Forest Policy and Economics 13 (2011) 570–574

Contents lists available at ScienceDirect

Forest Policy and Economics

journal homepage: www.elsevier.com/locate/forpol

The impact of biofuels on the propensity of land-use conversion among non-industrial private forest landowners in Florida

Nishita Pancholy [a], Michael H. Thomas [a], Daniel Solís [b,*], Nicholas Stratis [c]

[a] Florida A&M University, Division of Agricultural Sciences, Tallahassee, FL 32307, United States
[b] University of Miami, Division of Marine Affairs and Policy, RSMAS, Miami, FL 33149, United States
[c] Florida Department of Environmental Protection, and Florida State University, Tallahassee, FL 32399, United States

ARTICLE INFO

Article history:
Received 22 November 2010
Received in revised form 14 March 2011
Accepted 6 June 2011
Available online 29 June 2011

Keywords:
NIPF landowners
United States
Probit regression
Land-use conversion

ABSTRACT

A hypothetical market for renting and converting forested land into row cropping for biofuel production revealed that nearly half of the 1060 non-industrial landowners sampled in Florida are willing to accept payments for land type conversion and the resulting supply function is inelastic and positive. While respondent's previous involvement with forest management cost-share program increased their probability of accepting payments for forest type conversion, those who indicated forest aesthetics as the primary reason for the land ownership were less likely to participate in this hypothetical market.

1. Introduction

The United States (US) imports petroleum for more than 60% of its transportation fuels. This high level of reliance on foreign oil has a significant effect on the US national security, economy, and international relations (CFR, 2006). Biofuels (ethanol and biodiesel) have the potential to substitute for petroleum and reduce the national dependency on imported fossil fuels. Biofuels also provide important potential environmental benefits, such as reducing pollutant emissions and the net additions to atmospheric CO_2 (Rahmani and Hodges, 2006). Further contributing to the interest in ethanol, the Energy Policy Act of 2005 mandates the progressive use of renewable fuel in our domestic gasoline supply (Westcott, 2007).

Ethanol can be produced from a variety of renewable agricultural products, including corn, wheat, milo, citrus, crop wastes, and forestry residues. In the US, corn is the main feedstock for ethanol production because it is readily availability and there is a relatively high efficiency of conversion. However, cellulosic-based production of renewable fuels holds promise in the long term (Puppán, 2002).

Expansion of the ethanol sector will likely have a large and important impact on US agriculture. The ethanol industry is intensifying competition in the corn market, which has the effect of increasing prices for this commodity.[1] Higher demand and price for corn may provide economic incentives to farmers to acquire additional land to increase their corn production. Because agricultural land is limited, there is a distinct possibility that corn producers will attempt to rent or purchase forested land and convert it to corn production. This type of land-use transition has taken place in the past (see Ramankutty and Foley (1999) for examples), and there is a possibility that it may continue if prices for corn increase.

In Florida (FL), there is an abundance of land owned by non-industrial private forest landowners (NIPF)[2] that could be rented or purchased by farmers and converted to corn production. According to the Forest Inventory and Analysis factsheet (Brown and Nowak, 2009), the total forested area in FL is approximately 68,000 km^2. About 49% of the state is covered with forests and 94% of the forested land is classified as available for timber production. NIPF owners control 63% of these forested lands in FL.

While there is ample evidence of farmers substituting corn production for soybean, cotton and other row crops (Westcott, 2007), less is known about their propensity to convert forested land to corn production. This lack of market information generates problems in conducting traditional economic analyses based on a revealed preference framework, where peoples' preferences are revealed by their buying and/or selling habits. To solve this issue, economists have used stated preference (SP) techniques, in which market data are collected directly from individuals using hypothetical or contingent markets. According to Freeman (1993) SP techniques have come to refer to environmental studies in which respondents are

* Corresponding author.
E-mail address: d.solis@miami.edu (D. Solís).

[1] A comprehensive analysis of the impact of ethanol production on the US agricultural sector can be found in Westcot t (2007).

[2] NIPF landowners are defined as private forest owners who do not own or operate wood processing facilities, and include farmers, miscellaneous individuals and non-forest industry operations.

1389-9341/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.forpol.2011.06.006

asked questions designed to elicit information about their preferences or values. The most common elicitation approach is the contingent valuation (CV) method, a widely used procedure to determine consumer demand for difficult-to-measure non-market goods and services, which are often times environmentally based. With CV, respondents estimate values through their SP to a detailed hypothetical market for goods or services (Carson and Hanemann, 2005). With CV, individuals are asked to state their willingness to pay (WTP) or willingness to accept (WTA) for a specified amount of the non-market good or service through a bidding process.

