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Farm & Ranch Management

Marketing & Agribusiness

Natural Resources & the Environment

Policy & Institutions

Regional & Community Development

The Western Economics Forum

A peer-reviewed publication from the Western Agricultural Economics Association

Purpose

One of the consequences of regional associations nationalizing their journals is that professional agricultural economists in each region have lost one of their best forums for exchanging ideas unique to their area of the country. The purpose of this publication is to provide a forum for western issues.

Audience

The target audience is professional agricultural economists with a Masters degree, Ph.D. or equivalent understanding of the field that are working on agricultural and resource economic, business or policy issues in the West.

Subject

This publication is specifically targeted at informing professionals in the West about issues, methods, data, or other content addressing the following objectives:

- Summarize knowledge about issues of interest to western professionals
- To convey ideas and analysis techniques to non-academic, professional economists working on agricultural or resource issues
- To demonstrate methods and applications that can be adapted across fields in economics
- To facilitate open debate on western issues

Structure and Distribution

The *Western Economics Forum* is a peer reviewed publication. It usually contains three to five articles per issue, with approximately 2,500 words each (maximum 3,000), and as much diversity as possible across the following areas:

- Farm/ranch management and production
- Marketing and agribusiness
- Natural resources and the environment
- Institutions and policy
- Regional and community development

There are two issues of the *Western Economics Forum* per year (Spring and Fall).

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Agricultural Household Hedging With Off-Farm Income

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Introduction

Off-farm income (OFI) represents a high and generally increasing percentage of average farm operator household income in the United States (Mishra et al.). As shown in Table 1, OFI accounted for about 95% of total farm household income in 2002 whereas it represented only 88% in 1998. This trend has been in place for decades (OFI represented about half of farmers' income in 1964, Mishra et al.), but has been more noticeable since the 1980s because real farm income has been trending downward since the 1970s. A long-used explanation for the increase in OFI of farm households is that rural economies have developed, thus making off-farm employment more available to farm families. Certainly, *availability* is a necessary condition, but it is not sufficient to explain why some farmers pursue OFI and others do not. A second explanation sometimes suggested is that farmers pursue OFI to replace lost income from farming operations, thus implying that farmers focus on farm profit levels, possibly in a safety-first context, when making decisions about OFI. A third explanation has been proposed recently: that off-farm income represents a vehicle with which farm households can hedge against the variability in farm income. This view implies that risk (expressed as farm income variability) and farmers' risk attitudes are the factors driving the decision of whether or not to hedge. OFI is viewed as the obvious vehicle for hedging because labor is more flexible than land and physical capital, which are quasi-fixed in the short run. However, what has been overlooked in previous research on this topic is the effect of farm size on the decision to hedge with OFI.

Table 1. U.S. Farm Income, 1998-2004.

	1998	1999	2000	2001	2002	2003	2004
				$ Billion			
Total cash receipts	195.8	187.5	192.1	200.1	195.0	216.6	241.2
Net farm income	42.9	46.8	47.9	50.6	36.6	59.5	82.5
Direct government payments	12.4	21.5	22.9	20.7	11.2	17.2	13.3
Adjusted production income*	30.5	25.3	25.0	29.9	25.4	42.3	69.2
				$ Per Farm Operator Household			
Net cash farm income	14,357	13,194	11,175	14,311	11,336	14,979	20,638
Earnings from farming	7,106	6,359	2,598	5,539	3,477	7,884	14,201
Off-farm earnings	52,628	57,988	59,349	58,578	62,284	60,173	67,279
Avg. farm household income**	59,734	64,347	61,947	64,117	65,761	68,597	81,480

Source: USDA (2006 and earlier issues)
* This is calculated as net farm income minus direct government payments.
** This is the sum of "earnings from farming" and "off-farm earnings."

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Farm size must be considered to provide a more-complete understanding of the decision-making process of farm households that are allocating some of their labor to off-farm employment. Both the absolute *level* and *variability* of farm incomes are expected to increase with the size of farm. That means different production and investment decisions may be made by producers who are identical in all respects except for the size of their farming operations. For example, very small-scale farms may not be capable of generating sufficient income to support a household, even if all household labor is allocated to farming, whereas large-scale farms may easily support families that have allocated most household labor off-farm. This issue has regional implications because the West has many more large-scale operations than other parts of the country (USDA 2004), thus we may see different hedging patterns.

The objective of this study is to evaluate the effects of off-farm income on the labor-allocation and cropping decisions of households across farm sizes in a hedging context. A simple portfolio model is developed that identifies the optimal hedging position for farm households. Then, the effects of off-farm income opportunities are evaluated across farm sizes using the theoretical model. Next, regression analysis is used to test hypotheses about the effects of farm size, a variable neglected in the literature. Finally, results are presented by region to enable comparisons between the West and other parts of the country.

A Portfolio Model of Off-Farm Income Effects

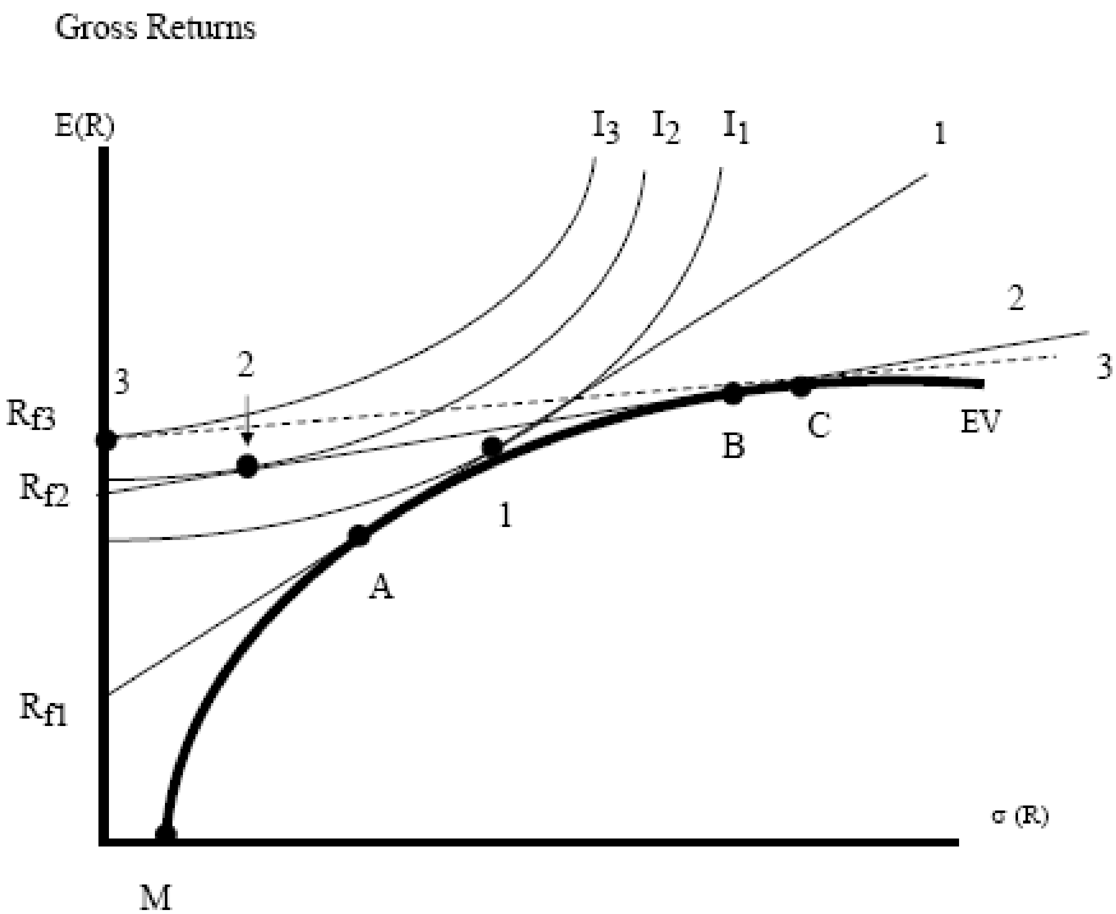
Crop market opportunities available to farmers vary over time and space. It is possible that a farmer's financial obligations and/or risk preference may not be satisfied by any of the returns currently expected from producing specific enterprises. In this case the farmer may consider "selling" some of the household's labor in some local market, rather than allocating it all to farming operations. The off-farm sales price of farm labor (i.e., the wage rate) was shown by El-Osta and Ahearn to depend on the current labor supply in the local market, local demand for particular skills, and the level of skills possessed by the individual job seeker (i.e., the human capital). Thus, the decision of whether to allocate some household labor to off-farm employment involves a comparison of the expected income from farming operations and the cost of foregoing off-farm opportunities.

A person deciding whether to produce crop and/or livestock enterprises in a particular market must first identify the opportunities available in that market. Those opportunities can be plotted on an expected return-variance (EV) graph to facilitate analysis. This is done for a hypothetical market in Figure 1. The curve is plotted with expected gross returns on the vertical axis and risk (in this case measured as the standard deviation of expected returns) on the horizontal axis. Each point on the EV curve is an enterprise or portfolio of enterprises that is efficient in terms of its return/risk relationship, meaning that points on the EV curve have the highest available returns for the associated level of risk. Thus, the EV curve is the collection of all efficient production choices available to the decision-maker. The location and shape of the EV is determined by the data used to calculate expected returns for all portfolios. Therefore, each person may have a unique EV curve because of differences in production capabilities and expectations between people.

If no off-farm employment is available, for whatever reason, farmers can invest household labor only in the production of crops and/or livestock. Each person would choose to produce the portfolio represented by the point on the EV that is tangent to one of his or her indifference curves. This leads to different enterprise portfolios being produced by farmers with different risk attitudes.

