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Adjusting Crop Insurance APH Calculation to Accommodate Biomass Production

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**Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's
2013 Crop Insurance and the Farm Bill Symposium, Louisville, KY, October 8-9, 2013.**

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Abstract

The United States federal government currently subsidizes crop insurance to provide a safety-net to insured farmers. Agricultural economists have debated indirect impacts of the subsidized crop insurance program on producer behavior. One of those debates surrounds the issue of extensiveness, or if crop insurance encourages the production of certain crops for which insurance is more readily available. The federal government is also fostering an emerging cellulosic bioenergy industry with subsidies for planting perennial grass crops like switchgrass and miscanthus. This article analyzes how the current method for calculating actual production history (APH) may deter producers from planting perennial grasses and penalizes those producers who convert some of their row crop land to perennial grasses. An alternative APH calculation method suggested here would continue to provide a safety-net to producers, reduce indemnity payments by insurance companies, and reduce an impediment to planting perennial grasses. The conclusions are based on a utility-maximizing stochastic budgeting model with actual grain yields and FAPRI baseline prices for a representative farm in northeastern Missouri.

Keywords: Crop Insurance, Bioenergy, Perennial Grasses

JEL Code: D81, Q16, Q18, C15

The federal government has a myriad of policies aimed at supporting agriculture and promoting rural development in the United States, which are primarily implemented through the U.S. Department of Agriculture (USDA). These policies affect decisions producers make and, in turn, their profitability and environmental impact. However, the breadth of goals and policies aimed at achieving those goals means that one policy could override another and at least partially offsets its intended effects. Stimulating the domestic production of renewable energy and providing a safety-net to farmers are two goals to which the federal government is committed. Those seeming unrelated goals both affect planting decisions made by Missouri producers.

Stimulating Production of Perennial Grasses for Renewable Energy

In the 21st century, the United States continues to expand our energy portfolio. The federal government wants to find a mix of sources that meets our demand at competitive prices without depleting natural resources, degrading our environment or exacerbating social problems. Growing cellulosic material or biomass could be an important contributor to energy production in the 21st century. Bioenergy from cellulosic material has gained attention as it can substitute for two of the more controversial energy sources, coal and petroleum. Cellulosic bioenergy relies on renewable resources, can be produced domestically, offers an opportunity to diversify rural economies, and can potentially decrease emissions of greenhouse gases.

Considering that potential, the federal government began implementing policies to develop cellulosic bioenergy. Although policies existed prior to 2007 (Solomon, Barnes,

and Halvorsen 2007), the State of the Union speech, given by President George Bush in that year, urged “setting a mandatory fuel standard to require 35 billion gallons of renewable and alternative fuels in 2017” (Bush 2007). Congress heeded the President’s advice and, later that year, passed the Energy Independence and Security Act establishing the Renewable Fuel Standard (RFS), a mandate for production levels of transportation fuels derived from bio-materials (Schnepf 2011).

Mandated production levels vary for different types of transportation fuels and ramp up between the years 2010 and 2022 (Schnepf 2011). In order to meet their particular mandated levels, two fuels, cellulosic biofuels and advanced biofuels, require cellulosic material to be turned into fuel. Sources of this cellulosic material vary, but perennial grasses including switchgrass and miscanthus are posed to meet at least some of the need for cellulosic material (Khanna, Dhungana, and Clifton-Brown 2008). The mandate for cellulosic ethanol should drive the demand for these grasses motivating farmers to grow them.

To complement the RFS mandate, the USDA implemented policies aimed at stimulating the production of cellulosic bioenergy. One policy, known as the Biomass Crop Assistance Program (BCAP), addresses “the quintessential “chicken and egg” problem—how do you encourage producers to grow cellulosic biomass when there is no existing market for that biomass, and how do you encourage investors to build cellulosic biofuels plants when there is no known existing biomass feedstock supply (Schnepf 2013)?”

BCAP subsidizes the production of cellulosic feedstock directly. It incentivizes producers who are within designated areas and working alongside an aggregator to plant dedicated energy crops by partially offsetting the establishment costs and by making annual rental payments. Currently, there are 11 BCAP areas in 31 states, and the federal government has funded BCAP \$552 million in 2010, \$112 million in 2011, and \$17 million in 2012 (Schnepf 2013).

The federal government has been committed to establishing the cellulosic ethanol sector. RFS and BCAP are two of the policies that have served that goal. Despite them, the industry has fallen short of the mandated amounts forcing revisions in the RFS in 2010 through at least 2012 (Schnepf 2013).

Providing a Farm Safety-Net

Federal government support for crop insurance dates back to the late 1930s. However, during the first 40 years, the government program remained relatively limited (Smith and Glauber 2012). With the passage of the Federal Crop Insurance Act of 1980, crop insurance became increasingly important. Since then, the federal government in the United States has increased the scope of the program allowing the premium subsidy to grow from under \$500 million in 1990 to almost \$7.5 billion in 2011 (Glauber 2013).

Crop insurance aims to provide disaster relief to producers whose income depends on uncertain factors including weather and market prices. Prior to the growth of crop insurance, disaster relief was provided on an *ad hoc* basis normally after the assistance was requested (Coble and Barnett 2013). By subsidizing multi-peril crop insurance

(MPCI), the federal government has provided that disaster relief (income stability) for producers without having to reauthorize programs every year.

