Supporting Cellulosic Ethanol Biomass Production and its Impact on Land Use Conversion

Feng Wu
PH.D. Student
Department of Agricultural, Food, and Resource Economics
Michigan State University
East Lansing, MI 48823
Email: wufeng@msu.edu
Phone: 517-355-8062

Zhengfei Guan
Assistant Professor
Department of Agricultural, Food, and Resource Economics
Michigan State University
East Lansing, MI 48823
Email: guanz@msu.edu

Selected Paper prepared for presentation at the Agricultural &Applied Economics Association 2009 AAEA & ACCI Joint Annual Meeting, Milwaukee, Wisconsin, July 26-29, 2009.

Abstract

One of the problems facing the cellulosic ethanol industry is the cellulose material supply. The U.S. forestlands have considerable potential to become one of the main sources of biomass to meet the 2022 renewable fuel target. Focusing on the land exiting the Conservation Reserve Program (CRP), the article finds that few landowners are willing to convert their land to forestland after the CRP contract is expired. Our econometric estimates show the choice decision is responsive to net returns of land use alternatives, especially cropland. Two policy initiatives are suggested to provide direct incentives for land use change. The nested logit estimates are used to simulate landowners' responses to policy mechanism. The results show that subsidies can substantially increase forestland, although a spillover effect exists.

Key word: Cellulosic Ethanol, Biomass, Land Use; the CRP; Forestland

As the second-generation ethanol, cellulosic ethanol has been given high expectation of putting the growing biofuel industry on a sustainable basis. At present, one of the problems facing the cellulosic ethanol industry is the cellulose material supply. A wide array of cellulosic biomass includes agricultural residues like wheat straw, herbaceous energy crops like switch grass, short-rotation woody crops like hybrid poplar and willow, and forest residues like thinnings from timberland. Among them, U.S. forestlands have considerable potential to become one of the main sources of biomass to meet the 2022 renewable fuel target (producing 20 billion gallons per year (BGY) of second-generation and other renewable fuels). Forestland can provide two primary sources: residues from the harvesting and management of commercial timberlands for the extraction of sawlogs, pulpwood, veneer log, and other conventional products; and currently non-merchantable biomass associated with the standing forest inventory. It is projected that if forest roadside prices range from roughly \$40 to \$46 per dry ton, forestland can provide sufficient feedstock to produce 4 BGY of renewable fuels (Biomass Research and Development Board 2007).

Two barriers to providing sustainable quantities of forest biomass that have been identified are the lack of biomass production capacity and the high relative costs of production, recovery, and transportation of feedstocks. Production capacity relies on land availability, which is relatively constant in agriculture. Therefore, converting land into forestland is a feasible path to pursue to increase forest biomass supply. One important potential source of agricultural land is acreage exited the Conservation Reserve Program (CRP). Land use conversion from productive cropland to forestland would require a high threshold return, while current CRP land may be relatively easy to convert because the CRP lands are less productive marginal lands.

The CRP, initiated by the Food Security Act of 1985, aims to reduce erosion, improve water quality, establish wildlife habitat, and provide other environmental benefits through retiring highly erodible and environmentally sensitive cropland from production for a fixed duration of 10 or 15 years. During the contract period, farmland is converted or maintained in grass, trees, wildlife cover, or other conservation practices. As of April 2008, CRP enrollment stood at 34.7 million acres (USDA 2008). However, under the current contract terms, a large number of contracts will soon be expired. There are 3.8 million CRP acres scheduled to expire in September 2009. In the next three years, the expected expired CRP acres are more than 4 million acres per year (Figure 1)[1]. The exiting land can become a potential pool to be flowing into forestland under appropriate incentives. Thus understanding land-use choice upon contract expiration is the key for developing suitable subsidy and tax policies to motivate forest biomass production.