If off-farm income is available, the opportunity set available to farmers is altered. In this study, a risk-free return (R_f) to labor is defined as the highest amount of money a farmer could earn (after related costs) from working off-farm. That amount is the product of the (net) hourly wage rate offered and the number of hours that can be worked (usually assumed to be "full-time," but could be less). Working only off-farm is analogous to investing entirely in a risk-free asset, which has a return of R_f, and is plotted as a point on the vertical axis of an EV graph.

Figure 1. Farm Labor Allocation and Production Decisions.



When off-farm income is available, and under the assumption of efficient markets, the separation theorem indicates that all farmers who have the same returns expectations (represented by a single EV curve) and OFI opportunities will produce the same crops, although the composition of their selected portfolios (which includes the OFI component as well as farm efforts) will still vary with their risk attitudes (Johnson). Using the risk-free return, a single optimal risky portfolio and a farmer's opportunity line (OL) can be identified. The OL represents the opportunity set available to farmers in a market (given some returns expectations). It is plotted as a straight line that passes through the point representing the risk-free return and is tangent to the EV. The OL dominates the EV at all points except where the two frontiers are tangent. The point of tangency represents the market's "optimal" portfolio, which has expected returns of $E(R_m)$. The particular portfolio selected by each farmer is found at the point of tangency between this linear OL and an indifference curve for that person. The selected portfolio in this case is a mix of the market portfolio of enterprises produced with the portion of labor allocated on-farm, and the risk free asset amount earned as OFI, and has total expected returns of $E(R_i)$.

For example, in Figure 1 the OL existing for farmers when OFI opportunities have the value R_{f1} is the line labeled "1", which is tangent to the EV at point A. If a farmer's indifference curve is tangent to line 1 at point A, all of that household's labor should be "invested" in producing the crops comprising the optimal portfolio represented by that point. If the indifference curve is tangent at some point to the left of A, the household will invest some labor in producing portfolio A (the specific combination of crops in the optimal portfolio) and will invest the remaining labor in the risk-free asset by working off the farm. Points on the OL to the right of A require an investment in portfolio A involving all of a household's labor and some additional hired labor. Thus, all labor used for crop production by farmers sharing the expectations represented by the EV will be used to produce the same portfolio of enterprises in the same relative proportions. The only difference in composition of selected portfolios between farmers will be the relative proportions of available labor each chooses to use on- or off-farm (and the resulting difference in total agricultural output due to different input levels). This result comes from the separation theorem that suggests that the selection of the crop mix does not depend upon the decision maker's risk preferences, since it is constant along the OL. Instead, the amount of labor allocated on- or off-farm is the variable affected by risk preferences.

A farmer's profit function for holding his or her selected portfolio over some future period can be specified as

$$E(R_i) = E(GR_m)X_m + R_fX_f - K \qquad (1)$$

where R_i is net profit (returns) from selected enterprise portfolio i, E is the farmer's expectations operator, GR_m is gross returns from the market's optimal enterprise portfolio, R_f is the risk-free return from off-farm employment, X_m is the proportion (or total number of units) of labor used to produce the market portfolio, X_f is the proportion (or total number of units) of labor sold (or hired if negative) off the farm, and K is the total fixed costs incurred in owning a farm (including mortgage, property taxes, insurance, investments in improvements, etc.), expressed in per acre (or total dollar) terms. If X_m and X_f are expressed in terms of proportions (hours), they must sum to one (the total hours available for the entire household).

In portfolio theory, utility maximization is assumed to be the objective. Therefore, the focus of decision making is the certainty equivalent of $E(R_i)$, which is

$$E(U_i) = E(R_i) - (\gamma/2)(\sigma^2_i) \qquad (2)$$

where U is utility, γ is a risk-aversion parameter (equaling the slope of the indifference curve at the tangency point) which is positive for risk-averse hedgers, and σ^2 is the variance of expected returns. The first-order conditions for equation 2 give the utility-maximizing portfolio composition,

(3)
$$X_m = \frac{E(GR_m) - R_f}{\gamma\sigma^2{}_m}$$

subject to the constraint $X_m \geq 0$, and remembering that the proportion of labor sold or hired (X_f in equation 1) is 100%-X_m. Thus, equation 3 is analogous to the "optimal hedge ratio" for a household allocating its labor to farm and off-farm activities.

Effects of Off-Farm Income Levels

Comparing OFI opportunities to expected production returns leads to implications concerning the decision whether or not to produce and, if so, what crop/livestock enterprises to produce. In general, if the situation facing some farmers is $E(R_m) < R_f$, those households would want to work "full-time" off-farm but may choose to continue farming as a "leisure" activity (Blank). On the other hand, if $E(R_m) > R_f$, some rational farmers may work full-time on-farm because higher returns are expected from production of efficient agricultural enterprise portfolios. However, most American farmers now allocate some household labor to both farm and off-farm employment activities.

Different cropping possibilities across time and spatial markets generate different levels of expected income that, in turn, help explain labor allocation differences between dates and locations. For farmers, returns from agricultural production are the alternative to working off the farm and earning the risk-free return. The higher the value of agricultural returns, the more incentive there is for farmers to produce crops rather than to work for others. The reverse is also true. It is hypothesized that OFI affects cropping decisions both directly and indirectly through other factors, as described in the following subsections.

Direct Effects of Off-Farm Income Changes

What direct effects do changes in off-farm income levels have on farmers' cropping decisions? To begin, it is assumed that a farmer has the OFI opportunities reflected by R_{f1}, making line 1 the relevant OL in Figure 1. The indifference curve I_1 reflects the farmer's risk attitude. Since I_1 is tangent to line 1 at point 1, the farmer would select portfolio 1. Portfolio 1 requires that the farmer use all household labor and some additional hired labor for production of the crops in portfolio A (the optimal portfolio). Thus, X_m in equation 3 is greater than one (or 100%) in this case.

If OFI opportunities increase to R_{f2}, cropping decisions of the farmer change significantly. Line 2 in Figure 1 becomes the relevant OL and it is tangent to the EV at point B. The farmer's utility is increased, as indicated by the move from indifference curve I_1 to I_2. The farmer's new selected portfolio is at point 2. Portfolio 2 requires that the farmer use only part of household labor for production of the crops in portfolio B (the new optimal portfolio), with the remaining labor being allocated off-farm ($1 > X_m > 0$). The composition of portfolio B is clearly more risky than that of portfolio A. Hence, theoretically farmers respond to increases in off-farm income levels by producing more-risky crops, but they produce using lower labor inputs (and probably fewer acres). This means, for example, that a wheat farmer in Washington State may be more willing over the long-run to shift some acreage into production of a specialty crop (such as a tree crop – e.g., apples, cherries) if some member of the household gains off-farm employment.

If available OFI levels increase further to R_{f3}, the farmer's cropping decisions change again. Line 3 in Figure 1 becomes the relevant OL and it is tangent to the EV at point C. The farmer's utility is increased further, as indicated by the move from indifference curve I_2 to I_3. The new selected portfolio is at point 3. Portfolio 3 requires that the farmer allocate all household labor off-farm ($X_m = 0$). The composition of the new optimal portfolio, C, is more risky than that of portfolio B and, considering the farmer's risk preferences, C is too risky to produce given current OFI opportunities (thus line 3 is dashed).

In sum, higher OFI opportunities lead to the production of more-risky crops and a "hedge ratio" involving more household labor being allocated off-farm. This can be seen by substituting higher values for R_f into equation 3.

Effects of Farm Size

Two of the variables on the right side of equation 3, GR_m and σ^2_m, are both functions of farm size. A farmer's gross revenues from producing the optimal enterprise portfolio obviously are expected to increase when that portfolio is produced on more acres. The variance of those returns is also expected to increase as farm size increases. It is easily seen that higher values of GR_m in equation 3 result in more labor being allocated on-farm, while higher values for σ^2_m encourage more labor to be allocated off-farm. Thus, in the simplest case, larger farm sizes can have either more or less household labor allocated off-farm, compared to decisions made by the same person when operating a smaller farm.

However, the simple case ignores economies of scale. One of the incentives for farmers to expand the size of their operations is the increased production and management efficiencies that lower production costs per unit, thus increasing profit margins. In other words, it is expected that economies of scale improve the return-risk tradeoff facing operators of increasingly larger farms. That means the value of X_m in equation 3 is expected to grow as farm size grows. This theoretical result is consistent with observed behavior of American farmers: a smaller portion of household labor is allocated off-farm by farms of increasingly larger size (Lee and Blank; Yee, Ahearn and Huffman).

This is illustrated graphically in Figure 2. There are three EV curves in the figure to represent three farms of different sizes, EV_1 being the smallest and EV_3 being the largest. The three curves are drawn so as to illustrate the two ideas mentioned above. First, the fact that returns and risk are positively correlated is shown by the position of each successive EV, from 1 to 3, being drawn above and to the right of previous curves. Second, the efficiency gain from larger sized farms is shown by having larger farms able to earn higher returns at the same levels of risk as available to smaller farms. In other words, a vertical line from the x-axis that intersects two or three of the EVs identifies portfolios (at the points of intersection with each of the EVs) that have identical levels of risk exposure, but have higher returns for larger farms. The effects of farm size on farm labor allocations are illustrated with three OLs drawn from a single off-farm income opportunity, R_1, tangent to the EVs to identify the optimal portfolio for each farm size at the points labeled A, B and C. This shows how a single farmer would react if he or she were operating farms of different sizes.

Figure 2. Off-Farm Income and Farm Size Effects.