Producers enroll in crop insurance to transfer production and price risks. In a competitive market, an insurance company would have premiums approximately equal to indemnity payouts, operating costs and contingency funds (Coble and Barnett 2013). In that market, producers pay to transfer that risk and expect negative returns from insurance. The crop insurance market, however, is not competitive, and producers in the United States received an average of \$1.90 in indemnity for every \$1.00 in premiums paid over the period 1990 to 2011 for all crops eligible for insurance (Glauber 2013).

As federally subsidized MPCI has grown, research has shown crop insurance alters production in two forms (Wu 1999). First, crop insurance changes production at the intensive margin. These changes occur in management practices and include changes in the amount of fertilizers and herbicides spread. The second and more relevant change for this article are ones occurring at the extensive margin. These changes are in the allocation and quantity of acreage devoted to certain crops.

Several studies have tried to explain the effect of the crop insurance on the extensive margin. LaFrance, Shimshack, and Wu (2000) use a stylized model of MPCI to show that “subsidized crop insurance creates greater incentives to utilize greater quantities of marginal quality land”. Two studies (Walters et al. 2012, Goodwin, Vandever, and Deal 2004) used either regression analysis or simulations to show that “crop insurance results in some statistically significant acreage response’s” although those changes are relatively

small. Of the three studies, two (LaFrance, Shimshack, and Wu 2000, Walters et al. 2012) connect extensive changes to environmental degradation as a result of increased planting of annual row crops on marginal lands.

Missouri is in the cross hairs of the two USDA goals of stimulating production of biomass for energy and of providing a farm safety-net. Of the 11 BCAPs awarded, three have been in Missouri. Two crops, switchgrass and miscanthus, which are slated to provide cellulosic material to make ethanol and meet RFS production levels, have lower breakeven prices in Missouri than elsewhere in the Midwest when factoring in their lower grain yield potential and opportunity cost (Jain et al. 2010).

The soil profile in Missouri, especially in the northeastern part of the state, partially explains that lower yield potential. Many Missouri soils in this part of the state have a well-defined argillic horizon or claypan underneath a layer of more productive topsoil. Even though corn and soybeans are cultivated on these soils, this soil profile is not ideally suited for those annual grain crops. The soils are highly erodible and prone to water, herbicide, and nutrient runoff (Ghidey et al. 2010, Lerch et al. 2005). Transitioning these eroded lands into perennial grasses would lead to improvements in the local environment including rejuvenated topsoil, improved water quality, and more carbon sequestration if managed properly.

Crop insurance influences decisions on what to plant in riskier production areas like those in Missouri with claypan soils. Miao, Feng, and Hennessy (2011) constructed a utility maximizing model and ran simulations using county-level data to show that planting

decisions on marginal lands are “more sensitive to changes of subsidy rate or crop prices than highly productive lands”. Producers are more inclined to plant riskier but more profitable crops like corn and soybeans if they can get subsidized insurance. In the absence of that insurance, producers may choose to plant a less variable crop such as perennial grasses for bioenergy or animal fodder. Miao, Feng, and Hennessy (2011) explicitly acknowledge that producers in Missouri would change their mix of crops if insurance subsidies were reduced by five percent.

Beyond how crop insurance weighs into the decision about what to plant, the relative subsidy for crop insurance is more for crops grown on marginal land than productive land. The Risk Management Agency (RMA) of the USDA sets premiums and subsidizes them on an equal percentage basis. Marginal lands normally have higher premiums and, thus, receive more subsidies in terms of dollars per acre.

This study focuses on the interaction of crop insurance and the federal government’s attempt to boost production cellulosic biomass for ethanol. The objectives of this study are: 1) to contribute to the debate about crop insurance at the extensive margin by outlining how the policy changes the risk equation in favor of certain crops, and 2) to demonstrate how crop insurance, by providing a safety-net for row crop producers, may be affecting the farm level decision to produce renewable fuel crops, 3) to propose an amendment to crop insurance that fosters production of renewable fuels on marginally productive land. We specifically test the impact of changing how APH is calculated on

land remaining in row crop production when a portion of the field is planted to renewable perennial fuel crops.

Model and Data

Producers weigh many factors when deciding what crops to plant. Profits are normally an important and often pivotal factor. Expected utility analysis has been used in research on planting decisions (Woodard et al. 2012) and on the influences of crop insurance (Walters et al. 2012). Here, the focus is on a risk-averse producer or a producer who will actively reduce uncertainty. The model we constructed assumes a producer has the liquidity to afford to plant perennial grasses and forgo grain income during the establishment phase of converting to perennial grass production. The model also assumes bounded rationality of the producer because he/she does not have perfect information about all potential outcomes. The framework presented here also relies on the assumptions that a producer can integrate perennial grass crops into his/her operation without excessive labor and equipment costs. Utility is maximized on the basis of a single goal, profit, according to the following equation:

$$U = E(\pi)$$

where utility is a function of expected profit, π . Following the model from Walters et al. (2012) which accounts for crop insurance, the expected profit equation is:

$$E(\pi) = E(p, y) - wX + \text{Indem}(p, y, \hat{p}, APH, cl, ins, u) - \text{Prem}(\hat{p}, APH, cl, ins, u)$$

$E(p,y)$ is expected revenue based on the harvest price p and actual yield y of the crop; w is the deterministic costs of inputs, X , associated with growing each cropping system.

Indemnity payouts are a function of a p , y , price guarantee \hat{p} , actual production history APH , coverage percent cl , type of insurance policy ins , and unit type u . Producers also pay premiums for insurance which are set by RMA.