Although numerous studies have used contingent behavior to elicit WTP and consumer demand, only a few have focused on the supply side, that is, analyzing the supplier WTA and estimating the corresponding hypothetical supply function. In this case, the supply side is represented by NIPF owners. This study explains NIPF owner WTA decisions regarding land-use conversion with the use of hypothetical corn prices. Their response will help policy makers better understand the influence of corn prices on possible conversion of forest land to row cropping. It will be useful for understanding the behavior of NIPF owners who may not convert their forests at prevailing prices, but may convert forests if the price reaches a level that is acceptable to them.

2. Analytical framework

The decision of NIPF landowners to convert forest land into row crop corn production can be estimated by constructing a model integrating forest land ownership, value, and use. A model proposed by Alberini et al. (1996) demonstrates that an owner's WTA payment for renting or selling a good will depend upon the owner's expected discounted stream of benefits from that good. In the case of NIPF owners, they will compare the discounted stream of benefits of the rent payments owners would receive from converting the land to corn production *versus* alternative uses such as keeping the land forested or even selling it outright.

Within this context, we assume r is the price offered to the NIPF owner as payment to convert his/her forested land to corn production. The forest owner will accept the hypothetical contract at offer price r if and only if r is greater than the landowner's WTA, the minimum price they are willing to accept for land conversion, i.e., r>WTA. Thus, the probability that an owner will accept payment r to convert their forested land to corn can be expressed as the probability that the owner's WTA is less than the offer price r or:

$$Pr(\text{accept payment } r \text{ to convert forested land}) = Pr(r > WTA) \tag{1}$$

Furthermore, WTA is influenced by variables related to the owner and forest land intrinsic characteristics:

$$f(WTA \mid z, x) \tag{2}$$

where, z is a vector of land or site characteristics and x is a vector of NIPF owner household characteristics, including attitudes and management choices.

To evaluate a forest owner's participation choices, the dependent variable WTA in Eq. (2) can be expressed as a dichotomous dependent variable, taking on the value of 1 if the owner accepts r and converts to corn production and 0 otherwise.

3. Data collection, empirical model, and procedure

3.1. Data collection

To elicit WTA responses by NIPF owners in FL to the prospect of converting their forested land to corn production, primary data were collected using a mailed survey instrument. The survey instrument was designed following Dillman's 'tailored design method' (TDM) (Dillman, 2000) in order to enhance response rates from survey participants, yield unbiased answers, and minimize measurement error. This TDM is a set of procedures for conducting successful self-administered surveys that produce both high quality information and high response rates (Dillman, 2000). Care was taken to develop efficient questions and graphical software was used in the final layout to give the instrument a professional look. The survey was pretested before being administered to the sample of NIPF owners.[3] Names and addresses of NIPF landowners in FL were obtained from the Forest Stewardship Program at the University of Florida Institute of Food and Agricultural Sciences (UF/IFAS). The UF/IFAS Stewardship Program manages the most comprehensive list of NIPF owners in FL.[4]

A total of 2832 surveys were mailed to NIPF owners in FL on 24 December 2008 followed by reminder postcards 10 days later. Non-respondents were mailed a second survey in March 2009 and the survey was concluded after 1150 surveys were completed and returned and 350 surveys were counted as undeliverable. Of the 1150 returned surveys, 1060 were completed with no missing relevant data, making the adjusted response rate of useable surveys for this study equal to 42.7%.

3.2. Empirical model and estimation procedure

To evaluate the NIPF owner's participation choice in the proposed hypothetical market consider the following empirical model:

$$ACCEPT = f(BID, HINC, FINC, LAND, TIMBER, NATURE, CSH, CS5, NORTH) + \varepsilon \tag{3}$$

The dependent variable, ACCEPT, is dichotomous in nature and represents the decision of the NIPF owner to accept or reject a payment r to convert forested property to corn production. The offer price r is represented by the variable BID and is one of five predetermined prices. Each survey participant was randomly presented one of these values as annual rent payments per acre for their land. To help avoid starting point bias, the range of contract offer prices was set to simulate a range in corn prices. Corn productivity (180 bushels per acre) and production costs ($300 per acre) were assumed fixed (North Florida Research and Education Center, 2006). While actual productivity and costs would likely vary from area to area, without knowing parcel details these assumptions will serve to build a generalized hypothetical market. Potential revenues were then determined for corn prices ranging from $3.66 to $8.27 per bushel in four increments. Revenues minus production costs were then considered available as annual rent per acre payments to forest owners and assigned as: $360, $480, $740, $980, and $1190. The remaining independent variables control the main characteristics affecting the NIPF owners' decision to accept r; i.e., landowner attitude and managerial strategies, land characteristics, and participation in assistance programs. Table 1 describes all the variables included in the empirical analysis.