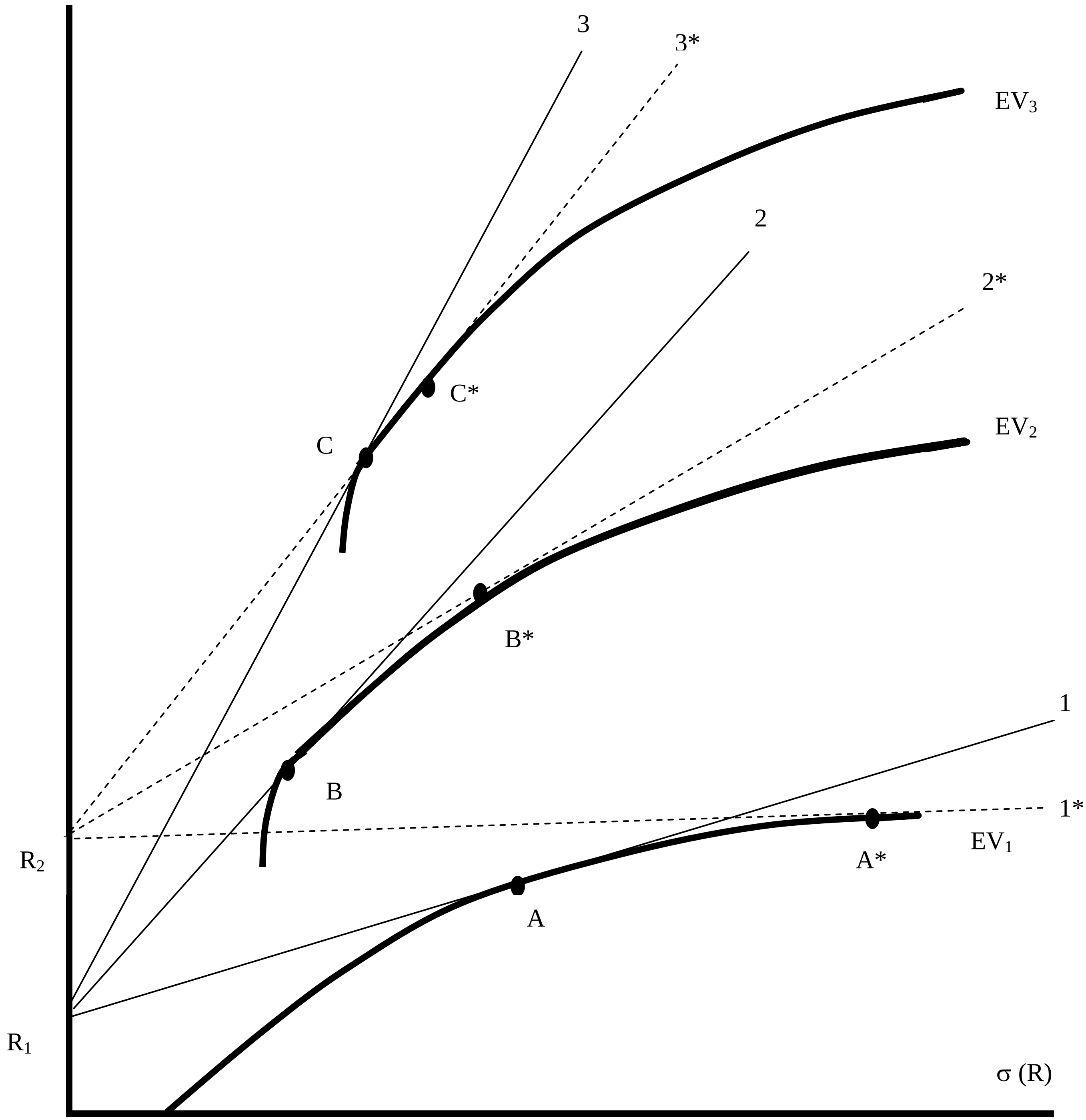


Figure 2 also illustrates the theoretical result that increases in OFI opportunities cause farmers in the aggregate to produce more-risky crops (as shown in Figure 1), but the scale of changes in production risk exposure and a farmer's reaction to it vary across farm sizes. For example, a change in OFI opportunities from R_1 to R_2 shifts the optimal portfolio from points A, B and C to points A*, B* and C*, respectively. It is clear in Figure 2 that the new optimal portfolios are each more risky than the original portfolios, but the amount of increase in production risk exposure between the pairs of points (measured by the horizontal distance between the points, e.g., between A and A*) is smaller with larger farm sizes. As a result, the points of tangency between the new opportunity lines (1*, 2* and 3*) and the farmer's indifference curves indicate much different hedge ratios across the farm sizes. If it is assumed that the tangency point for OL 1* is at R_2 on the vertical axis, all labor would be allocated off-farm by the farmer. That same person, however, would not allocate all labor off-farm if he or she was operating the farm represented by OL 2*. Finally, even less labor would go off-farm if the person was operating the largest farm.

Empirical Analysis

The main hypothesis raised in the discussion above was tested empirically with farm household survey data. Specifically, the significance of OFI to household wealth was assessed across farm sizes.

Off-farm income is expected to be important to a farm household because it is a source of wealth (Koenigstein and Lins). Wealth changes (measured by changes in a farmer's total equity) during a period of time ending at t are expected to consist of some function (j) of farm income (FInc) plus off-farm income (OFInc) plus capital gains (ΔK) minus consumption (C). Thus, at the time that production and investment decisions must be made, t, the resulting expectations for changes in wealth are

$$E_t(\Delta W_{t+1}) = f_j(FInc_t + OFInc_t + \Delta K_t - C_t). \tag{4}$$

The components on the right-hand side of equation 4 are themselves functions of other factors. For example, the capital variable (K) is a function of many other factors, including farm size. It can be expressed as the sum of the market values for all assets (farm real estate, nonreal estate, and non-farm assets) held by a person at time t. Those assets, such as farm real estate, may have market values based on factors such as expected farm income. Thus, a reduced form of equation 4 can be estimated over time for farms of different sizes to determine whether OFI does, in fact, play a significant role.

Equation 4 was estimated using farm-level data from the U.S. Department of Agriculture's Agricultural Resource Management Survey (ARMS). It was estimated using repeated cross-sectional data from annual surveys for 1996-2004 over the ten production regions making up the 48 contiguous states: the Northeast, Lake States, Corn Belt, Appalachia, Southeast, Delta, Southern Plains, Northern Plains, Mountain, and Pacific (the last four of those regions are "the West").[2] Then, factors affecting the change in wealth were examined, given farm size and time effects. A total of 95,517 observations were used following the jackknifing procedure described in Kott.

The farm-level data were assigned to three size categories, based on the USDA's farm typology groups (Hoppe and MacDonald). Farm size 1 includes "limited resource," "retirement," and "residential" farms. These farms all have total sales of less than $250,000 per year (most have

[2] The ARMS data, as a whole, are designed to give a representative "snap shot" of American agriculture each year, not a detailed assessment of any particular crop, state, or production region. Hence, this study is general in its focus and does not try to assess any particular group of households.

less than $100,000 per year) and the operators may report farming, a non-farm occupation, or retirement as their major occupation. Farm size 2 includes typologies "farm/lower sales" and "farm/higher sales." Their total annual sales are less than $100,000 or less than $250,000, respectively, but farming is the operator's primary occupation. Farm size 3 covers the typologies "large family farms" and "very large farms" that have annual sales of $250,000 and more.

The nominal values of the monetary variables were deflated by the GDP implicit price deflator using the year 1996 as the base. Variables presented in Table 2 are in year 1996 dollars.

It is clear from the results in Table 2 that Size 1 households have focused some of their investment activities off the farm. Farm and non-farm capital gains were both significant sources of wealth for small-sized farms. Medium- and large-sized farms derive wealth only from gains on their farm capital, which is most likely their land. Equation 4 was estimated with variables representing capital gains coming from both farm and non-farm capital, although about 75% of farm household wealth is held in the form of farmland. Both capital components were highly significant when examining changes in farm wealth for farm size 1 (Table 2).

Medium- and large-sized farms both derive wealth from gains on their farm capital only, which indicates that larger farms cannot afford to invest much money off-farm. Neither farm nor off-farm income were significant for any farm size, thus indicating that capital gains dwarf earned income. Therefore, wealth comes from capital, not income, for all farms. This result partially explains why farms that lose money each year on their production stay in agriculture: if their capital gains exceed their operating losses, the farm is increasing the wealth of its owners.

Table 2. Change in Wealth Estimation Results by Farm Size (1996-2004).

	Farm Size 1		**Farm Size 2**		**Farm Size 3**	
Variable	**Estimate**	**t statistic**	**Estimate**	**t statistic**	**Estimate**	**t statistic**
FarmInc	-0.653	-0.92	-0.039	-1.31	-0.149	-1.08
NonFarmInc	0.009	0.11	0.077	1.54	-0.111	-0.72
ChngFarmCap	1.113	10.09***	1.018	40.74***	1.100	86.85***
ChngNFarmCap	0.318	20.09***	0.100	1.09	0.299	1.64
Consumption	0.516	1.01	-0.089	-1.21	0.313	0.89

***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 confidence levels. NS denotes "not significant."
Farm Size 1 corresponds to limited resource, retirement, and residential farms. Farm Size 2 corresponds to farm/lower sales and farm/higher sales. Farm Size 3 includes large family farms and very large farms.

