Title of Poster: Farmer Participation in the Conservation Reserve Program and Bio-fuel Production under Uncertainty and Irreversibility

Authors: *Luca Di Corato**, *Maitreyi Mandal* & *Carl Johan Lagerkvist*

Corresponding address: Department of Economics, SLU, Box 7013, Johan Brauners väg 3, Uppsala, 75007, Sweden. Email: luca.di.corato@slu.se. Telephone: +46(0)18671758. Fax: +46(0)18673502.
Department of Economics, SLU, Uppsala, Sweden.

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Farmed switchgrass can be grown on marginalized land as a renewable and carbon neutral alternative to corn ethonal production. Credit: Photo provided by the USDA-ARS.

Farmer Participation in the Conservation Reserve Program and Bio-fuel Production under Uncertainty and Irreversibility

Luca Di Corato* Maitreyi Mandal** Carl-Johan Lagerkvist***

Department of Economics, Swedish University of Agricultural Sciences, Uppsala, Sweden

Introduction

The Conservation Reserve Program (CRP) is a voluntary agricultural land program established in the 1985 Farm Bill as a strategy to environmentally enhance and benefit farmlands. The program's provisional benefits offer the mitigation of soil erosion and sedimentation, the improvement of watershed control, and increased biodiversity and wildlife habitat conservation. It technically and financially supports farmers to switch marginalized and unproductive acreage to vegetative cover.

The 1985 Farm Bill exercised strong restrictions on the commercial development of CRP land. Following much debate, in 2002, amendments were made to the Farm Bill which incorporated the opportunity for CRP land management to include grazing, haying and biomass harvesting. The stipulations in the revised legislation maintain that land use for grazing, haying or biomass energy crop cultivation shall be assessed a 25 percent reduction in annual rental payment, as well as limit harvesting or grazing management to a maximum of once every three years (Mapemba et al., 2007). Changes in energy policies, by supporting the growing demand for biomass production, are influencing land competition and consequently impacting CRP participation.

Objective: To focus on the impact that policies subsidizing energy crop cultivation may have on CRP participation.

This paper focuses on the biomass energy crop, *switchgrass (Panicum virgatum)*, which is a warm-season perennial grass native to North America. After establishment, switchgrass for biomass feedstock is expected to have a productive life of 10-20 years if managed well. Switchgrass is an extremely well competitor within the stand; though it is not considered to be an invasive plant. It adapts well to a variety of soil and climatic conditions and is most productive on moderately well to well-drained soils of medium fertility with a soil pH at 5.0 or above.

Motivation

Energy policies, by supporting energy crops, have increased land competition and consequently impacted on CRP participation. In the period 2010-2014, 20.6 million acres of land under CRP contracts across the US will expire. Hence, it is crucial to undertake research focusing on land-use choice after contract expiration. This will allow the design of CRP contracts able to promote enrolment (and re-enrolment) under the rising pressure of energy crops.

Methods

The farmer is considered as holding the option to participate to the CRP. The exercise of such option is triggered by a critical threshold at which, accounting for uncertainty on agricultural returns and subsidy, enrolment is preferred to the cultivation of energy crops. Intuitively, we must have two thresholds at which according to the policy state the farmer enters the CRP. Three possible scenarios are of interest:

a) $\pi_t \leq \pi^*_0$: profit are so low that the farmer switch to CRP in any case,
b) $\pi^*_0 < \pi_t \leq \pi^*_1$: the farmer wait if under state 0 and enroll under CRP
c) $\pi^* < \pi_t$: the farmer waits and cultivate energy crops in any case.

This is formulated as an optimal stopping problem in continuous time which, completely characterizes the optimal enrolment strategy as a critical time threshold triggering participation. We regulate the switches between the two possible policy regimes, 0 and 1, where subsidies s_0 and $s_1 = (1-\eta)s_0$ with $0 < \eta \leq 1$ are paid, respectively. The switch regimes is irreversible and regulated by a Poisson process with intensity λ and a jump probability λdt. This will allow us to isolate the impact that subsidy policy and its expected duration have on farmer willingness to participate.

The optimal enrolment time threshold under state 0,$\pi_0 \leq \pi_1$ solves the following equation (see paper for details):

$$\widetilde{L}\pi_0^{*\gamma_1}(1-\frac{\gamma_1}{\gamma_2}) - c_1\pi_0^*(1-\frac{1}{\gamma_2})\frac{r-\alpha}{\lambda} - [\frac{r}{\lambda}c_2 - \eta s_0\frac{1-e^{-(r+\lambda)T}}{r+\lambda}] = 0$$

$$where\ \widetilde{L} = L_1 = \frac{c_1\pi_1^*(1-\frac{1}{\gamma_2})(r-\alpha)+rc_2}{\lambda\pi_1^{*\gamma_1}(1-\frac{\gamma_1}{\gamma_2})} > 0.$$

and in terms of economic insight in can be shown that this requires that the net instantaneous benefit from enrolling cover the rental cost of the capital invested.