Our analysis applies this utility maximization model in profit and indemnity simulations to demonstrate how the current method for calculating APH versus a proposed method for calculating APH affect a producer facing the decision to plant perennial grasses on part of his currently insured land. Further, to calculate our proposed APH, we assume that the producer has 10m x 10m grid, geo-referenced yield records acceptable to RMA for calculating APH. In our model, each grid is denoted by j . The entire field is composed of n_1+n_2 portions, where n_1 represents a more productive portion of the field which will remain in row crop production, and n_2 represents a less productive portion of the field which may be planted into perennial grasses such as switchgrass or miscanthus. Figure 1 provides a visual of the transition that will occur with this field.

The profit associated with corn and soybean production is simulated on a field with a varying soil profile. A majority of the field is upland and noneroded soil (n_1). A portion of this field is upland and eroded soil (n_2). To demonstrate the effect crop insurance has on the decision to plant perennial grasses for bioenergy, simulations were run for four cropping systems on eroded soils (n_2): corn, soybeans, miscanthus, and switchgrass. Corn and soybeans are each modeled both with and without insurance.

Profits and indemnity payments are also simulated for three different scenarios to demonstrate the effect of APH. Scenario 1 is the current situation, where the entire field (n_1+n_2) is planted to row crops. Scenario 2 assumes that the n_1 portion of the field remains planted to row crops, and the n_2 portion of the field is planted to perennial grasses. The expected average yield from row crops on the field comprised only of n_1 is expected to increase because the less productive soil areas are no longer included when calculating field yields.

APH for scenarios 1 and 2 is calculated according to the following equation.

$$APH_c = \frac{\sum_{i=1}^T \sum_{j=1}^{n_1+n_2} y_{ij}}{T n_{1+2}}$$

Where c is crop (corn or soybeans), i is individual years, T is the total years for which yield data are available (assumed 10 in our analysis), and j is individual grids records of n_1 and n_2 soils. APH for scenario 2 does not change because under current RMA rules the APH for a portion of the field would still be determined using the previous yield data for the entire field.

Scenario 3 assumes that perennial grasses are planted in the least productive portion of the field (n_2) while row crops continue to be planted in the more productive portion of the field (n_1). Scenario 3 differs from scenario 2 in that we propose a new method for calculating APH (denoted by APH*) that reflects the fact that the field average yield is expected to increase when the least productive portion of the field is no longer planted to row crops and that area is excluded in the yield calculation.

$$APH_c^* = \frac{\sum_{i=1}^T \sum_{j=1}^{n_1} y_{ij}}{Tn_1}$$

APH* is expected to be greater than APH.

The simulations incorporate uncertainty for both grain yields and grain prices. The grain yields come from a dataset of actual gridded yields from producers in northeastern Missouri for the years 2000 to 2009. The yields used to simulate profit are detrended to reflect technology gains, whereas the yields used to calculate APH are not detrended in order to model non-trend adjusted crop insurance. The process for that detrending follows Woodard, Sherrick, and Schnitkey (2010). Detrending added 2.0 bu/ac of corn per year and 0.5 bu/ac of soybeans per year.

The yields are gridded and linked to a specific soil profile through NRCS resource mapping which includes classification of the soil series, landscape position, and susceptibility to erosion. Productive upland and noneroded soils (n_1) are represented by the Putnam soil series; eroded upland soils (n_2) are represented by Armstrong and Armster soil series.

Figure 2 depicts the yields of corn, soybeans, switchgrass and miscanthus on the eroded portion of the field (n_2). Table 1 provides summary statistics of the data. Yields of miscanthus and switchgrass are simulated from ALMANAC using 30 years of weather data for Audrain County, MO and parameters from Parajuli (2012). Biomass crops are uninsured. This article assumes the producer is in a long term contract to sell all the biomass grown to an aggregator at the price \$50/ton at the farmgate (Dolginow 2013).

This system follows one outlined by Epplin et al. (2007) and assumes the biomass will be co-fired alongside coal. Furthermore, the producer is enrolled in a BCAP, offsetting 75 percent of the establishment costs and receiving rental payment in each of the first five years (Schnepf 2013).

Figure 3 is a panel of histograms showing the actual distributions of yields. Table 2 contains summary statistics about the distributions, including the subset of just n_1 soils planted to row crops (Myers, Kitchen, and Sudduth 2012). The corn yield averages used to calculate APH and APH*, respectively, are 147 bu/ac for the entire field ($n_1 + n_2$) and 164 bu/ac when the row crops are only planted in n_1 soils. Similarly, average soybean yields used to calculate APH and APH* rise from 43 to 46 bu/ac when the soybeans are planted in only n_1 soils. The mean of the trend adjusted yields, used in the simulations, are 154 and 171 bu/ac for corn and 45 and 48 bu/ac for soybeans.

Corn and soybean prices are taken from a distribution of 500 simulated national prices from FAPRI-Missouri's 2012 baseline model (Westhoff, Binfield, and Gerlt 2012). The prices are correlated and based on an array of assumptions about macroeconomic conditions, policies, and production. Figure 4 contains the histogram of the distribution of prices, and Table 3 has the summary statistics of prices.

Costs and management practices were taken from extension guides on growing corn, soybeans and dedicated bioenergy perennial grasses in Missouri (Dolginow and Massey 2013). Insurance premiums were found at Illinios' FarmDoc (FarmDoc 2013). This

analysis assumes revenue protection with a coverage level of 75 percent using enterprise units, the most common insurance policy purchased in Missouri (USDA 2013).