There is a rich literature on land use change. The relationship between land-use choices and relative returns from alternative uses is often estimated in econometric models. Multinomial-choice model (Skaggs, Kirksey, and Harper 1994), logistic model (Janssen and Ghebremicael 1994; Isik and Yang 2004; Lubowski, Plantinga, and Stavins 2008), and ordered probit model (Cooper and Osborn 1998) can be found in the literature. However, specific studies on land use after exiting the CRP are rare. Roberts and Lubowski (2007) make use of observed land-use choices following expiration of CRP contracts between 1995 and 1997, and examine the relationship between the landowner response and observable variables (changes in return from land alternative uses). The advantage of this study is to use parcel-level data rather than aggregate data as in many empirical land-use studies (Alig 1986; Plantinga 1996; Hardie and Parks 1996; Miller and Plantinga 1999; Plantinga and Ahn 2002) to estimate landowners' response to determinants of land use choice (including quasi-rent, land characteristics, and farmer characteristics). Robert and Lubowski (2007) regard the specification of quasi-rent function as a difficult empirical challenge in aggregate data because of broad cross-sectional variations in land characteristics. Problems of misspecification and omitted variables may result in inconsistent estimates. Similarly, in this study we adopt parcel-specific data to examine landowner decision after exiting the CRP.

The research mainly aims to improve cellulosic forest biomass production by proposing and initiating policies which target CRP land conversion to forestland. Specification of discrete choice model is an issue even if data on parcel-level land characteristics are available. In this article, we propose a theoretical model of landowner choice to guide empirical econometric modeling. We model farmers' land use decision making and investigate the conditions under which land conversion to forestland is economically attractive for landowners. A nested logit specification is employed for the transition probabilities to relax the restriction of Independence of Irrelevant Alternatives in multinomial logit model. The results show the transition probability is responsive to crop net return. Other majority of estimated parameters and respective elasticities are found to be consistent with economic expectation.

Based on econometric results, we simulate transition probabilities change to two policies: subsidizing conversion to forest and taxing land out of forest. Simulation results show landowner can quickly respond to the subsidy for forestland and convert cropland to pasture and forest, while the tax policy is not effective because of large conversion cost.

An Optimal Control Model of Land Use

We first construct an optimal control model of land use choice at the individual landowner level. Our focus is the land exiting the CRP. The landowner faces three choices: cropland, pasture, and forestland. A variety of economic and hydrologic factors relevant to decision making are observed. Typically, landowners observe agricultural prices and production costs, agricultural yields in their area, typical timber returns, grazing rate, land quality, and land cover practices in the CRP (Stavins and Jaffe 1990). Based on this information, the landowner makes the decision of whether to keep land in the original cover in the CRP (pasture or forest) or convert to cropland. A risk-neutral landowner will seek to maximize the present value of the stream of expected future returns by allocating land use once exiting the CRP.

$$\underset{\{g_{ijt},v_{ijt}\}}{Max}\int_0^\infty \begin{bmatrix} (A(p_{it}^a,q)g_{ijt} - C_{it}^g g_{ijt} + B(p_t^b,q)v_{jit} \\ -C_{it}^v v_{ijt} + f_{it}^c S_{ijt} \end{bmatrix} e^{-rt}dt$$

$$\text{subject to: } \dot{S}_{ijt} = -g_{ijt} - v_{ijt}$$

$$0 \le g_{ijt} \le \bar{g}_{ijt}$$

$$0 \le v_{ijt} \le \bar{v}_{ijt}$$

Where *i* indexes counties, *j* indexes individual land parcels, *t* indexes time， c indexes the original CRP cover prior to exit[2]; uppercase letters are stock variables; and lowercase letters are flow variables.

These variables are:

$A(p_{it}^{a},q)$ = the present value of expected agricultural revenue less variable cost per acre in county i; p_{it}^{a} is the price vector faced by landowners at time t for crop outputs and non-land inputs. q is land quality; $A(p_{it}^{a},q)$ is a monotonic function of q.

g_{ijt} =acres of land converted from the CRP to cropland;

$B(p_{t}^{b},q)$ = the present value of expected pasture[3] revenue less variable cost per acre in county i and time t; p_{it}^{a} is the price vector faced by landowners at time t for forage outputs and non-land inputs; $B(p_{t}^{b},q)$ is also a monotonic function of q.

v_{ijt} = acres of land converted from the CRP to pasture;

C_{it}^{g} =average cost of conversion from the CRP to cropland per acre;

C_{it}^{v} = average cost of conversion from the CRP to pasture per acres;

S_{ijt} =stock (acres) of the original CRP;

f_{it}^{c} =expected average annual net income from stock land per acre which depends on the cover practices (if forest, it is annuity of stumpage value; if pasture, it is forage return or grazing rate);

$\bar{g}_{ijt},\bar{v}_{ijt}$ =maximum feasible rate of conversion resulted from institutional or other considerations, e.g., available labor or capital. These are the bounds of conversion land.