The 2002 Census of Agriculture (USDA 2004) reports that 53.3% of all farms generated a net loss for the year, although the average household earnings from farming activities for that year were $3,477 (Table 1). Mid-sized farms are likely to fall in the middle of the farm income distribution, which offers insufficient income to support a family, but those farms are not big enough to substitute much skilled hired-labor for family labor that might work off the farm (as large-sized farms can do). This leads to the ironic conclusion that the households that need the income-risk-reducing effects of OFI the most (operators of mid-sized farms), are generally the least able to pursue OFI. The resulting higher risk exposure of mid-sized farms would make them more likely to be forced out of business over time, even compared to small-sized farms.[3]

Economies of Scale and Household Off-Farm Income

The model presented in this paper implies that there may be a negative relationship between economies of scale and the portion of a household's total income coming from off-farm sources. In other words, larger farms are expected to achieve economies of scale in agricultural production that improve profit margins, thus creating an incentive to allocate more household labor on-farm than would be allocated by a smaller farm producing the same commodities. This hypothesis was evaluated using 2003 ARMS data, shown in Table 3. Average values for each region in the United States were calculated by farm size for two factors. The first factor is the average income per acre coming from agricultural production. The second factor is the average percentage of total household income coming from off-farm sources. It is clear that the data support the hypothesis; the correlation between the two factors is -0.83. The farm profit per acre increases with farm size across all regions, while larger farms earn a smaller portion of total household income from off-farm sources. Apparently, the West is no different than other parts of the country in this regard.

Table 3. Regional Averages by Farm Size, 2003.

	Farm Income per acre ($)			OFI as % of Total Household Income		
REGION	**Farm Size 1**	**Size 2**	**Size 3**	**Farm Size 1**	**Size 2**	**Size 3**
Northeast	-97.59	8.55	117.29	112	97	36
Lake States	-20.22	44.46	74.26	104	74	31
Corn Belt	-9.69	34.42	68.52	102	74	30
Appalachia	-28.39	30.18	166.97	105	88	25
Southeast	-26.15	42.73	184.33	105	86	30
Delta	-28.92	19.02	118.36	106	85	24
Southern Plains	-26.11	1.17	54.71	110	98	32
Northern Plains	1.40	12.48	35.56	99	71	22
Mountain States	-9.35	5.58	22.41	107	76	24
Pacific	-62.62	25.31	115.10	109	81	21

Source: Calculated from USDA ARMS data

This simple assessment is not a complete test of the hypothesis, but it does make sense. Small farms have more incentive to invest household labor off-farm than do larger farms. This result is also consistent with the safety-first hypothesis of household labor allocation: labor is allocated first to the least risky source of income until sufficient income has been earned, and thereafter labor is allocated so as to maximize household utility. This means that until total income is

[3] Many owners of financially stressed mid-sized farms may opt to reduce their scale of operations to "small-sized" farms, enabling them to shift some household labor off the farm, rather than leaving farming entirely. Ironically, this shift may lead to much higher household income because of the significant contributions available from OFI, as indicated in Table 1. However, in regions with few opportunities for OFI, households unable to maintain their mid-sized farms may have no choice but to exit agriculture entirely.

sufficient to assure that the bills are paid, a household allocates its labor to the activity most likely to provide a positive return to labor. In most cases, the least risky income source is off-farm employment (assuming it is available). After the bills are paid, household labor is allocated to the activities that bring the most utility, adjusted for risk. Thus, for a person who wants to live and work in agriculture, the marginal return to (presumably less-desirable) off-farm employment goes down as total household income increases above the amount needed to pay the bills, enabling the person to allocate more time to his/her preferred vocation in agriculture. Therefore, OFI truly serves as a hedging tool in a safety-first context with generally smaller optimal hedge ratios expected for larger sized farms.

Summary and Policy Implications

This study uses portfolio theory to evaluate the effects of off-farm income levels on farmers' production and investment decisions. An "optimal hedge ratio" of farm household labor allocated on- and off-farm is derived from a simple model of hedging with off-farm income. It is found that off-farm income opportunities have direct and indirect effects on cropping decisions and farm household wealth.

Farm size is shown to have significant effects on production and investment decisions through the improved return-risk tradeoff coming from economies of scale. As a result, large farm operators are expected to pursue fewer OFI opportunities than are small farm operators.

The results from the simple model presented here have some significant theoretical implications for both American agriculture and policy. First, hedging with OFI makes agriculture more risky in that the composition of enterprise portfolios produced by individuals with off-farm income is more risky than the portfolios of enterprises those people would produce if they did not have OFI. In other words, total output of "risky" enterprises increases with OFI. Second, hedging with OFI enables many risk-averse farmers to remain in agriculture longer than they would without OFI. Third, as OFI increases as a proportion of total household income, it facilitates hysteresis in that farmers become less likely to diversify or to use other risk-reducing strategies (Mishra and El-Osta). This, in turn, makes markets less responsive and agricultural policies aimed at market operations less effective.

The empirical results provide evidence that OFI appears to affect farm household wealth, but possibly not in the way expected. The data in Table 1 show that OFI amounts are far larger, on average, than are annual farm income amounts. However, the results in Table 2 show that farms are not significantly aided by OFI, on average, in building wealth. This means income, in absolute amounts, was small compared to capital gains. Therefore, the contribution of OFI to farm household efforts to build wealth may be indirect, rather than direct. OFI enables farm households to "pay the bills" while capital gains accumulate over time through the appreciation of farm capital – mostly farmland.

In summary, hedging with off-farm income is effective in reducing farm households' level of risk exposure, but the increase in its use makes clear there is a need for a new agricultural policy perspective. When a majority of farmers voluntarily stay in agriculture despite low or negative profits, production or investment policies based on profit-maximizing behavior by all farmers are obviously inappropriate. New policies must incorporate the wealth- and utility-maximizing perspectives of today's American farmers.[4] For example, policies intending to stimulate investments in small "hobby" farms will be ineffective for the nation because there is little incentive for most of those households to expand their agricultural operations. However, policies that direct resources to mid- and large-sized farms and their potential for farm capital gains may generate the best production and investment results for American agriculture.

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[4] As a reviewer pointed out, "tax policies are also a major influence on farmer behavior, especially in [the] first category. In fact, tax policy could dominate agricultural policy in many producers' decision-making."

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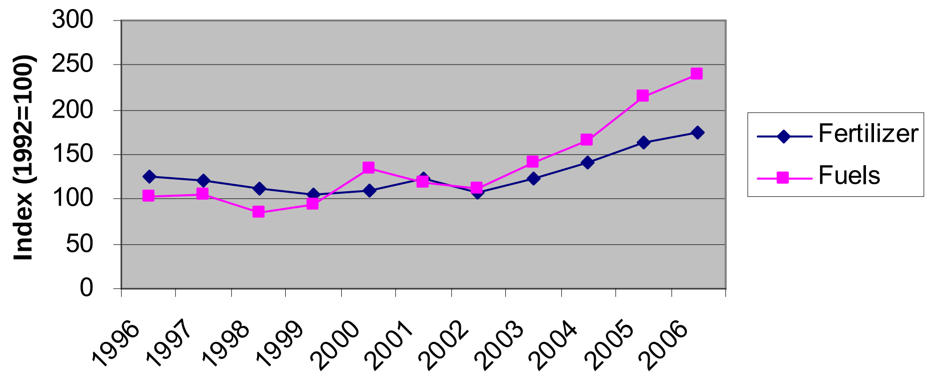
U.S. Corn Producer's Response to Increased Energy Prices: Evidence from Producer Surveys in 2001 and 2005

Stan Daberkow, Dayton Lambert and Wesley Musser[1]

Introduction

Recent price increases for both direct (i.e., fuel and electricity) and indirect (i.e., fertilizer) energy have resulted in higher production costs for corn producers. Indexes of prices paid by farmers for fertilizers and fuels rose 33% and 82%, respectively, between 2001 and 2005 with further increases recorded in 2006 (Figure 1)[2]. Consequently, the share of per acre corn operating costs attributable to direct and indirect energy inputs rose from 44% in 2001 to nearly 50% in 2005 (USDA/ERS 2006). Expenditures by corn producers for fuel ($42/acre) and fertilizer costs ($59/acre) were estimated to be over $100/acre, or about $8 billion in aggregate in 2006 (Figure 2)[3]. Furthermore, while real fossil fuel prices are forecast to decline somewhat during the 2007-10 period, prices are expected to remain well above the levels experienced during the late 1990s and early 2000s (Figure 3).

Figure 1--Indexes of prices paid by farmers for fertilizers and fuels, 1996-2006



Source: USDA/NASS

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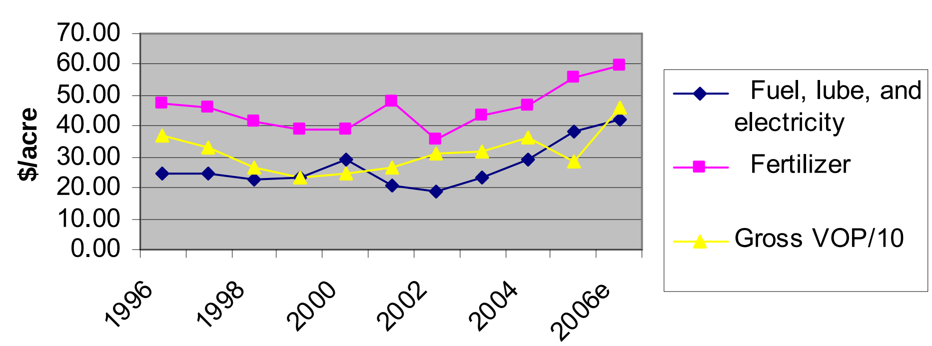
[2] Nitrogen fertilizer prices spiked in 2001 and were much lower in 2000 and 2002. The fertilizer index increased nearly 50% between 2000 and 2005.