Simulations were run using Simetar Add-in (Richardson, Schumann, and Feldman 2011) to Microsoft Excel. The yields and prices used in each iteration are drawn from an empirical distribution calculated from the actual yield data. The stochastic variables are correlated in a two-step process in Simetar. Correlation values are taken from Woodard, Sherrick, and Schnitkey (2010). Each of the 5,000 iterations outputted an income and amount of indemnity paid on a per acre basis.

Results

Figure 5 presents the CDFs of the simulated profits of perennial grasses, insured and uninsured corn and soybeans for the eroded portion of the fields (n_2). The results show that a safety-first producers of miscanthus and switchgrass, receiving the BCAP subsidy, would choose to grow miscanthus or switchgrass over uninsured corn or soybeans as the minimum value is greater. Fifty percent of the time, miscanthus provides higher profits than uninsured soybeans on eroded soil. However, with crop insurance, a safety first decision-maker opts for corn or soybeans as those extreme negative profits are no longer realized.

Figures 6 and 7 present the results of the simulations of corn and soybean profit, respectively, in the form cumulative distribution functions (CDFs). Each crop figure contains three curves representing the profits in the three scenarios. Scenarios 2 and 3

dominate scenario 1 for all decision makers since their CDFs are greater than or equal the CDFs for scenario 1 at all probabilities. It is important to note that scenarios 2 and 3 consider profits generated by row crops planted on the productive Putnam soils (n_1). Whether or not the entire field ($n_1 + n_2$) is more profitable depends on the percent of the field planted in the grasses and income from selling the biomass. As previously shown, biomass is not as profitable as corn and soybeans, even on n_2 portion of the field.

The differences between scenarios 2 and 3 demonstrate the benefit of the APH* calculation (scenario 3) versus the current method of calculating APH (scenario 2). The CDF for scenario 3 is greater than or equal to the CDF for scenario 2 at all points. The effect is the most noteworthy for the bottom quintile of profits where APH* increases the income for the producer. The minimum profit for corn with the APH* is \$107 per acre versus \$45 per acre in scenario 2. For soybeans, the minimums rise from negative \$22 per acre to negative \$2 per acre.

The shifts in income result from changes in indemnity. Table 4 contains information on the mean and frequency of indemnity payments in each scenario. Both the average indemnity payment and frequency of those payments decreases when the least productive lands (n_2) are converted from row crop production to perennial grasses. The frequency of corn indemnity payments decreases from 27 percent to 16 percent comparing scenario 1 and 2. In scenario 3, which uses the proposed method for calculating APH*, the frequency rises back to 23 percent, which is still lower than scenario 1. The mean of the

indemnity payments follows a similar path decreasing from \$43.63 per acre in scenario 1 to \$18.71 in scenario 2 and rising back to \$32.81 in scenario 3.

Indemnity frequency and payments with soybeans are similar to those of corn except for magnitude of the payment differences. Scenario 3 mean of indemnities is very similar to the mean of indemnities for scenario 1.

Conclusions

This article proposes a new method for calculating APH for producers with geo-referenced gridded yield records who convert a portion of their field into perennial grasses. The new APH calculation is not a drastic change in the farm safety-net program nor will it singularly provide sufficient incentive to convert lands to biomass production. Although the focus is converting eroded cropland to perennial grasses grown for bioenergy, it may have relevance when portions of fields are put into continuous CRP contracts or other conservation compliance programs.

Producers should welcome the change because the new APH calculation recognizes that the more productive land still in row crops has a higher expected yield than the original field which contained eroded soils. The higher profit potential on the portion remaining in row crops allows the farmer to take a lower profit on the land planted to biomass. This provides a greater safety-net to the producer as yields are less variable and the income guarantee is increased.

The RMA and insurance companies should also welcome this change. It reduces both the frequency of payouts and the average payout to farmers. With riskier land in perennial grass production, liabilities will decrease leading to smaller outlays for crop insurance by the federal government.

The conversion of eroded cropland from annual grain to perennial grasses has an impact on greater societal as well. Planting perennial grasses on that risky cropland has positive impacts on the local environmental (McLaughlin and Walsh 1998). Those environmental benefits to society are not modeled here but are expected and include decreased environmental hazards associated with annual row crop production (Mudgal et al. 2011, Mudgal et al. 2012) as well as increased production of domestic and renewable source of energy.

This article focuses on the interaction between crop insurance and growing perennial grasses. Federally subsidized crop insurance dissuades producers from converting their land because their land remaining in annual grain production is less likely to receive indemnity payments and average indemnity payments will be lower. However, using the proposed APH partially overcomes the impediment caused by subsidized crop insurance if producers do convert their cropland to perennial grasses.

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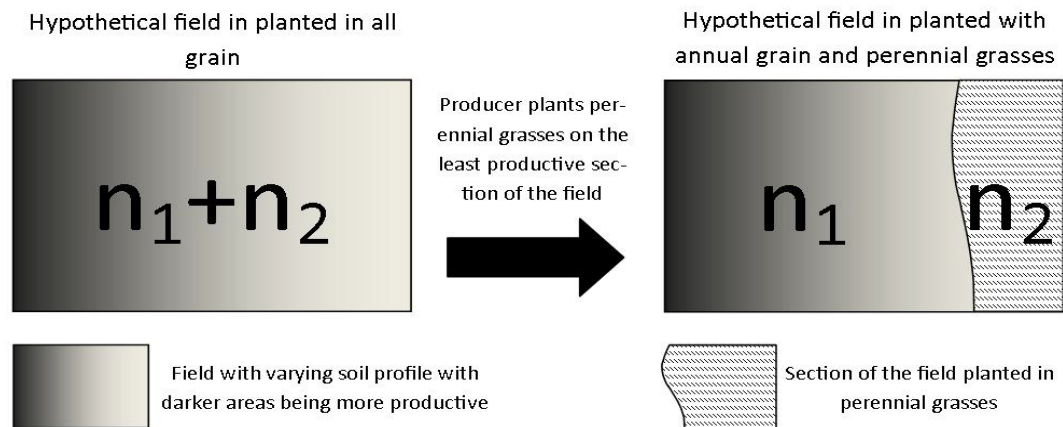