The user will determine conversion rates, g_{ijt},v_{ijt}, based on the current-value Hamiltonian, $H(q)$.

$$H(q)=\left[(A(p_{it}^{a},q)g_{ijt}-C_{it}^{g}g_{ijt}+B(p_{t}^{b},q)v_{jit}-C_{it}^{v}v_{ijt}+f_{it}^{c}S_{ijt}\right]-\lambda_{t}(q)(g_{ijt}+v_{ijt})$$

where $\lambda_t(q)$ is the undiscounted opportunity value to the landowner of an additional acre of forestland at time t. The optimal conversion rate is derived from the first order conditions:

$$\frac{\partial H(q)}{\partial g_{ijt}} = \left[A(p_{it}^{a}, q) - C_{it}^{g}\right] - \lambda_t(q)$$

$$\frac{\partial H(q)}{\partial v_{ijt}} = \left[B(p_{it}^{b}, q) - C_{it}^{v}\right] - \lambda_t(q)$$

Arbitrary condition is

$$\dot{\lambda}_t = r\lambda_t - f_{it}.$$

And

$$\dot{S}_{ijt} = \frac{\partial H(q)}{\partial \lambda_t} - g_{ijt} - v_{ijt}$$

Since the objective is linear in g_{ijt} and v_{jit}, the optimal conversion rule under the application of control theoretical methods is:

$$g_{ijt} = \bar{g}_{ijt} \text{ if } A(p_{it}^{a}, q) - C_{it}^{g} = Max\{A(p_{it}^{a}, q) - C_{it}^{g}, B(p_{it}^{b}, q) - C_{it}^{v}, f_{it}/r\}$$

$$v_{ijt} = \bar{v}_{ijt} \text{ if } B(p_{it}^{b}, q) - C_{it}^{v} = Max\{A(p_{it}^{a}, q) - C_{it}^{g}, B(p_{it}^{b}, q) - C_{it}^{v}, f_{it}/r\}$$

$$v_{ijt} = 0 \text{ and } g_{ijt} = 0 \text{ if } f_{it}/r = Max\{A(p_{it}^{a}, q) - C_{it}^{g}, B(p_{it}^{b}, q) - C_{it}^{v}, f_{it}/r\}$$

The rule implies that a parcel in the CRP should be converted to other alternative use if the present value of expected profit less conversion cost is the highest among all alternatives. Otherwise, it will keep the same cover as in the CRP.

Nested Logistic Model

The landowner's profit components are not always observable for econometricians. Specific distribution assumptions on the structure of the unobserved components yield alternative specifications of discrete choice models. In general, discrete choice decision can be done with the multinomianl logit model (MNL), but the MNL assumes proportional substitution patterns (Independence of Irrelevant Alternatives), which means the ratio of the probabilities of any two alternatives is independent of the presence or absence of other alternatives in the model. This assumption is not realistic because of correlations among alternatives. To overcome the shortcoming, various extensions of the MNL exist that relax the restrictive substitution assumption and allow correlations between the alternatives' error terms. The nested logit model partially relaxes the assumption. It groups similar or close alternatives into nests and assumes that the error terms of alternatives within a nest are correlated while error terms of alternatives in different nests are uncorrelated (Train 2003).