[3] With the exception of rice ($182), the 2006 estimate of per acre cost of fertilizer and fuel for all the major field crops is less than for corn (i.e., cotton ($81), sorghum ($66), wheat ($46), barley ($44), oats ($36), and soybeans ($24) (USDA/ERS).

Not only is corn is an energy-intensive crop, but it is also widely grown in the United States. In 2006, the 79 million acres planted to corn for all purposes accounted for nearly one-fourth of all cropland used for crops in the United States. (Lubowski et al. 2006). Furthermore, the use of energy for domestic corn production is likely to increase during the next few years in response to growing demand for corn (Collins 2006). Based on USDA's recent Prospective Plantings report, planted acreage may reach over 90 million acres in 2007 with the increase largely linked to growing demand for corn by-products, especially ethanol (USDA/NASS 2007). While higher commodity prices resulting from increased demand may lead to a greater ability to absorb large energy-related production costs, corn producers will likely continue to seek ways to offset these costs through energy conservation where economically feasible or growing less energy intensive crops (Raulston et al. 2005). However, between 2001 and 2005 (the period of our analysis), corn producers experienced only modest increases in per acre gross value of production (Figure 2)[4]. Clearly, enhanced market prices and trend-line yields led to a much different picture in 2006.

Figure 2--Fuel and fertilizer cost per acre and gross value of production (VOP/10) per acre for corn production, 1996-2006e



Source: USDA/ERS. e=estimated

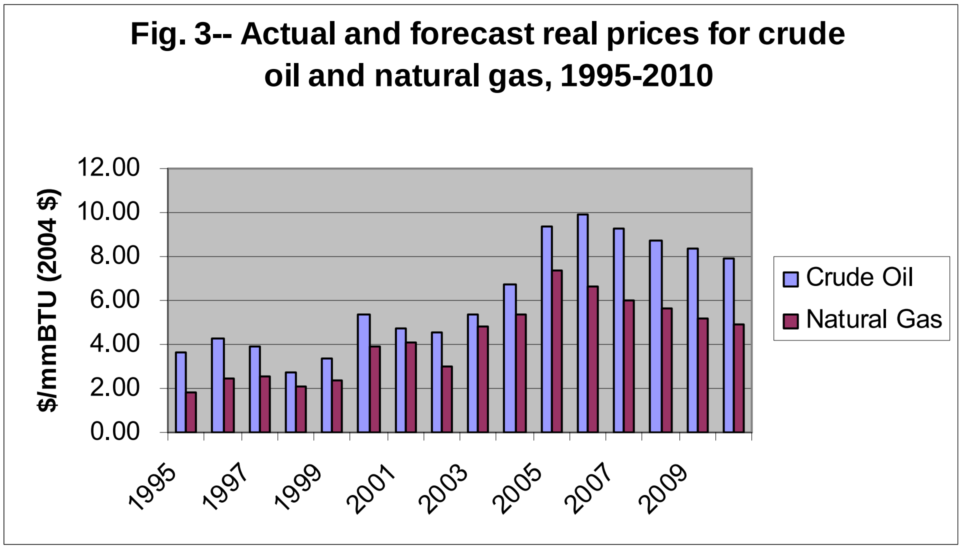
Objectives

Given that corn production is a relatively energy intensive crop and that energy prices have increased significantly in recent years, producers have received clear signals to conserve energy and/or find suitable substitutes. The objective of this analysis is to document changes in the use of energy-using or conserving practices by U.S. corn producers during a period of rapidly rising fossil fuel prices. Using field-level, probability-based surveys conducted in 2001 and 2005, we statistically tested for differences in the use of energy-related practices and technologies between the two years. This analysis also examines the extent of practice and technology adoption which is indicative of the potential for additional energy conservation by corn producers. However, we recognize that changing production systems often entails

[4] Based on ERS data, per acre gross margin (VOP minus fertilizer plus fuel costs) actually declined from $198 to $191 between 2001 and 2005.

additional costs including new capital equipment, financial resources, information sources, or training.

The limitations of our approach to examining producer response to changing direct and indirect energy prices should be made explicit. The analysis is essentially a comparative static analysis and does not directly test for causation (i.e., changes in production practices cannot be directly linked to energy price/costs changes). As noted above, numerous factors are likely involved with any decision to adopt new production practices or technologies. Nevertheless, documenting the levels and shifts in energy-related practice and technology adoption between two points in time offers insights into the role of energy in modern production agriculture.



Source: USDOE/EIA

Literature Review

Most studies have found that producers respond slowly to energy and fertilizer price changes, primarily because of the costs and/or time lags associated with capital stock or production management changes (Miranowski 2005; Uri and Herbert 1991; Denbaly and Vroomen 1993; McCamley and Kleibenstein 1985)[5]. But over time, producers can adapt to rising real energy prices in a variety of ways. Field operations, crop drying and irrigation account for most of the direct energy consumed in corn production. Fuel conservation has been well documented for conservation tillage systems (which require fewer trips across the field), in-field crop drying, and low-pressure irrigation systems (Collins 2000; Werblow 2005)[6]. Custom operations, such as crop drying or field operations, also consume energy for corn production but may be able to provide services in a more energy-efficient manner (e.g., economies of scale) than those

[5] Most of these studies found that the demand for fuel and fertilizer by farmers was inelastic, although Uri and Herbert reported a range for diesel fuel of 0.26 to 1.15.
[6] Clearly, weather influences the use of direct energy, especially for drying and irrigation, but also because of weather's impact on weeds/pests. One estimate (Fawcett and Towery) is that no-till systems save about 3.9 gal/acre of fuel compared to conventional tillage. Another estimate (Successful Farming) suggests a fuel savings of about 2.3 gal/acre by adopting a no-till system.

performed by farm operators (Hill 1970). Larger multi-function machines and diesel powered tractors (compared to gasoline) can also produce energy savings (Uri and Day 1992). In general, fuel use per acre declines as the number of trips over the field declines and as the size of machine increases (University of Illinois 2006a, 2006b). Depending on the level of maintenance, older tractors may be less fuel-efficient than new models (Successful Farming 2005).

Conservation of indirect energy used on the farm typically focuses on the adoption of best management practices for pest control and nutrient use (USDA/NRCS 2005). The Natural Resources Conservation Service (NRCS) often recommends a combination of nutrient management practices for both economic and environmental reasons. Such practices include reducing application rates for commercial fertilizer as prices increase (especially nitrogen, which consumes large amounts of natural gas during the manufacturing process and, hence, its price is sensitive to natural gas markets); using fertilizer substitutes (such as nitrogen inhibitors, manure, or legumes in rotation with corn); improving nitrogen fertilizer efficiency by applying nitrogen several times during the growing season (especially after planting and by minimizing fall application); and acquiring more information to determine optimal application rates (i.e., setting reasonable yield goals, conducting soil and tissue tests, and seeking advice about nutrient use) (University of Nebraska 2000). Weed and insect management practices, such as cultivation and pest scouting, can also affect energy use primarily through the number of pesticide treatments. The relatively new bio-tech seed and precision agriculture technologies can reduce energy use by lowering the number of trips across the field, reducing use or changing the type of fertilizer and pesticide products, or improving tillage and chemical application efficiency via the use of guidance systems or variable rate applicators (Fawcett and Towery 2001)[7].

The relatively rapid increase in direct and indirect energy prices has generated interest in modifying current conservation programs to encourage on-farm energy conservation. Such programs as the Conservation Security Program (CSP) and Environmental Quality Incentives Program (EQIP) can encourage the adoption of selected practices, such as conservation tillage and nutrient management, which impact energy use (U.S. Department of Agriculture 2006)[8]. Also, producers with cropland designated as "highly erodible land" (HEL) may be able to meet commodity program participation requirements by adopting conservation tillage systems. As a result of participation in various conservation programs, producers may be required to produce a written whole-farm plan which addresses appropriate resource concerns including energy conservation along with preserving soil, water and air quality.

Data

Data for the analysis come from USDA´s 2001 and 2005 Agricultural Resource Management Survey (ARMS) of corn producers. The ARMS data used in this study are from a field-level survey of farms producing corn for grain in the 19 largest corn producing states[9]. Information is

[7] Fawcett and Towery report that on average each tillage pass consumes about 0.7 gal/acre and that soybean growers who had adopted herbicide-tolerant varieties reduced tillage operations by 1.8 trips, resulting in a savings of 1.26 gal/acre.
[8] In addition to energy conservation, these programs may also achieve environmental objectives such as improved water and air quality, carbon sequestration, and reduced greenhouse gas emissions (CTIC 2006)
[9] The surveyed states were: CO, GA, IL, IN, IA, KS, KY, MI, MN, MO, NE, NY, NC, ND, OH, PA, SD, TX, and WI.

collected on input use (i.e., seed, fertilizer and pesticides), production practices (i.e., tillage, pest and nutrient management), participation in conservation program as evidenced by field-level conservation plans, sources of information on nutrient management, field operations (i.e., tillage, planting, cultivation, fertilizer and pesticide applications, and harvesting), bio-tech and precision agriculture technologies, and tractor use. Producers were also asked if they responded to recent increased fuel and nitrogen prices and, if so, how they responded.

Each corn field sampled in the ARMS represents a known number of fields with similar attributes. By appropriately weighting the data for each field, inferences about the entire planted area of the surveyed states is possible. The surveyed states represent over 90% of the acreage planted to corn in the United States. A smaller number of fields were sampled in 2005 than 2001, but the amount of planted acreage actually increased (Table 1). Paired t-tests were used to test for mean differences between survey years. Due to the complex design of the ARMS survey, standard errors were estimated using a jackknife replication approach (Dubman 2000).