Figure 1. Illustration of Land Converted into Perennial Grass Production

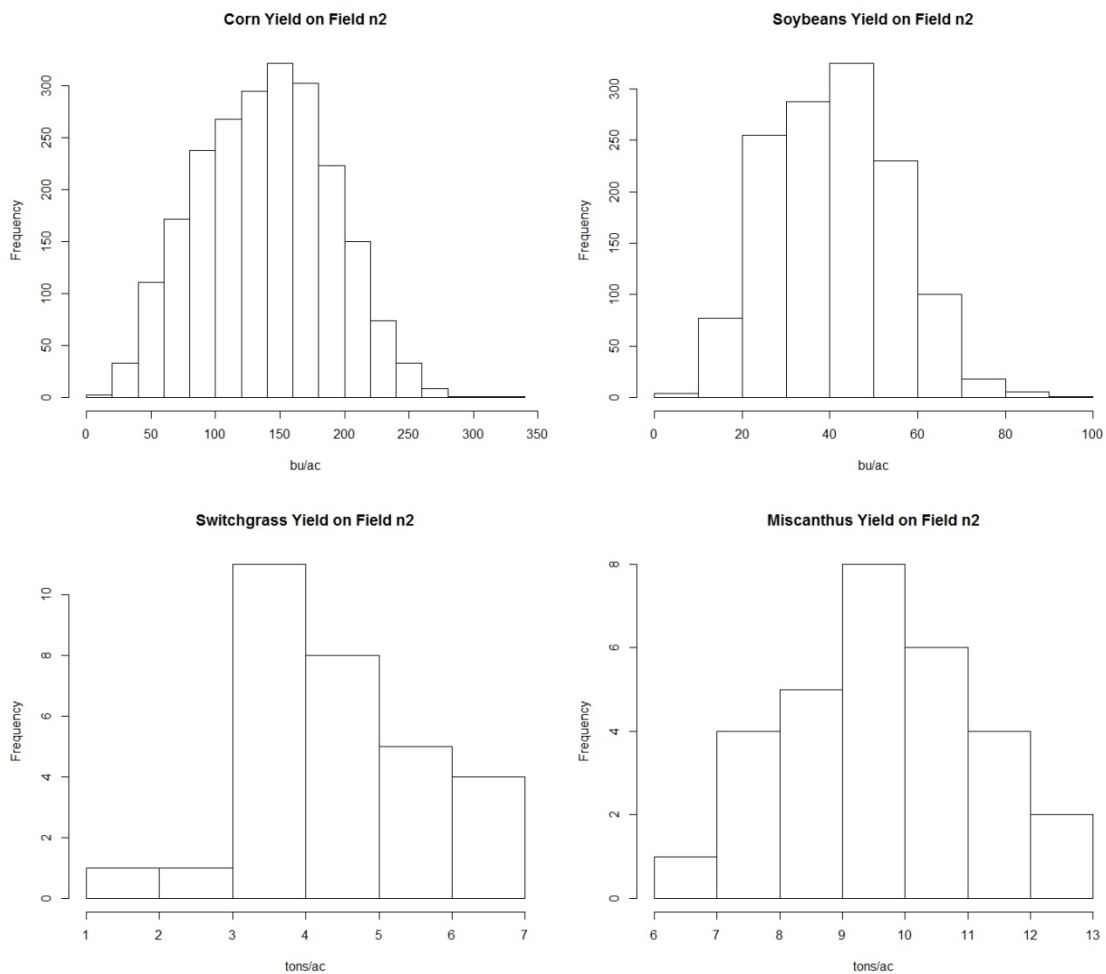


Figure 2. Histograms of Corn, Soybean, Switchgrass, and Miscanthus Yields on Eroded Soils.

Table 1. Summary Statistics of Yield Distributions on Eroded Soils

	Corn	Soybeans	Switchgrass	Miscanthus
APH	131	40		
Mean	139	41	4.34	9.74
Standard Deviation	51	15	1.19	1.53
Coefficient of Variation	36.8	35.6	27.4	15.7
Minimum	18	2	1.25	6.91
Median	140	43	4.15	9.68
Maximum	321	93	6.84	12.93
Number of Observations	2235	1760	30	30