A two-level nested logit model is proposed in the article. Suppose a parcel, labeled j, faces a choice among K agricultural management alternatives. We define, B_{jk}, the landowner's benefit from allocating j in use k. The random benefit is the sum of a marginal benefit component B_{jm} from the nest m and a conditional benefit component, $B_{jk|m}$, which both consist of a deterministic part V and a random part v.

$$B_{jk} = B_{jm} + B_{jk|m} = V_{jm} + v_{jm} + V_{jk|m} + v_{jk|m}$$

Under the assumption of specific distribution of error terms, the probability of choosing alternative k that is grouped in m, P_{jk}, can be expressed as the product of the marginal choice probability P_m for nest *m* (top level) and the conditional choice probability $P_{k|m}$ for alternative j within nest *m* (bottom level).

$$P_{jk} = P_m \cdot P_{k|m} = \frac{\exp\left(V_{jm} + \tau_m IV_{jm}\right)}{\sum_{m=1}^{M} \exp\left(V_{jm} + \tau_m IV_{jm}\right)} \cdot \frac{\exp\left(V_{jk|m}\right)}{\sum_{k=1}^{K_m} \left(V_{jk|m}\right)}$$

where $IV_{km}$is the inclusive value as the expected benefits of nest m connecting the two decision levels.

Land use is easier to substitute each other when they have similar land quality requirement. Based on this, two-level nesting structure is established by two land quality measures—the land capability class & subclass (LCC) and Universal Soil Loss Equation (USLE)[4] slope percent (Slope). The LCC is the soil suitability rating for agriculture, between 1 and 8— the class 1 soil has a few restrictions that limit its use, the class 8 soil has limitations that nearly preclude its use for commercial crop production. Slope percent is a critical index determining soil erodibility, which has also been tied to crop production costs through conservation compliance provisions required of farmers receiving farm program assistance. In general, land in crops has the highest average land quality while pasture and forest appear to have more similar land quality requirement. We incorporate these differences in land quality requirements by specifying our nested logit model with two nests: $m_1(crops)$, and $m_2(Pasture\ and\ Forest)$.

Following Lubowski et al. (2006) specification, conditional benefit component that is unique to each alternative k is specified as

$$B_{jk|m} = \alpha_0 + \alpha^l LCC_j + \alpha^s Slope_j + \alpha^c Cover_j + \beta^j R_{kc}$$

$$+\beta^l LCC_j \cdot R_{kc} + \beta^s Slope_j \cdot R_{kc} + \beta^c Cover_j \cdot R_{kc} + e_{jk}$$

where α_0 is an alternative-specific intercept, $R_{kc}$is the net return to land alternative k in county c, $Cover_j$ is the original cover practices in the CRP, and e_{jk} is the error term. The term,

$\alpha_0 + \alpha^l LCC_j + \alpha^s Slope_j + \alpha^c Cover_j$, is used to model land conversion cost because the cost data are not available and we expect costs may be closely related to land quality and cover practices. The terms, $LCC_j \cdot R_{kc}$, $Slope_j \cdot R_{kc}$ and $Cover_j \cdot R_{kc}$ are to capture the parcel-level variation of land returns in one county because we only observe county level average returns rather than parcel-specific net returns.

Similarly, for the marginal benefit component that is common across the alternatives within each nest, we include a constant term and three variables representing land quality measures and cover.

$$B_{jm} = \gamma_0 + \gamma^l LCC_j + \gamma^s Slope_j + \gamma^c Cover_j + \varepsilon_{jm}$$

Where γ_0 is a constant specific to nest m.

Data

A primary parcel-specific data source for the CRP is the Natural Resource Inventory (NRI), which is conducted by the Natural Resource Conservation Service (NRCS). The NRI is a scientifically-designed, longitudinal panel survey of the nation's soil, water, and related resources designed to assess conditions and trends every five years. The 1997 NRI contains data on nonfederal lands and water areas within the 48 conterminous United States, Hawaii, Puerto Rico, and the U.S. Virgin Islands. The 1997 NRI provides information on land use, land characteristics, and conservation practices for about 80000 points in four intervals – 1982, 1987, 1992, and 1997. Each NRI point represents a different land area according to an acreage weight (expansion factor). The total CRP acreage in one county or region can be calculated by summing the expansion factor for all sites enrolled in the CRP.