Study Area

State of Nebraska in USA has been chosen as the study area to estimate the parameters of our model. CRP program was first introduced in Nebraska in 1986 and as of December 2010, it covers a total area of 919714 acres. The return is equal to the farm gate price of switchgrass times yield minus the various production costs. Ethanol price in $/gallon is available from the Department of Energy Office of Nebraska from 1982 onwards. We have used an estimated biofuel conversion cost of $ 1.4 per gallon (Babcock et al, 2007) and a production cost of $194/acre as reported by Duffy and Nanhou (2001), respectively. Transportation cost is assumed to be $8 per ton (Babcock et al. 2007). Switchgrass yields are based on pilot experiments (Khanna et al. 2008, Khanna 2008, US-EPA, 2009) and the average switchgrass yield is 3.10 tons/acre and the standard deviation is 0.20 tons/acre. It is also assumed that a ton of switchgrass produces 100 gallon of ethanol (Schmer et al. 2008).

Preliminary Results & Discussion

Table 1: Characteristic Model Parameters of State of Nebraska

Parameter	Representation	Value used in the study
p	Fixed CRP Rental Payment of Nebraska	$60.83/acre
r	Risk Free Interest Rate	0.09
α	Drift of Switchgrass return	0.04
σ	Vol. of Switchgrass return	0.544

Numerical simulations

a) Contract length 10 years

	Enrollment Threshold ($/acre) at State 0	Enrollment Threshold ($/acre) at State 1
Subsidy Level 100% (i.e. $139.5/acre)	2.927	16.53
Subsidy Level 80% (i.e. $111.6/acre)	6.757	16.53
Subsidy Level 50% (i.e. $69.75/acre)	11.006	16.53
Subsidy Level 20% (i.e. $27.9/acre)	14.479	16.53

b) Contract length 15 years

	Enrollment Threshold ($/acre) at State 0	Enrollment Threshold ($/acre) at State 1
Subsidy Level 100% (i.e. $139.5/acre)	1.832	15,38
Subsidy Level 80% (i.e. $111.6/acre)	4.196	15,38
Subsidy Level 50% (i.e. $69.75/acre)	8.027	15,38
Subsidy Level 20% (i.e. $27.9/acre)	12.268	15,38

The nominal returns have been deflated to a 1982 base using the PPI available from the Bureau of Labor Statistics. Finally, we have calculated the drift (α) and volatility (σ) parameters of the associated Geometric Brownian motion (GBM). A risk free rate of 9% which is equal to the current yield of 3-moths US treasury notes (source: Bloomberg) was used. Table I represents various exogenous model parameters which are characteristic of Nebraska.

For convergence purpose, we use a drift of 0.04 (drift < risk free rate) though our calculated drift was 0.15. We take $45/dry ton as offered by the BCAP program as the current level of subsidy to biofuel producers. There is some ambiguity regarding the exact amount of subsidy a bioenergy farmer will be entitled to in future when the actual commercial production will take place. We also take the cost of switching (k) between growing switchgrass as bioenergy stock and joining the CRP program as 0 as the representative farmer here grows switchgrass in both the cases. For numerical simulation purpose, we have created 4 subsidy scenarios representing a subsidy share of full 100% ($139.6/acre), 80% (111.6/acre), 50% ($69.75) and 20% ($27.9/acre) as received by the feedstock producers. Subsidy at state 1 i.e. = $0/acre. We also take 2 different contract lengths of 10 and 15 years each to represent the effect of contract size in our model.

Conclusion

Results are preliminary but consistent with our expectation. We expect that the enrollment threshold will be lower with increasing subsidy. As subsidy goes up from $27.9/acre to $139.5/acre, the switching threshold of enrollment ($/acre) at State 0 goes down from $14.4/acre to $2.9/acre in case (a) and from $12.26/acre to $1.8/acre in case (b). A longer contract length effectively lowers the switching thresholds as longer contract period increases uncertainty.

If Interested in Learning More:

* luca.dicorato@slu.se
** maitreyi.mandal@slu.se
*** carl-johan.lagerkvist@slu.se

Department of Economics
Swedish University of Agricultural Sciences (SLU)
P.O. Box 7013, Johan Brauners väg 3
SE-750-07 Uppsala, Sweden