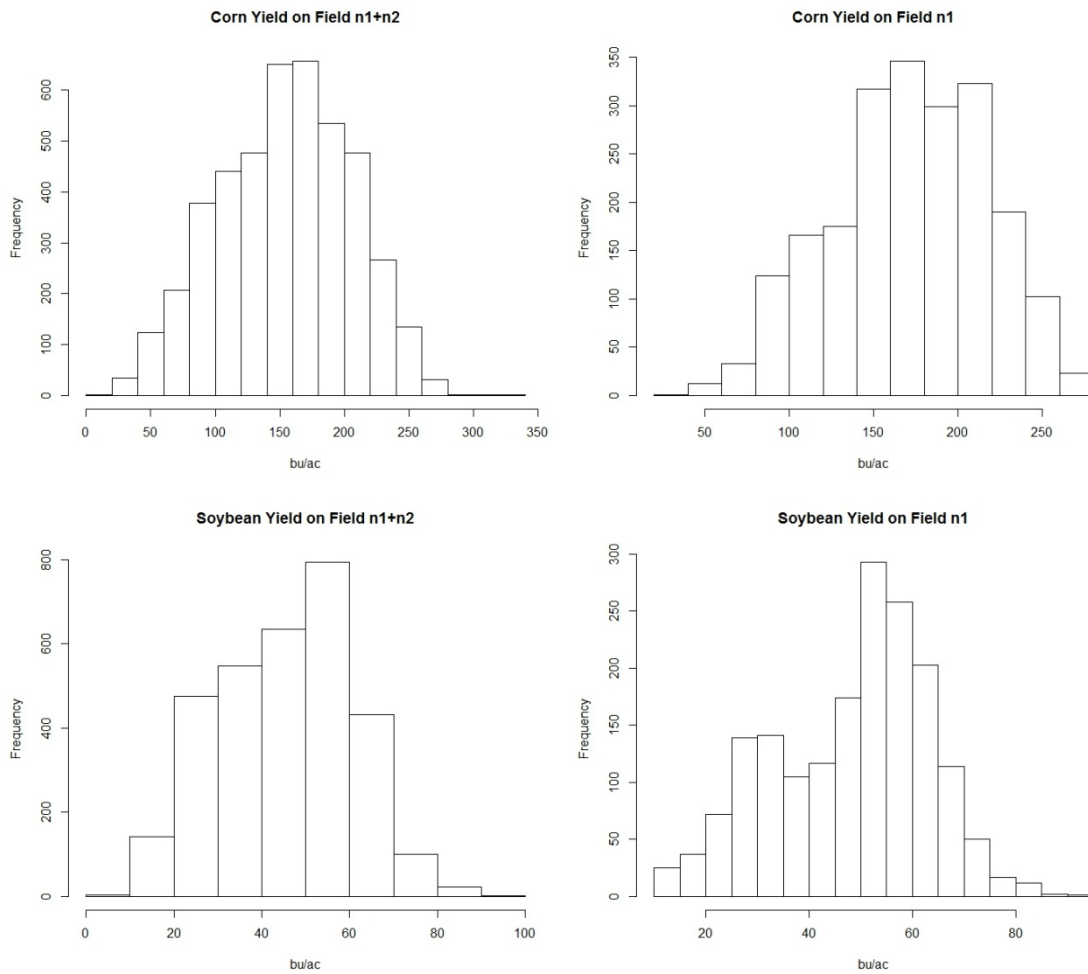


Figure 3. Histograms of Corn and Soybeans on Entire Field (n_1+n_2) and More Productive Portion (n_1)

Table 2. APH and Summary Statistics of Detrended Yields Used in Each Simulation

Scenario	Corn			Soybeans		
	1	2	3	1	2	3
Field	Corn (n ₁ +n ₂)	Corn (n ₁)	Corn (n ₁)	Soybeans (n ₁ +n ₂)	Soybeans (n ₁)	Soybeans (n ₁)
APH	147	147	164	43	43	45
Mean	154	171	171	45	48	48
Standard Deviation	51	46	46	15	15	15
Coefficient of Variation	33.1	26.6	26.6	33.8	31.2	31.2
Minimum	18	32	32	2	11	11
Median	157	173	173	47	51	51
Maximum	321	278	278	94	94	94
Number of Observations	4414	2111	2111	3153	1760	1760

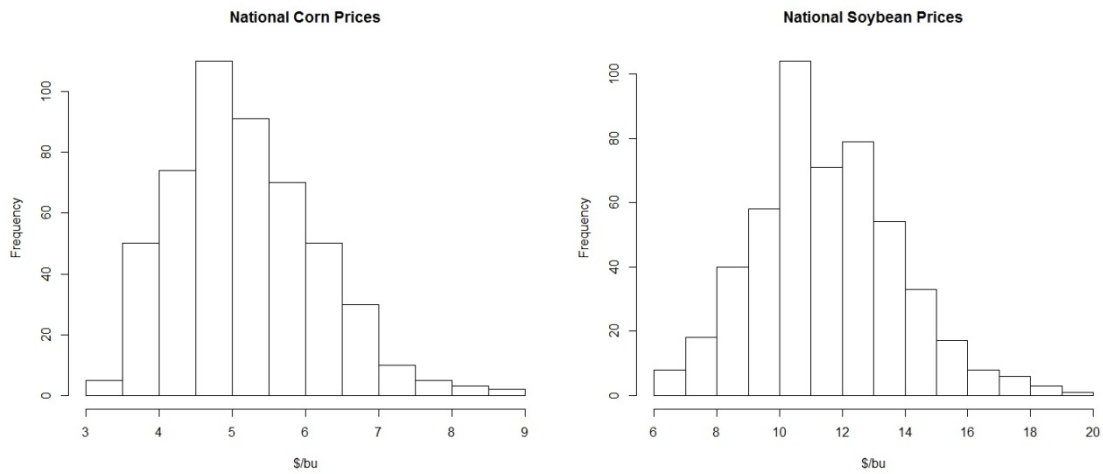


Figure 4. Histogram of 2012 FAPRI Simulated Prices for Corn and Soybeans

Table 3. Summary Statistics of 2012 FAPRI Simulated Corn and Soybean Prices

	Corn Price	Soybean Price
Mean	\$5.18	\$11.49
Standard Deviation	\$0.97	\$2.32
Coefficient of Variation	18.7	20.2
Minimum	\$3.38	\$6.41
Median	\$5.07	\$11.29
Maximum	\$8.65	\$19.02
Number of Observations	500	500