Because ACCEPT is binary, a probit regression was used to estimate Eq. (3). Specifically, the model is assumed to take the form:

$$Pr(Y = 1 \mid x) = \Phi(x'\beta) \tag{4}$$

where Pr denotes probability, Φ is the cumulative distribution function of the standard normal distribution, x is the vector of independent variables and β is the vector of unknown parameters. Estimates for unknown parameters were obtained using maximum likelihood (ML) estimation (Greene, 2003).

[3] The questionnaire is available by the author upon request.

[4] More information on this program can be found at http://www.sfrc.ufl.edu/forest_stewardship.

Table 1
Variable definitions and descriptive statistics.

Variable	Type	Definition	Mean	Std. dev.
ACCEPT	Dummy	Dependent variable equals 1 if the NIPF owner accepts the BID; 0 otherwise	*0.45*	–
BID	Continuous	Offered price per acre per year in US Dollars	755	314
HINC	Ordinal	Annual household income. 1 = ≤$25,000 2 = $25,000–$49,000 3 = $50,000–$99,000 4 = $100,000–$199,000 5 = ≥$200,000	3.19	1.12
FINC	Categorical	Importance of forest based income: 1 = unimportant to 5 = very important	1.88	1.15
LAND	Continuous	Total acres of forestland owned	490	1907
TIMBER	Dummy	1 if manage forest for timber production; 0 otherwise	0.83	–
NATURE	Categorical	Relative importance of forest beauty, protecting nature, hunting or fishing. 1 = unimportant to 5 = very important	3.85	0.85
CSH	Dummy	1 if ever participated in a cost share program; 0 otherwise	0.57	–
CS5	Dummy	1 if participated in the cost share program in the past 5 years; 0 otherwise	0.52	–
NORTH	Dummy	1 if site is located in north Florida; 0 otherwise	0.91	–

4. Results and discussions

Table 2 presents the percentage of NIPF owners willing to accept payments to rent their woodlands for land-use conversion at each of five prices offered (BID). For most of the sample, the rate of acceptance increases with the offer price. However, when the bid increases from $360 to $480 there is a slight but non-significant drop in the acceptance rate. The data also show a significant drop of approximately 8% when the bid increases from $980 to $1190. Similar behavior has been reported in the literature (Kennedy, 2001; Shyamsundar and Kramer, 1996).

Shyamsundar and Kramer (1996) argue that the slight drop in the acceptance level with increased bid values could be explained as a random event. However, there may be additional reasons for the drop in the acceptance rate when bid increased from $980 to $1190. Table 3 shows the main reason given by the respondents when asked why they did not accept the price offered. The group of NIPF owners who were offered $1190 appears to have greater concern for the environment than the other groups, a bias that was not avoided through random sampling. In comparison, this group had more individuals who opposed converting their land at any price and they ranked their reasons for land ownership, such as valuing beauty, higher than other groups. Importance of preserving land in a forested condition by landowners was also reported by Kennedy (2001), who indicated that in Virginia, NIPF owners with high environmental preferences are generally less likely to accept bids even with increases in offered prices. Additionally, a larger proportion of respondents at the higher bid level indicated that they do not believe the hypothetical market for corn production would work. Furthermore, only 1.9% of the respondent indicated that the offer price was too low. Thus, participants may doubted the offer price and felt that $1190 may have been too high for this specific market, which would have further contributed to their skepticism.

The data in Table 2 are used to plot a supply curve (Fig. 1) which describes, *ceteris paribus*, NIPF owners' WTA a bid at a given price. The supply curve follows a positive trend and depicts a steep slope, suggesting an inelastic behavior. Binkley (1993) explained that woodlands display, in general, inelastic supply curves because of the substantial capital and time invested to operate in this sector. On the other hand, the trend of the supply curve shows an r^2 equal to 0.711 indicating that the offered price explains 71.1% of WTA. A more refined analysis of factors affecting the NIPF owners' likelihood of accepting the offered bid is presented in Table 4.