Our analysis uses the set of points from the NRI enrolled in the CRP in 1992 and not enrolled in 1997. The period from 1992 to 1997 covers the expiration of contracts from the first five CRP sign-ups, conducted from 1985 through 1987(Robert and Lubowski 2007). During the period, 2576 sites representing 3,577,200 acres exit the CRP. According to land cover categories, Table 1 provides the distribution of points and acres.

<Table2>

Table 2 reports 1997 land use for parcels under different covers that exits CRP between 1992 and 1997. Of acres exiting the CRP, 62.92% returned to crop production by 1997, 22.27% were converted into pastureland, 8.31% into rangeland, 1.35% into other use, and only less than 6% into forestland. The data also show that if the parcel did not return to crop production, they in general continue under ground cover similar to that contracted for under the CRP.

<Table 3>

<Tables 4>

In Table 3, we report summary statistics of land quality index—LCC and Slope—and original cover practices according to land use categories. Surprisingly, the average LCC of forestland is lowest among them, which means forestland have the highest land quality. This is not consistent with expectation because the majority of forests are always standing at marginal land. The reason is that the forestland sample is not enough or not representative. LCC only embodies partial information to land quality. The similar situation is found for Slope that forestland has the lowest slope percentage. Land converted to forestland in general is covered by forest or wildlife habitat before exiting the CRP while land to cropland and pasture is covered by grasses or legumes. Table 4 provides summary statistics of net returns to three alternative uses in 1997. Only county-level data are available. The procedure of data estimate can be found in

Appendix A. Data show that net crop return is higher as compared to lands that exit but were not converted to crops.

Estimation Results

We employ maximum likelihood methods to estimate the parameters of the model of transitions to these three uses (crop, pasture and forest) using observations of land with different covers exiting between 1992 and 1997. Estimated parameters for the nested logit model are reported in Table 5. The results are basically consistent with the expected economic relationship.

<Table 6>

Table 6 reports the elasticity of the probability of choosing alternative land uses with respect to the net return to land use (including own and cross elasticities). Crop and forest use have positive own-return ealsticities while pasture has negative elasticity, although the coefficient is not statically significant. That the latter is not responsive to net return shows that conversion to pasture is determined by other factors rather than economic benefit consideration. The cross elasticities are not always negative. The increase in net return to pasture may also promote land conversion to cropland. The elasticities with respect to forest net returns are especially important for our simulation model of land use. The elasticity with respect to forest net returns is positive and significantly different from zero. In addition, forest net return increase also helps land conversion to pasture.

Simulation Model of Land Use

Using the estimated coefficients for the land use choice model, we simulate agricultural land use changes under two suggested policies. The policies involve a subsidy for the conversion of land to forest and a tax on the conversion of land out of forest[5]. We simulate two policy scenarios and examine the land use change. We specify the level of the subsidy and tax, denoted Z in two scenarios:

- for land moving into forest, give the subsidy Z
- for land moving out of forest, give the tax Z.

Initial simulations are run based on the values of the models' independent variables in 2007 in order to generate the baseline probabilities of choosing each alternative. Using the baseline probabilities, we calculate the aggregate acreage of alternative land uses using the following equation:

$$A_{kj} = \sum_{j=1}^{I} \mathrm{Prob}(k)_j \cdot \mathrm{xfact}_j$$

Where A_j is the aggregate acreage of alternative k, Prob(k) is the probability of choosing k at point j, xfact is the acreage of point j in the 1997 NRI. Once the baseline simulations are performed, the effect of policies at each NRI site is evaluated. With an increase in the return from alternative uses, we re-estimate the probability of land use at each NRI site. Finally, based on the re-estimated probabilities, the aggregate CRP acreage after a policy change is calculated.