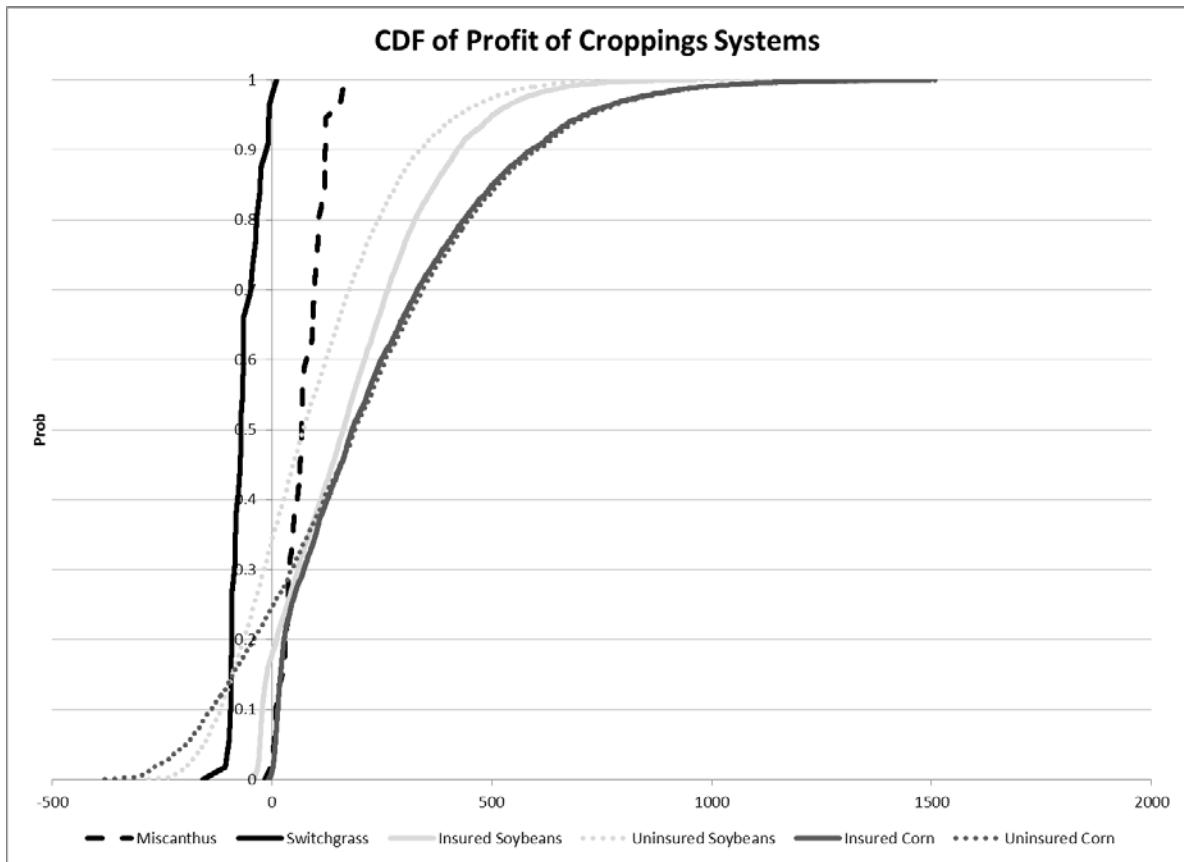


Figure 5. CDF of Simulated Profits in \$/ac of Miscanthus, Switchgrass, Insured Soybeans, Uninsured Soybeans, Insured Corn, and Uninsured Corn on Eroded Soils