Table 4 shows the maximum likelihood the (ML) estimates of the probit model (Eq. (3)) that specify the probability an NIPF owner accepts a bid as a function of the offer price, participant's attitude and managerial strategies, land characteristics, and history of participating in forest assistance programs. This table displays the estimated coefficients along with their respective marginal effects (MEs). The MEs measure the change in the probability of WTA due to a one-unit change of a specific explanatory variable. The MEs for dummy variables are estimated by taking the difference between the value of the prediction when the exogenous variable equals 1 and when it equals 0. By contrast, MEs for continuous variables are estimated as $ME = \phi(\delta Z)\delta$, where ϕ is the probability density function, Z is the vector of exogenous variables, and δ are the estimated parameters (Maddala, 1983). The MEs for both kinds of variables are measured at the mean value of the regressors.

As shown in Table 4, the probit model performs fairly well in explaining variations in responses to the contingent valuation question. More precisely, the model correctly predicts NIPF owners' decisions to convert their land at the offered price for 51% of the observations and the likelihood ratio test rejects the null hypothesis that all slope coefficients are equal to zero at the 1% level. Individually, 9 out of the 10 estimated parameters are statistically different from zero and most of them present signs consistent with the literature and intuitive expectations.

The main results of the probit model can be summarized as follows. The variable BID displays a positive and significant effect in

Table 2
Percentage willingness to accept (WTA) per offered price.

Offered price, $	Acceptance %	N
360	40.3	226
480	40.2	209
740	49.7	193
980	53.9	204
1190	45.6	228
Total	45.8	1060

Table 3
Reasons respondents gave for not accepting hypothetical contract at different offered prices. All values are in %.

Offered price	Price too low	Don't believe program would work	Will never convert forest property	Other reasons[a]
360	15.0	17.0	51.5	16.5
480	16.0	12.7	56.8	14.5
740	9.2	16.3	56.7	17.8
980	11.4	17.0	55.6	16.0
1190	1.9	19.1	60.2	18.8
All	10.7	16.2	56.2	16.9

[a] Other reasons include environmental issues like high value of forest beauty, protecting nature, and interest in hunting or fishing.

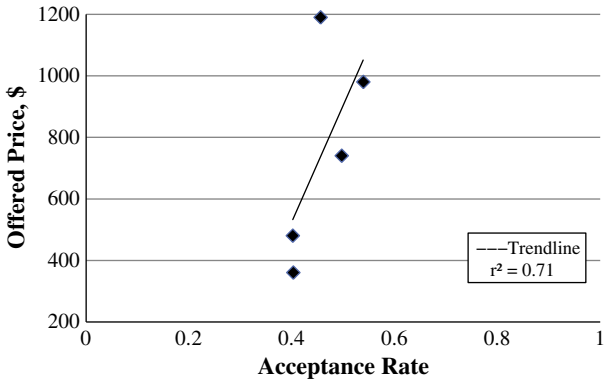

Fig. 1. Hypothetical supply curve of NIFP forested land for corn production in Florida.

determining the acceptance level for land-use conversion. This result agrees with economic theory and indicates that NIPF owners in FL are rational decision-makers (respond positively to increasing offer prices). In addition, the ME for this variable is low, confirming the finding described earlier that woodlands display an inelastic price relative to supply. Similar results were reported by Shyamsundar and Kramer (1996).

The annual household income (HINC), which includes woodland and non-woodland earnings, displays a positive and statistically significant coefficient, which indicates that NIPF owners with higher annual incomes are more likely to accept the offered bid than those earning less. This result is consistent with the finding of Joshi and Arano (2009) who suggested that as income level increases, the capacity of landowners to acquire resources (i.e., tract size, information and private consultation) increases, which in turn allows them to engage in those forest management activities that will maximize profits. It is worth noting that contradictory findings were reported by Kennedy (2001), who found that in Virginia wealthier landowners tend to hold their woodlands as long-term investments.

The variable FINC evaluates the effect of forest-based income on the probability that a respondent would accept the offered BID. To avoid collinearity problems with HINC, this variable was measured as a categorical variable reflecting the importance of forest-based income on total income. FINC also displays a positive and significant relationship with WTA the offered bid. This result could be explained by the fact that NIPF owners with more of their income coming from their woodland tend to be more business oriented and more willing to accept the notion of hypothetical markets and transforming their forest into a different use. Conversely, NIPF owners with less of their income coming from their woodlands could be holding their properties for non-economic (environmental) reasons or as a long-term investment and less likely to willingly convert their forests.