<Table 7>

<Table 8>

Table 7 presents the simulated effect of the subsidy to forestland on land use acreage after exiting the CRP. Overall, farmers are quite responsive to this policy. Although the acreage responses are inelastic with rates less than $40 per acre, the CRP acreage adjusts relatively rapidly when the rental rate rises to more than $40 per acre. It should be noted that all land converted to forest is from cropland. Furthermore, the policy initiative has spillover effect. Pastureland acreages also increase simultaneously in response to the higher level of forest rent. In contrast to forest elastic acreage responses, its growth rate increases by only 9% and 10%, but the increase is substantial in amount. The spillover effect makes the policy not cost-effective as expected. Table 8 shows the simulated effect of the tax to land use out of forest on land use choice. From the simulation, tax reduces crop acreages while increasing pasture and forest acreages. However, the changes are not so significant compared to those in the subsidy scenario. Alike, the acreage reductions of cropland are absorbed by a simultaneous expansion of pasture and forestland. That is, spillover effect still exists, but the degree is not strong as the former.

Conclusion

The primary objective of this study is to evaluate the effect of policies supporting cellulosic forest biomass production on agricultural land use choice when these lands exit the CRP.

The objective is achieved by estimating a nested logit model that based on a behavioral model of optimal land allocation and using the estimated coefficients to predict land use choice. Results show that land use choice is responsive to crop net return, but not sensitive to pasture rent and forest rent. Policy simulation results suggest that subsidizing conversion to forestland after exiting the CRP can significantly increase acreages devoted to forest, but it also has spillover effect. Finally, the results show that a tax to land out of forest has limited impacts.

---

[1] In order to reduce the number of contracts expiring, USDA offered holders of general signup contracts set between 2007 and 2010 (28 million acres) the opportunity to re-enroll or extend their contracts in 2006 (USDA/FAS 2006).

[2] In the 1997 NRI, land cover practices are classified into three categories: grasses and legumes, trees, and wildlife and components.

[3] Here pasture land includes pasture and rangeland, even if the two types are separately summarized in the NRI documents, we integrate them into a type because of their similar requirement for land quality.

[4] Universal Soil Loss Equation (USLE) is an erosion model designed to predict long-term average annual soil loss (due to sheet and rill erosion) from specific field areas in specified cropping and management systems.

[5] We do not directly subsidize the forest biomass production because the market about cellulosic biomass market has not been established under the environment that the cellulosic ethanol technology is not mature.

Reference

Biomass Research and Development Board. 2007. “Increasing Feedstock Production for Biofuels Economic Drivers, Environmental Implications, and the Role of Research.”

Cooper, J. C., and C. T. Osborn. 1998. “The Effect of Rental Rates on the Extension of Conservation Reserve Program Contracts.” *American Journal of Agricultural Economics* 80:184-194.

Hardie, I., P. Parks, P. Gottlieb, and D. Wear. 2000. ‘‘Responsiveness of Rural and Urban Land Uses to Land Rent Determinants in the U.S. South.’’ *Land Economics* 76, 659–73.

Isik, M., and W. Yang. 2004. “An Analysis of the Effects of Uncertainty and Irreversibility on Farmer Participation in the Conservation Reserve Program.” *Journal of Agricultural and* Resource Economics, 29(2): 242-259.

Janssen, L. L., and T. Ghebremicael. “Post-Contract CRP Land Use Decisions in South Dakota: Results from a 1993 CRP Survey.” the NCT-163 Post-Conservation Reserve Program Land Use Conference, Denver CO,10–1 1 January 1994.

Lubowski, R. N., A. J. Plantinga, and R. N. Stavins.2006. “Land-use change and carbon sinks: Econometric estimation of the carbon sequestration supply function.” *Journal of Environmental Economics and Management*, 135-152

Miller D.J., and A.J. Plantinga. 1999. “Modeling Land Use Decisions with Aggregate Data.” *American Journal of Agricultural Economics* 81, 180-194.

Parks,P., and I. Hardie, 1995. “Least-cost forest carbon reserves: cost-effective subsidies to convert marginal agricultural land to forests.” *Land Economics* 71 (1), 122–136.

Plantinga, A.J., J. Buongiorno, and R.J. Alig. 1990. "Determinants of Changes in Non-Industrial Private Timberland Ownership in the United States." *Journal of World Forest Resource Management* 5, 29-46.