Results

Practices/technologies associated with direct energy use

Field operations, drying and irrigation are critical activities associated with direct fuel consumption (i.e., diesel, gasoline, electricity, LP, and natural gas) (Foreman 2006) [10]. With the exception of an increase in conservation and no-till acreage, there was little change in the share of corn acreage using a particular technology for tillage, drying or irrigation (Table 1). While the mean number of trips over the field did not change (i.e., about six), the number of custom operations increased slightly between 2001 and 2005 (Table 2). However, the share of acres reporting more than seven trips over the field declined over the five year period (Table 1). The mean size of planters and harvesters increased between the two years (Table 2), but the share of acres using relatively small equipment (i.e., less than six rows) remained about the same—between 30 and 40% of all planted acres[11] (Table 1). While causality cannot be established between rising fuel costs and changes in production practices, some corn producers have altered their field operations since 2001.

Even though the survey data indicate a statistically significant decline (1%) in the share of acreage using a diesel tractor, it is clear that the “dieselization” of U.S. agriculture is nearly complete and little energy conservation potential exists from the adoption of more diesel tractors. However, the average age of the largest tractor used on the field continues to increase (Table 2) and the share of the acres using a tractor of older than 15 years remains substantial (i.e., 35-39%) (Table 1).

[10] The drying data indicate a large increase between 2001 and 2005 in the share of corn acreage which was dried in the field which would greatly reduce energy use. However, the data were not collected in a similar manner between the two years and a t-test was not appropriate. Furthermore, weather can have a large influence on the feasibility of in-field drying.
[11] A reviewer noted that landscape factors, such as field size and conservation structures, can limit the size of equipment used on many fields.

Practices/technologies associated with indirect energy use

Nearly all corn acres are treated with nitrogen fertilizer (Table 3) and herbicides (Table 4) which suggest that more careful management of these inputs could have an impact on energy use as well as a potentially positive economic impact. However, only a few of the pest or nutrient management practices showed significant changes over the study period[12]. Acreage receiving all applied nitrogen after planting declined, but there was no statistically significant evidence of changes in the share of acres with multiple season applications (Table 3). A decline in the share of corn acres rotated with a legume (mirroring a significant increase in continuous corn acres) suggests that less nitrogen was available from sources other than commercial fertilizer (Table 4). On the other hand, a significant decline in the share of acres treated with insecticides and cultivated for weed control clearly saved energy[13]—a phenomenon possibly related to the significant increase in use of herbicide-tolerant and Bt seed varieties[14] (Table 4).

Significant changes in the use of several nutrient use practices were unexpected (Table 3). For example, the share of acres reporting a phosphorus test declined while an increasing share of acres relied on a fertilizer dealer for nitrogen rate information[15] . Also, the share of acres reporting a yield goal in excess of actual yield (greater than 20%) increased between 2001 and 2005. Yield goal can be a critical aspect of nitrogen management because Extension services often make application rate recommendations based on a farmer's yield goal (University of Nebraska 2000). To the extent that yield goals influence nitrogen application rates, an unrealistic yield goal in excess of actual yields can lead to more nitrogen being applied than is used by the crop[16].

Participation in Conservation Programs

Several conservation programs have provisions designed to influence on-farm energy conservation. However, the modest share of corn acres managed under various conservation management plans (i.e., 1-9%) suggests that these programs have had a modest impact on energy use (Table 5). Survey data for 2005 indicate that participation by corn farmers in EQIP or CSP was limited. To the extent that an HEL designation on cropland encourages the adoption of energy-conserving tillage systems, a maximum of about 20-22% of all corn acreage may have been impacted.

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[12] In fact, nitrogen application rates were statistically unchanged between 2001 and 2005 despite a 25% increase in anhydrous ammonia prices and a near doubling of prices between 2000 and 2005 (Table 3). However, the share of acres receiving over 200 lbs/acre of nitrogen (a rate about 33% above the average) remained unchanged at 8-9% between 2001 and 2005.

[13] A reviewer noted that the Prices Paid Index for agricultural chemicals (e.g., herbicides) has been fairly stable over the last several years which may have made energy-intensive field cultivation less attractive than chemical weed control.

[14] While the share of acres scouted declined between the two years, this result may have been influenced by a change in how the question was asked.

[15] One study found that farmers who rely on independent consultants for fertilizer recommendations had lower application rates compared to farmers using dealers (McCann and Easter 1999).

[16] The mean of the yield goal/actual yield ratio did not change between 2001 and 2005 (Table 2). Clearly weather and other factors influence actual yield and account for much of the divergence between yield goal and actual yields. However, the data indicate that producers tend to be optimistic with respect to their yield goal (i.e., yield goals exceeded actual yields by 8% in our two survey years). Furthermore, national yields in 2001 and 2005 were not influenced by extreme weather events—based on USDA's 2001 baseline (USDA/WOAB 2001) expected or trend yields for 2001 and 2005 were 136 and 146 bu/acre, respectively, while actual yields were 138 and 148. However, a reviewer pointed out that a 8% yield divergence could be an economically rational response to variability in weather or fertilizer and corn prices.

Producer identified responses to increased fuel and fertilizer prices
Respondents were asked about specific responses to the nitrogen price increases in the early part of 2001 and 2005 (Table 5). Between 2001 and 2005, some producers responded to increased nitrogen fertilizer prices by changing one or more nutrient use practices on a much larger share of corn acres, especially reducing their nitrogen application rate and closer N management (i.e., soil-testing, split application, soil incorporation, etc.)[17]. With respect to fuel price increases, no 2001 data are available for comparison, but by 2005 producers indicated that they had reduced the number of field operations and increased field drying on a large share of corn acreage—a finding consistent with other survey data such as the significant increase in conservation tillage. Nevertheless, on the vast majority acres, producers did not report changing their nutrient management practices in response to the spike in nitrogen prices in the early part of 2001 or 2005.

Practices/technologies with a large potential for conserving energy use in corn production
Large and sustained fuel and fertilizer price increases would likely encourage producers to consider adopting energy-conserving practices and technologies. Based on survey data for 2001 and 2005, several potential energy-saving production practices have not been adopted on a significant share of corn acreage. For example, nearly a quarter of corn acres still utilize conventional tillage systems (including 3-4% using moldboard plows—a very energy intensive tillage operation) (Table 1). Of all the corn irrigated with a pressure system, only about half utilized an energy-saving low pressure system. Even though the mean size of planters and harvesters is increasing, small-scale machines are still used on 30-40% of all corn acreage. Similarly, older tractors (greater than 15 years) are used for at least one field operation on 35-39% corn acres. While the use of bio-tech seed and precision agriculture technologies is increasing, adoption remained below half of all corn acres in 2005 (Table 4).

The level of adoption of several recommended nutrient management practices remains modest. For example, nitrogen inhibitors and manure, which can act as substitutes for commercial nitrogen, are not widely used but, in the case of manure, local availability is constrained to regions with concentrated livestock operations (Table 3). About 12-15% of all acres still receive a single nitrogen application in the fall and only about 30% receive nitrogen after planting. Only about 25% of all acres are soil-tested for nitrogen each year. Also, setting realistic yield goals seems to be problematic for producers on 19-25% of all acres[18].

Conclusions/Implications

Since 2000, indexes of prices paid for fuel and fertilizer have increased significantly. Much of the previous empirical economic research concluded that farmers respond slowly to increased prices for direct and indirect energy. In general, the survey data presented in this analysis reflect modest shifts in the use of selected practices and technologies which influence energy use. Part of the slow response is likely attributable to the fact that changing production systems often entails additional costs including new capital equipment, financial resources, information

[17] Note, however, that the data for the entire sample did not show a statistically significant decline in nitrogen application rates.
[18] Surprisingly, of the 25% of the acres that are soil-testing about 1/5 (or 5-6% of all acres) receive at least 10% more nitrogen than the recommended rate. On the other hand, about half (11-13% of all acres) of the soil-tested acres report receiving less than the recommended rate.

sources, or training. However, significant increases in conservation tillage (and related decreases in the number of tillage operations), declines in cultivation for weed control, and fewer acres receiving insecticides likely led to reduced energy use on a significant share of acreage. Also, a significant number of corn producers, as exhibited by their willingness to rapidly adopt both bio-tech and precision agriculture technologies over a relatively short period, can respond relatively quickly to changing economic conditions and availability of new technologies. Finally, producers stated that, between 2001 and 2005, they changed certain production practices in response to energy prices.

Another implication of this study is that the potential for additional energy-conservation in corn production is quite large. A significant share of acreage used to produce corn (i.e., about 25%) still uses conventional tillage, only about half of all corn acres are systematically scouted, soil-testing is used on only one-fourth of all acres, and split nitrogen applications and after planting applications are not widespread. The use of small scale (i.e., less than 6 rows) planting and harvesting machines and older tractors, which may be less fuel efficient, will likely decline over time and lead to additional energy-savings. Less than half of all corn acres currently utilize bio-tech seed or precision agriculture technologies. Finally, given the modest level of participation in current conservation programs, there is considerable opportunity for public policy to influence energy conservation.

Static economic models used to evaluate the impact of increased input prices on net returns often assume that producers do not change input use, production practices or technologies in response to increased input prices. This study found that such an assumption can be misleading when, in fact, producers can adapt to higher energy prices. As the survey results presented in this analysis indicate, producers made adjustments between 2001 and 2005 in the practices and technologies used to produce corn and these changes were at least consistent with producer responses to sustained increases in energy-related input prices.