Land area (LAND) presents a positive but not statistical effect on the NIPF owners' WTA the offered bid. The literature reports mixed results on effect of parcel size on NIPF owners' forest management behavior. On one hand, Amacher et al. (2003) reported that land size was the single most important variable in explaining landowner managerial behavior. However, Joshi and Arano (2009) found that forest area had negative effects on landowners' willingness to engage in silvicultural activities. No significant effects were reported by Romm et al. (1987).

The variable TIMBER is positive and significant suggesting that NIPF owners who manage their woodlands for timber production are more likely to rent out their woodland than are non-timber oriented landowners. In fact, the ME for TIMBER indicates that the former group is 20.8% more likely to accept the offered price than the latter group. This result agrees with Egan (1997), and Conway (2002). Specifically, Conway (2002) shows that landowners who were heavily involved in non-timber activities were very reluctant to accept any kind of compensation for harvesting their woodlands.

The variable NATURE is negative and significant revealing an inverse relationship between the probability of participating in the program and owning forest for its non-timber amenities (recreation, wildlife, environment, etc.). Joshi and Arano (2009) showed that owning forestland for non-timber forest products and environmental services is becoming popular, especially in areas where population density is high. In fact, Hodge and Southerland (1992) claimed that the main reasons why NIPF owners owned forestland in Virginia were to preserve nature, to maintain scenic beauty, and to view wildlife. On the other hand, Zhang et al. (2005) argued that when a landowner makes frequent use of non-timber products and services, owning forestland is more efficient for them because it saves the transaction costs involved in getting these services from the market.

The variables CSH and CS5 analyze the behavior of NIPF owners involved in any state or federally sponsored cost share programs (CSP) for more or less than five years, respectively. CSH shows a positive and significant coefficient and an ME of 0.22 suggesting that NIPF owners using CSP for more than five years are 22% more likely to accept a bid than their counterparts. Demers (2010) verifies this and states that agricultural farmers have a history of using CSP to obtain additional governmental payments for their land. If the offered bid exceeds what owner is receiving from the government for keeping the land forested, then switching back to an agricultural commodity will become more economically attractive.

NIPF owners involved in CSP for less than five years (CS5) show a negative and significant preference towards accepting the bid, which contrasts with preferences of NIPF owners involved in CSP for more than five years. This behavioral change could be explained by changes in the type of NIPF owner seeking involvement with CSP in FL. According to Demers (2010), in recent years NIPF landowners owning non-commercial forests have joined the CSP mostly through the wildlife habitat improvements program (WHIP). WHIP is a voluntary program for conservation-minded landowners who want to develop and improve wildlife habitat. A similar trend is reported by Joshi and Arano (2009) among NIPF owners in West Virginia. In this case, the offered price is irrelevant to landowners because land profitability falls outside of their objectives.

Lastly, the dummy variable NORTH evaluates potential differences in WTA between NIPF owners located in north and south Florida. This variable has a positive and significant coefficient and its ME suggests that NIPF owners in north Florida are 17.8% more likely to accept the offer price than those who own woodlands in the south. This result could be explained by the fact that south Florida presents a higher urban population than north Florida. Thus, NIPF owners in the south might be holding their land for non-production purposes, such as real estate development.

Table 4
Determinants of WTA (probit model).

Variable	Coefficient	SE	ME
CONSTANT	−1.4262***	0.4187	–
BID	0.0003*	0.0001	0.0001
HINC	0.1527***	0.0512	0.0609
FINC	0.1126**	0.0515	0.0449
LAND	0.0000	0.0000	0.0000
TIMBER	0.5376***	0.1816	0.2089
NATURE	−0.1824***	0.0662	−0.0727
CSH	0.5712***	0.1723	0.2219
CS5	−0.2849**	0.1249	−0.1132
NORTH	0.4582**	0.2193	0.1787
Likelihood ratio test (χ^2[9])		62.96***	
% of Correct predictions		51.05%	

* 10%, ** 5% and ***1% level of significance.
NOTE: The dependent dichotomous variable reflects the level of acceptance.