Plantinga, Andrew J. 1996. ‘‘The Effects of Agricultural Policies on Land Use and Environmental Quality.’’ *American Journal of Agricultural Economics* 78 (4): 1082–91.

Plantinga, A. J., and S. Ahn. 2002.‘‘EfficientPoliciesforEnvironmentalProtection: An Econometric Analysis of Incentives for Land Conversion and Retention.’’ *Journal of Agricultural and Resource Economics* 27 (1): 128–145.

Roberts, M. J., and R. N. Lubowski. 2007. “Enduring Impacts of Land Retirement Policies: Evidence from the Conservation Reserve Program.” *Land Economics* 83(4):516-538

Skaggs, R. K., R.E. Kirksey, and W.M. Harper. 1994. “Determinants and Implications of Post-CRP Land Use Decisions.” *Journal of agricultural and Resource Economics* 19,299–312.

Stavins, R.N., and A.B. Jaffe. 1990. "Unintended Impacts of Public Investments on Private Decisions: The Depletion of Forested Wetlands." *The American Economic Review* 80, 337-352.

Train KE (2003) Discrete Choice Methods with Simulation. Cambridge University Press.

USDA FSA. 2006. “USDA Announce Results of Intentions of Re-enroll and Extend CRP Contracts.”http://www.fsa.usda.gov/FSA/printapp?fileName=nr_20070308_rel_0058.html&newsType=newsrel

USDA. 2008. “Agriculture Secretary, Deputy and FAS Discuss Conservation Reserve Program (CRP) Decision.”

Figure 1: ACRES EXPIRING FROM CRP THROUGH 2015

Adjusted for Re-enrollment and Extension Offers

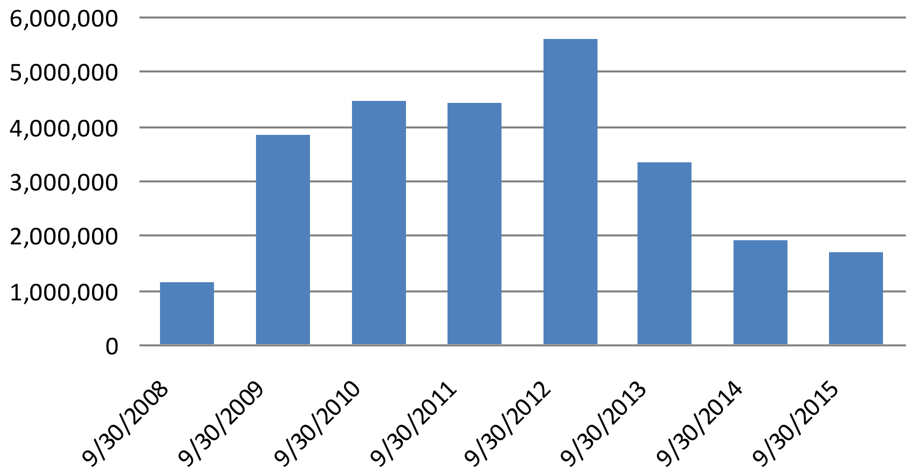

Table.1 Summary Statistics for Land Exiting the CRP in 1992-97

CRP Cover Practices	# of Points(percentage)	Acres (percentage)
Grasses and Legumes	2,471(89.7%)	3,287,000(91.9%)
Trees	198(7.2%)	207,200(5.8%)
Wildlife and Components	87(3.1%)	83,000(2.3%)
Total	2,756(100%)	3,577,200(100%)

Note: the data is summarized from the 1997 NRI that were reported in the CRP in 1992.

Table. 2 Land Use Alternatives after Exiting the CRP in 1997

Land Use	#of Points	Percentage	Acres	Percentage
Cropland	1600	58.06%	2250800	62.92%
Pastureland	737	26.74%	796600	22.27%
Rangeland	166	6.02%	297200	8.31%
Forestland	203	7.37%	184400	5.15%
Others	50	1.81%	48200	1.35%
total	2756	100.00%	3577200	100.00%

Note: cropland contains cultivated and non-cultivated cropland. Others contain urban and build-up land, rural transportation land, small water areas, and other rural land. The data derived from the 1997 NRI on 2756 survey points that exited CRP between 1992 and 1997.