Areas for further research include: 1) assessing the factors which inhibit rapid adoption of energy conserving technologies and practices; 2) the role of policy in agricultural energy conservation; and 3) given the likely increase in continuous corn production, what are the economic and environmental implications of changes in tillage, pest, nutrient and water management practices used to produce more corn. Additionally, econometric or other models could be used to isolate the ceteris paribus response of producers to increasing energy prices. Raulston et al. is a recent example of such research but more would be helpful.

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Table 1. Production practices and technologies influencing direct energy use on U.S. farms producing corn for grain, 2001 and 2005.

Item	2001	2005
Number of fields in survey	2,454	1,816
Planted acres in states surveyed (mil.)	65.2	71.2
	(share of planted acres)	
Tillage system		
Conventional till	26	24
Moldboard plow	4	3
Reduced till	31	27
Conservation till	43 B	48 A
No till	20 B	25 A
Tractor/implement use		
Age of largest tractor > 15 yrs.	39	35
Largest tractor is diesel	99 B	98 A
Planter width < 6 rows	30	29
Harvester width < 6 rows	39	36
> 7 trips across the field 1/	20 B	16 A
> 3 custom trips across the field 1/	12	14
Crop drying 2/		
Custom dried (off-farm)	11	11
Dried on farm	45	29
Not dried	44	60
Irrigation system		
Irrigated acres	14	12
Gravity system	4	2
Pressure system	10	10
Low pressure system	6	6

1/ Includes the following field operations: tillage, planting, fertilizer and pesticide applications, cultivation, and harvesting. Some trips could involve two or more field operations.
2/ t-test not available for these estimates.
A and B indicate significant column difference tests based on pairwise two-tailed [Ho:B_1=B_2] delete-a-group Jackknife t-statistics at a 90% confidence level or higher with 15 replicates and 28 degrees of freedom.
Source: 2001 and 2005 USDA Agricultural Resource Management Survey.

Table 2. Means for selected energy use indicators on farms producing corn, 2001 and 2005.

Item	Unit	2001	2005
Yield goal	bu/acre	145 B	153 A
Actual yield	bu/acre	134 B	142 A
Ratio: yield goal/actual yield	---	1.08	1.08
Nitrogen application rate	lb/acre	118	123
Age of largest tractor	years	16 B	18 A
Number of rows			
Planter	no.	8.24 B	9.15 A
Harvester	no.	5.79 B	6.23 A
Number of trips across the field			
Total trips	no.	6.21	6.09
Custom trips	no.	1.03 B	1.15 A

See footnotes on Table 1.
Source: 2001 and 2005 USDA Agricultural Resource Management Survey.

Table 3. Nutrient management practices and technologies influencing indirect energy use on U.S. farms producing corn for grain, 2001 and 2005.

Item	2001	2005
	(share of planted acres)	
Nutrient use		
Treated with commercial nitrogen	95	96
Nitrogen application rate > 200 lb/acre	8	9
N inhibitor	11	9
Manure use	12	13
Nitrogen application timing		
All applied before planting--fall	12	15
All applied before planting-spring	37	36
All applied after planting	13 B	11A
Applied in fall and before planting-spring	12	12
Applied before planting-spring and after planting	10	10
Applied before planting-fall and after planting	7	7
Applied in fall and before and after planting	1	1
Soil/tissue testing		
N soil test	26	28
N app. rate 10% > recommended rate	5	6
N app. rate 10% < recommended rate	13	11
P soil test	40 B	35 A
Tissue test	3	5
Source of information about nitrogen application rates		
Crop consultant	20	21
Fertilizer dealer	28 B	35 A
Extension service	4	5
Yield goal 20% > actual yield	19 B	25 A

N=nitrogen; P=phosphorus
See footnotes on Table 1.
Source: 2001 and 2005 USDA Agricultural Resource Management Survey.

Table 4. Selected production practices and technologies influencing energy use on U.S. farms producing corn for grain, 2001 and 2005.

Item	2001	2005
	(share of planted acres)	
Precision technologies		
Yield monitor	36 B	45 A
Guidance system	7 B	16 A
VRT (fertilizer, pesticides or seed)	10	11
Crop rotation (previous crop)		
Corn	20 B	24 A
Legume (including soybean)	71 B	64 A
Other	9	12
Pest management		
Applied herbicide	94	95
Applied insecticide	31 B	24 A
Cultivated to control weeds	38 B	15 A
Systematic scouting for insects or weeds	54 B	49 A
Seed technologies		
Herbicide-tolerant 1/	13 B	30 A
Bt 1/	28 B	34 A

1/ Includes stacked varieties.
VRT=variable rate technology
See footnotes on Table 1.
Source: 2001 and 2005 USDA Agricultural Resource Management Survey.

Table 5. Conservation programs participation and respondent identified responses to increased fertilizer and fuel prices on U.S. farms producing corn for grain, 2001 and 2005.

Item	2001	2005
	(share of planted acres)	
Participation in Conservation Programs and Plans		
Highly erodible land (HEL)	20	22
Enrolled in CSP	X	2
Enrolled in EQIP	X	2
Farm plan participation		
Nutrient management plan	X	9
Pest management plan	X	4
Irrigation management plan	X	1
Respondent identified responses to increased fertilizer and fuel prices 1/		
Nitrogen prices		
Reduced N application rate	9 B	22 A
Increased manure use	2 B	3 A
Changed N fertilizer product	1 B	5 A
Managed N more closely 1/	7 B	24 A
Fuel prices		
Reduced number of tillage operations	X	25
Increased amount of corn dried in the field	X	33
Reduced amount of irrigation water	X	4
Changed other production practice	X	8

1/ Includes increased soil-testing, split application, VRT, and soil incorporation.
CSP=Conservation Security Program; EQIP=Environmental Quality Improvement Program
X= data not available
See footnotes on Table 1.
Source: 2001 and 2005 USDA Agricultural Resource Management Survey.

Shifting from Commodity Programs to a Stewardship Program

Mike Dicks[1]

Introduction

Interest in moving from the current format of providing price and income support for the major commodities to stewardship payments has increased over the last three decades. But the joining of old forces with new friends has brought a heightened pressure for change. Old antagonists continue to argue that highly profitable and wealthy farm families should not be receiving income support from non-farm families with substantially less average income and wealth. In addition, the environmental community has continued their effort to move funding from subsidy programs to conservation expenditures. And, budget hawks continue to target cuts in agriculture based on the notion that large corporate farms do not need public assistance.

The current Doha round of WTO has a principle goal of reducing payments to farmers that are coupled to production and/or prices. Moving to payments tied to specific production practices that also maintains some level of income support would aid the United States in the Doha negotiations as these payments would not contribute to amber or blue box and hence would be seen as a reduction in the Aggregate Measure of Support (AMS) in the United States.

In addition, the fruit and vegetable industries have increased their demands to be included at the subsidy table. The movement from supply management to direct payments for the major commodities has led to a new push by the fruit and vegetable industry to move away from marketing orders to direct payments.

The combined impact of the worsening federal budget picture, the Doha round of the WTO, and demands by both the fruit and vegetable industries and environmental groups has led to an increased interest in shifting from direct price and income support to support through resource stewardship efforts. While a complete shift from commodity programs to a stewardship program in the next farm bill is unlikely, the shift has already begun and discussions of potential strategies for a continued shift are needed to build support amongst all stakeholders and ensure movement towards an efficient and equitable program.

The Conservation Security Program was enacted under the Food Security and Rural Improvement Act of 2002. The CSP was a response to concerns that existing conservation programs that attempted to obtain the "biggest bang for the buck" often rewarded the worst land stewards. Under the CSP, payments would be made based upon the level of conservation practices currently implemented on the farm, providing a reward for the best land stewards. While the CSP began in concept as a national stewardship program, implementation has produced just another targeted watershed protection program falling short of a national program due to limits on funding. In addition, the level of payments a producer receives is tied to use of specific practices rather than the level of environmental benefits provided.

What might happen if the United States were to truly dismantle price and income support programs and use the $15 – $20 billion per year for environmental stewardship? How would the

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program be shaped and more importantly how would the program be implemented? How would the program provide equity between so many diverse farm and ranching activities and between farm and non-farm families?

This paper provides some initial thinking about how an environmental stewardship program might be constructed and implemented. Principle concerns for agriculture in receiving federal financial assistance include equity across commodities, structural implications, national availability, and a seamless program between reserve lands and working lands. For the environmental groups, many of the same concerns have been voiced but an additional concern that landscape effects guide the level of funding also has been raised. And finally, for the implementing agencies the programs must be easy to implement and easy to check for compliance.

Equity Based on Financial Reality

The concept of providing an economic incentive to land owners or operators to manage farm land to meet social objectives is not new. Incentives have been used to expand and reduce the cropland base, implement specific production practices and minimize the use of specific inputs in the production process. Thus, the technical knowledge required to implement a program that transfers funds from taxpayers to landowners/operators to induce certain land management practices is already in place. However, past programs to induce changes in land use management have not been used to specifically distribute funds equitably based upon the profitability of the crops produced in specific locations.

Equity is always a prominent issue in the farm bill debate. A move from commodity programs to environmental stewardship payments, inclusion of livestock, fruits and vegetables and other agriculture enterprises into the pool of producers eligible for financial assistance certainly has the potential for dramatically altering the distribution of government payments across states and congressional districts. Thus, the issue of equity, particularly with respect to how changes in policy will affect the status quo will likely be central to the success of obtaining a shift in policy.

From the national perspective the large difference between farm and non-farm family income suggests that no transfer from taxpayers to farms should occur. Over the last three years the agriculture sector has posted record levels of net farm income and gross profit on cash revenue (GPOCR) has approached 32% when government payments are included and nearly 20% based only on cash receipts. The level of income and profitability describes a very profitable industry.