5. Summary and conclusions

This study evaluates the propensity of non-industrial private forest (NIPF) landowners to rent their forested land to cultivate corn for biofuel production. A contingent valuation approach is used to estimate the NIPF owner's willingness to accept payments under alternative rent values, derived from hypothetical corn price scenarios. The empirical analysis uses data collected from 1060 NIPF owners in Florida. The results shows that 45.8% of the studied NIPF owners are willing to accept payment to rent their land and the overall supply function is positive and inelastic. NIPF owners who manage their woodlands for timber and those using any state or federally sponsored cost share programs have the highest probability of accepting payments. Opposite results are found for those owning their forest for beauty, hunting, or other recreational activities. Regional differences are also demonstrated with NIPF owners in north Florida more likely to rent their land than those in central and south Florida.

Acknowledgments

The authors gratefully acknowledge the helpful comments received from Chris Demers, Oghenekome Onokpise and Keith Ingram. This work has been supported by the Center for Biological Control at Florida A&M University and the Southeast Climate Consortium.

References

Alberini, A., Harrington, W., McConnell, V., 1996. Estimating an emissions supply function from accelerated vehicle retirement programs. The Review of Economics and Statistics 78, 251–265.

Amacher, G.S., Conway, M.C., Sullivan, J., 2003. Econometric analyses of nonindustrial forest landowners: is there anything left to study? Journal of Forest Economics 9, 137–164.

Binkley, C.S., 1993. Long-run timber supply: price elasticity, inventory elasticity, and the use of capital in timber production. Natural Resource Modeling 7, 163–181.

Brown, M., Nowak, J., 2009. Florida 2007, Forest Inventory and Analysis Factsheet. U.S. Department of Agriculture Forest Service.

Carson, R.T., Hanemann, W.M., 2005. Contingent Valuation. : Handbook of Environmental Economics, Volume 2. Elsevier, pp. 821–936.

CFR, 2006. National Security Consequences of U.S. Oil Dependency. Council on Foreign Relations, Washington, D.C.

Conway, C.M., 2002. Targeting Nonindustrial Private Landowner Groups for Timber Market Entry. Virginia Polytechnic Institute and State University, Ph.D. dissertation.

Demers, C., 2010. Personal communication. University of Florida Forest Stewardship Coordinator.

Dillman, D.A., 2000. Mail and Internet Surveys: The Tailored Design Method, 2nd edition. John Wiley and Sons, New York.

Egan, A.F., 1997. From timber to forests and people: a view of nonindustrial private forest research. Northern Journal of Applied Forestry 14, 189–193.

Freeman, A.M., 1993. The Measurement of Environmental and Resource values: Theory and Methods. Resources for the Future, Washington, D.C.

Greene, W., 2003. Econometric Analysis, 6th Edition. Prentice-Hall, New Jersey.

Hodge, S.S., Southerland, L., 1992. A profile of Virginia NIPF landowners: results of a 1991 survey. Virginia Forests 53, 7–11.

Joshi, S., Arano, K.G., 2009. Determinants of private forest management decisions: a study on West Virginia NIPF landowners. Forest Policy and Economics 11, 118–125.

Kennedy, N.S., 2001. Reservation prices and willingness to accept price offers for nonindustrial forest landowners in Western Virginia. Master thesis, Virginia Tech.

Maddala, G.S., 1983. Limited-Dependent and Qualitative Variables in Econometrics. Cambridge University Press, Cambridge.

North Florida Reasearch and Education Center, 2006. Enterprise budget. Available at: http://nfrec.ifas.ufl.edu/programs/enterprise_budgets.shtml#field_crops.

Puppán, D., 2002. Environmental evaluation of biofuels. Periodica Polytechnica Ser. Soc. Man. Sci. 10, 95–116.

Rahmani, M., Hodges, A., 2006. Potential feedstock sources for ethanol production in Florida. EDIS document FE650, Institute of Food and Agricultural Sciences, University of Florida.

Ramankutty, N., Foley, J.A., 1999. Estimating historical changes in global land cover: croplands from 1700 to 1992. Global Biogeochemical Cycles 13, 997–1027.

Romm, J., Tuazon, R., Washburn, C., 1987. Relating investment to the characteristics of nonindustrial private forestland owners in northern California. Forest Science 33, 197–209.

Shyamsundar, P., Kramer, R.A., 1996. Tropical forest protection: an empirical analysis of the costs borne by local people. Journal of Environmental Economics and Management 31, 129–144.

Westcott, P.C., 2007. Ethanol Expansion in the United States: how will the Agricultural Sector Adjust? USDA Economic Research Service Outlook Report No. FDS-07D-01. Washington, DC.

Zhang, Y., Zhang, D., Schelhas, J., 2005. Small-scale non-industrial private forest ownership in the United States: rationale and implications for forest management. Silva Fennica 39, 443–454.