Table. 3 land Characteristics according to Land Use Categories

		Mean	St. De.	Min.	Max.
Crop	LCC	3.19	1.25	1.00	8.00
	Slope	5.15	4.49	0.10	31.00
	CRP Cover	1.06	0.30	1.00	3.00
Pasture	LCC	3.58	1.41	1.00	8.00
	Slope	5.07	5.31	0.10	40.00
	CRP Cover	1.06	0.28	1.00	3.00
Forest	LCC	2.96	1.21	1.00	7.00
	Slope	4.29	2.91	0.40	18.00
	CRP Cover	2.09	0.57	1.00	3.00

Note: pasture contains pastureland and rangeland. CRP cover: 1=grasses or legumes; 2=trees; 3= wildlife components.

Table. 4 Summary Statistics of County-level Land net return to Alternatives

	Net Return($/acre)			
Land Use	Mean	St. De.	Min	Max
Cropland	57.59	33.79	21.60	218.00
Pasture	26.33	23.42	0.03	99.81
Forestland	16.96	19.76	0.06	100.00

Table 5. Nested Logit Results for Land-Use Choice Model, 1992-1997

Explanatory Variables	Co.	St. De.	p-value
Crop return × Slope	-0.001	0.000	0.058
Crop return × LCC	0.002	0.002	0.186
Crop return × Cover	0.029	0.009	0.001
Pasture return ×Slope	0.000	0.000	0.644
Pasture return ×LCC	0.002	0.002	0.143
Pasture return ×Slope	-0.001	0.007	0.924
Forest return ×Slope	0.001	0.001	0.177
Forest return ×LCC	-0.002	0.002	0.352
Forest return ×Cover	-0.007	0.007	0.312
Net forest return	0.010	0.010	0.354
Net pasture return	-0.012	0.010	0.206
Net crop return	-0.038	0.011	0.001
Slope(Pasture)	0.031	0.032	0.327
LCC(Pasture)	0.102	0.104	0.329
Cover(Pasture)	-1.205	0.438	0.006
Pasture Constant	0.466	0.581	0.423
Slope(Forest)	-2376.360	772.858	0.002
Slope(Forest)	-9.943	5.875	0.091
Cover(Forest)	183.810	55.047	0.001
Forest Constant	-215.203	64.734	0.001

Inclusive value para.(crop)	1.000	
Inclusive value para. (pasture/forest)	40.601	11.094

Table 6. Land-Use Choice Elasticity

Land Use	Crop return	Pasture return	Forest return
Crop	0.792***	0.133	-0.008
	(0.256)	(0.095)	(0.060)
Pasture	-1.253***	-0.211	0.013
	(0.360)	（0.152）	（0.095）
Forest	-0.237	-0.001	0.035
	(3.0839)	(1.2293)	(1.3959)

Note: standard errors are in parentheses. *, **, *** denote significance at 10%, 5% and 1% levels, respectively.

Table 7. The simulated effect of the subsidy to forest on agricultural land use

Subsidy($/acre)	Crop	Pasture	Forest
10	2024329	1239450	211636
20	2020728	1275990	225813
40	2013526	1349069	254167
80	1999122	1495228	310875
120	1984717	1641386	367583

Table 8. The simulated effect of the tax to land use out of forest on land use choice

Subsidy($/acre)	Crop	Pasture	Forest
10	2011311	1217822	197748
20	2000712	1226682	197934
40	1990307	1237657	198162
80	1985792	1244937	198512
120	1985792	1243896	198690

Appendix A

The net return per acre cropland is composed of net cash return from agricultural sales and received government payment. Information on net cash return and government payment in each county in 1997 is from Agricultural Resources and Environmental Indicators (AREI) Database. County-level cropland acreage is from the National Agricultural Statistics Service (NASS), USDA. Pasture net returns per acre are proxied by net cash rent for pastureland and rangeland. The Census of Agriculture provides county-level cash grazing rent amounts, while pasture acreage in each county is from NASS. Forest net returns are from USDA Forest Services (NFS).