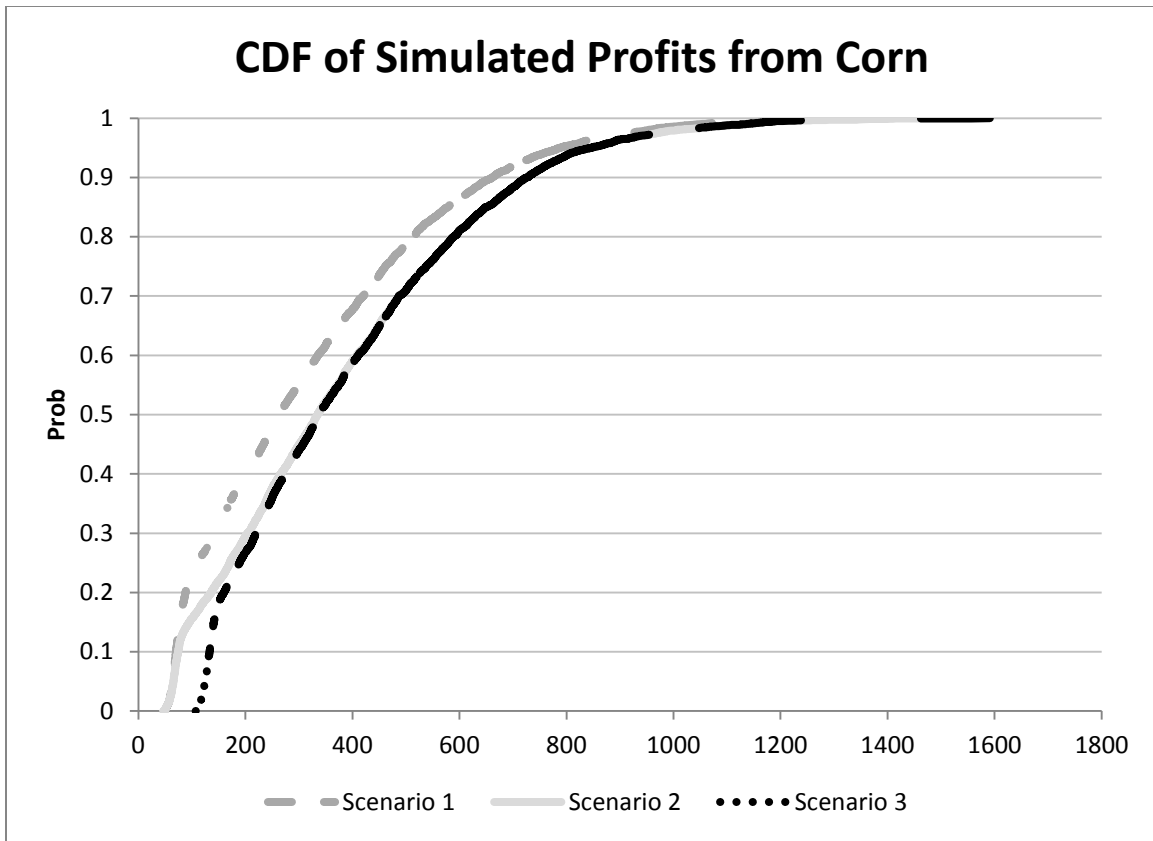


Figure 6. CDF of Simulated Profits in \$/ac of Corn for Each Scenario

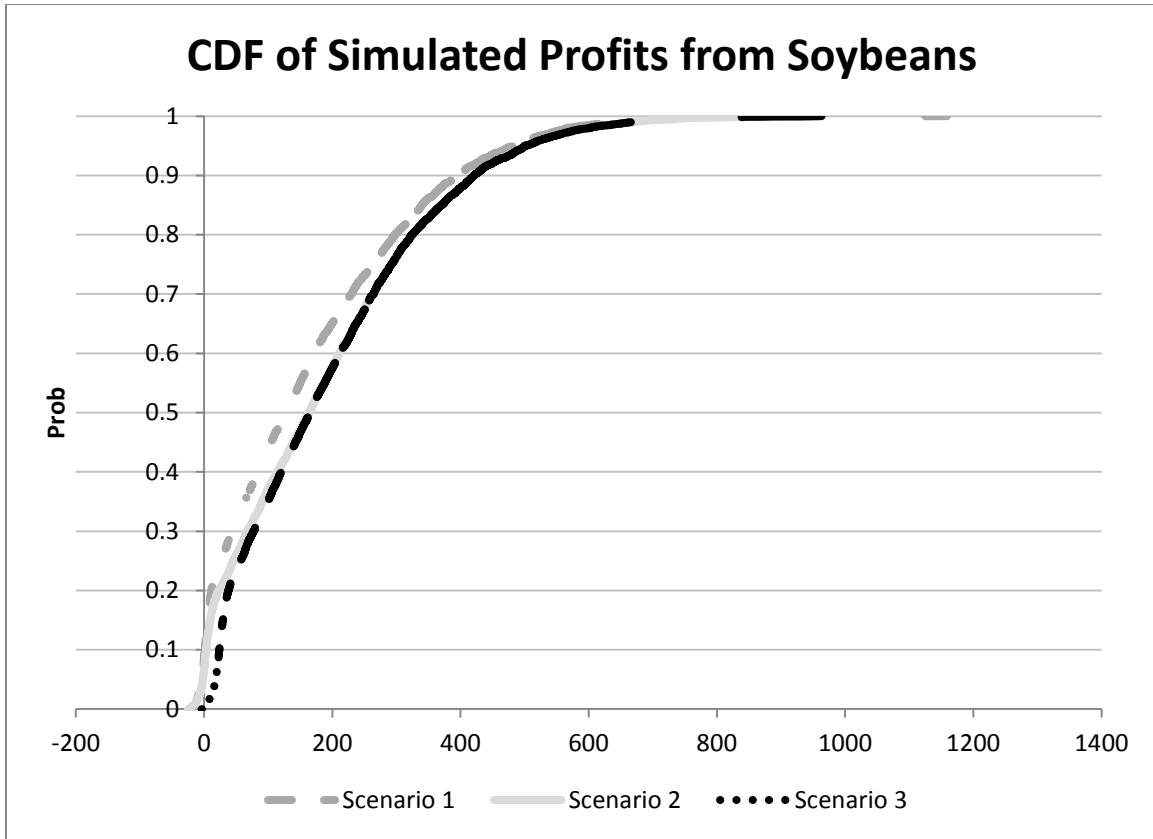


Figure 7. CDF of Simulated Profits in \$/ac of Soybeans for Each Scenario

Table 4. Mean in \$/ac and Frequency of Indemnity Payments for Corn and Soybeans Under Each Scenario

	Corn			Soybeans		
Scenario	1	2	3	1	2	3
Field	n_1+n_2 with APH	n_1 with APH	n_1 with APH*	n_1+n_2 with APH	n_1 with APH	n_1 with APH*
Mean	\$43.67	\$18.78	\$32.99	\$30.25	\$23.42	\$29.74
Frequency	28%	17%	23%	31%	24%	28%