and stored) - baseline value
ALTF (2009)	Prairie mix	2020	101	per t	Supplier breakeven (delivered and stored) - baseline value
Miranowski and Rosburg (2010)	Prairie mix	2007	139	per t	Midwest supplier breakeven (delivered and stored)
Rosburg and Miranowski (2010)	Prairie mix	2007	138	per t	Midwest supplier breakeven (delivered and stored)
James et al. (2010)	Prairie mix		60	per Mt	Price assumption from literature
Brummer et al. (2002)	Reed Canarygrass		55-88	per Mt	Farm-gate cost; cropland
Brummer et al. (2002)	Reed Canarygrass		51-79	per Mt	Farm-gate cost; grassland
Hallam et al. (2001)	Reed Canarygrass	1993	60	per t	1993 hay auctions in Iowa

Hallam et al. (2001)	Reed Canarygrass		45-74	per Mt	Breakeven price
James et al. (2010)	Hay (Non-alfalfa)	06-09	110	per MG	06-09 Michigan average
Gallagher et al. (2003b)	Oats	1997	34	per t	Value as livestock feed (97$)
Gallagher et al. (2003b)	Rice	1997	25	per t	Value as livestock feed (97$)
Chen et al. (2010)	Sorghum	2007	145	per t	Observed commodity price (07$)
Chen et al. (2010)	Sorghum	2007	131	per t	Modeled price (2007$)
Gallagher et al. (2003b)	Sorghum	1997	43	per t	Value as livestock feed (97$)
Hallam et al. (2001)	Sorghum		33-42	per Mt	Breakeven price; forage
Rahmani and Hodges (2006)	Sorghum		50-90	per dt	Production cost (Florida); use Hewitt (2006) excel spreadsheet
Rahmani and Hodges (2006)	Sorghum		64	per t	Mean assumption; silage
Rosburg and Miranowski (2010)	Stover/Alfalfa	2007	88	per t	Midwest supplier breakeven (delivered and stored) - rotation
Banowetz et al. (2008)	Straw		45-50	per t	Competing use value
Grant et al. (2006)	Straw	2004	32-42 (60)	per dt	Delivered value (max) in Idaho dairy market
Hess et al. (2007)	Straw	2004	35-46	per Mt	Delivered value (04$); info from straw broker (Duane Grant)
Hess et al. (2007)	Straw		31-66	per Mt	Price to grower (quality and supply); cite straw broker (Duane Grant)
Leistritz et al. (2006)	Straw		40	per t	Supplied to biorefinery
Gallagher et al. (2003b)	Sugarcane	1997	6	per t	Value as livestock feed (97$)
Seabra et al. (2010)	Trash		15	per dt	Assumption
Chen et al. (2010)	Wheat	2007	197	per t	Observed commodity price (07$)
Chen et al. (2010)	Wheat	2007	217	per t	Model (07$)
Del la Torre Ugarte et al. (2009)	Wheat		5.9-7.6	per bu	Different scenarios and years
Elobeid et al. (2007)	Wheat		3.8-4.6	per bu	Baseline to long run solution
Gallagher et al. (2003b)	Wheat	1997	21	per t	Value as livestock feed (97$)
Huang and Khanna (2010)	Wheat	97-07	4.17	per bu	97-07 County-level average
Huang and Khanna (2010)	Wheat	97-07	1.8-8.6	per bu	97-07 County-level range
ALTF (2009)	Wheat Straw	2008	70	per t	Supplier breakeven (delivered and stored) - baseline value
ALTF (2009)	Wheat Straw	2020	55	per t	Supplier breakeven (delivered and stored) - baseline value
Kerstetter and Lyons (2001)	Wheat Straw		35-59	per Mt	Delivered to 20 MMGY plant
Larson et al. (2005)	Wheat Straw	77-01	27	per dt	77-01 mean crop price
Miranowski and Rosburg (2010)	Wheat Straw	2007	74	per t	PNW supplier breakeven (delivered and stored)
Rosburg and Miranowski (2010)	Wheat straw	2007	69	per t	PNW supplier breakeven (delivered and stored)