However, return on assets (ROA) in agriculture is very low especially if only those returns to assets that originate with cash receipts are considered. The low returns on assets are a result of the large capital investment needed in agriculture because the industry is land based. As an industry, agriculture has a very low value of sales per dollar of fixed assets (S/FA).

Land represents roughly 85% of the fixed assets in agriculture. As land values increase, new land purchases with stagnant commodity prices leads to a further decline in the dollar of sales per dollar of fixed assets. In most areas land values continue to move away from parity with the capitalized value of the land. Demand for land to provide recreation, homesteads, urban and other uses continues to push the market value of the land further from the value generated by returns to agricultural production activities (capitalized value). One has to move to remote areas of the United Sates to approach parity between the market value and the capitalized value of land.

The disparity between the capitalized value of land and the market value favors older landowners and operators who lease land in remote areas. Operators who have made recent land purchases (e.g., new farmers and ranchers) and those living nearer to urban areas are forced to purchase land at a price above the land's ability to provide income that will cover all costs. Farmers and ranchers of this land will be financially unable to pay for conservation practices that do not increase profit. The financial incentives required to induce landowners/operators to implement specific conservation practices will be different based upon land tenure, distance to urban areas and other socioeconomic factors.

To the extent that under the stewardship programs conservation practices are implemented that bring lands into compliance with current and future environmental regulations land values will increase. However, if the market value of the land exceeds the capitalized value the increase in land value that might occur as a result of the implementation of new conservation practices will not likely be observed.

Similar Allocation of Payments

Equity between commodities will pose the biggest road block in determining how to reallocate current commodity program payments to land stewardship payments. Table 1 provides a comparison of the GPOCR, S/FA and ROA and government payments per harvested acre from representative of typical commercial operations in the United States.[2]

Table 1. Comparison of financial indicators for typical commercial operations, 2005-2009 Baseline.

	S/FA	GPOCR	ROA	Gov. Pmt ($/acre)
Feed Grains	0.39	0.16	6.24	$65
Wheat	0.26	0.28	7.28	$46
Cotton	0.59	0.08	4.72	$206
Rice	0.44	-0.03	-1.32	$421
Dairy	0.42	0.18	7.56	
Beef	0.17	0.22	3.74	

Using the FAPRI baseline for 2005-2009, the government payments per harvested acre vary by commodity and are consistent with need as demonstrated by the GPOCR. For instance, rice with a negative profit margin of 3% receives the highest per acre government payment ($421) while wheat with the highest level of profitability receives the lowest per acre government payment ($46).

To move to a stewardship program that rewards landowners/operators for carrying out specific practices would require per acre government payments similar to current allocations to obtain

[2] Data were obtained from Representative Farms Economic Outlook for the December 2005 FAPRI/AFPC Baseline J.L. Outlaw, J.W. Richardson, et al.

support from farm and commodity groups. This would be difficult using current working land conservation program strategies such as the Environmental Quality Incentives Program (EQIP) that pay per unit for a specific practice.

Current support programs, because of their attachment to historic production, also provide larger payments for larger farmers. Payments per unit for stewardship practices would likely continue this trend. Concerns about structure (e.g., programs encourage farm enlargement as larger farms get larger payments) could not be dealt with through payment limits without constraining the ability of the programs to obtain environmental benefits.

A National Program

Unlike the CSP, where the program is targeted to specific watersheds, a new stewardship program that may be used to supplant the commodity programs would have to be available nationally, to all lands. Without other specific changes, the national diffusion of dollars would reduce the marginal increase in environmental benefits per dollar expended. The targeting of payments enables more concentrated efforts within a watershed. The more acres within a watershed that implement a specific practice to achieve a specific objective the greater the average benefit per dollar expended. In most cases a threshold exists that requires a certain percentage of the area in a watershed/landscape have a specific practice implemented before any benefits are obtained.

Producers need a program that is seamless from reserve lands to working lands. In some situations such as cropland within close proximity to short grass prairie grasslands a case could be made for developing prescribed management practices that enable economic use of the lands but only under strict guidelines that preserve the habitat for native species. These lands would be considered for restoration and as such should be offered only a permanent easement that prevents future cropping or development. The cost of restoration makes 10 year contracts infeasible. This option would be similar to the Grassland Reserve Program except that management would be prescribed by USDA.

Other croplands could be returned to grasslands and may need to be rested or simply placed into a less intensive use such as haying or grazing. These lands could be managed similar to CRP acres accept that options would be available for no use to unlimited alternative (to annual cropping) uses.

Working lands could have a literal smorgasbord of practices to select for incentive payments to increase water or air quality, wildlife habitat, or soil productivity. In addition, incentive payments could be used for on-farm research to entice producers to try new technologies, processes or new crops.

Administer within the Landscape

An important concept for the stewardship program to be endorsed by environmental groups will likely be the allocation of incentive payments based upon benefits within the landscape. The CRP uses an Environmental Benefits Index (EBI) to rank offers for selection to the program. However, without knowledge of the surrounding lands and how a specific field fits into the landscape it is impossible to determine what environmental benefits a specific field will yield. And, these benefits will change if land use of the surrounding lands change.

To provide a stewardship payment for conversion of cropland to native grassland to support the greater prairie chicken on 160 acres may be meaningless if the 160 acres is surrounded by only cropland but may provide enormous benefits if it enlarges a contiguous area of native tall grass. One potential solution to this problem would be to increase the payment level for stewardship practices based upon the level of implementation of this practice in the landscape. This may entice landowners/operators to work cooperatively to obtain larger scale environmental benefits. However, this same strategy would provide even larger payments for larger landowners.

A Multi-Agency Approach to Implementation and Compliance

For the stewardship incentive program to work will require a more focused, expanded and cooperative effort on the part of the Farm Services Agency (FSA), Natural Resource Conservation Service (NRCS) and Cooperative Extension (CE). FSA has been developing a GIS delivery system with a Common Land Unit (CLU) that will be invaluable in estimating costs and benefits of a new program. FSA has a long history of working with landowners and operators in administering programs from data collection to payments. FSA should be responsible for the administration of the stewardship program including signing up producers, making incentive payments, and assessing program impacts.

NRCS has historically provided the technical assistance required to implement appropriate conservation practices and should retain the role of being responsible for working with FSA to deliver Resource Management Systems (not single practice conservation plans) to landowners/operators.

One final point is whether management of excess capacity will be considered a stewardship benefit and thus available for incentive payments. Both idled land and stocks are means of holding food or production potential off the market and in reserve in case an exogenous event such as drought, floods, or other catastrophic events cause sharp rises in prices. Holding excess capacity by producers caps prices, providing benefits to consumers to the detriment of producer incomes. Including capacity management as an objective in the stewardship program would provide a potential solution to the issue of equity between commodities. In addition, rather than idling land to maintain excess capacity, other inputs (e.g., fertilizer, agricultural chemicals) could be reduced through offsetting stewardship payments. This may provide more environmental benefits than the idling of land, maintain the productive capacity and minimize the adverse consequence on local economies.

Summary

A new stewardship program that is born out of commodity programs must be a seamless program providing for land and resource management that would include incentives for options from permanent land use changes to temporary changes in resource/input use. Each of these management options should provide incentives that reflect reduced profit and increased value of public amenities. The stewardship program must be available to all farmland owners and operators with consideration for cross-commodity equity and predetermined structural objectives.

Incentive payments must be based on both farm level management and cooperative management within the landscape. The payments must also be based upon the level of specific changes in environmental amenities provided by changes in practices. Where the initial cost in the change in practice exceeds the increase in the value of environmental amenities or that value is unknown the incentive payment would reflect the cost of changing practices.

High Economic Values from High Peaks of the West

Catherine M. Keske and John B. Loomis[1]

Introduction

The geography of the West provides many distinguishing features, including wide open spaces, extensive public lands, and the crown jewels of the National Parks System such as Yellowstone. Soaring peaks of the West like Mt. Rainier, Mt. Hood, Grand Tetons, and Pikes Peak are also towering symbols of their respective Western states. While these mountains are clearly a source of regional pride, they have also provided national inspiration for songs like "America the Beautiful" and renowned artwork like Ansel Adams' photography and paintings by Albert Bierstadt.

The presence of these high peaks in the Sierra Nevada Mountains, the Cascades and the Rocky Mountains also serve as a symbol of the beautiful Western landscape and the high quality of life enjoyed by many residents in the West. Residents report that a contributing factor to their perceived high quality of life in Western States is the rural character of their communities, scenic beauty, and access to recreation opportunities afforded by the region (Rudzitis and Johansen 1989; Inman, McLeod and Menkhaus 2002). However, the value of mountain scenic amenities and recreational opportunities is neither limited to residents, nor passive recreational uses. These high peaks are often the highlight of a trip to the West for many visitors from the Midwest and Eastern United States. Furthermore, residents and non-residents alike aspire to rise to the physical and mental challenge to climb and summit these peaks and to gaze down on the amazing vistas below. For those living in the lowlands, climbing these peaks usually involves months of training, and is often the fulfillment of a lifetime dream. For example, according to the American Alpine Club's 2005 report, on Mt. Rainier, the number of annual climbers has increased from 300 in the early 1950s to over 11,000 in the first half of this decade. For Alaska's Mt. McKinley, the annual numbers rose from less than 50 in the early 1960s to over 1,200 this decade (Athearn 2005). Climbing high peaks involves significant risks to life and limb as well, testament to the high value people place on climbing them. Clearly, standing on the summit of these peaks gives an incomparable sense of accomplishment not otherwise available in our world of increasingly virtual reality.

An interesting question is whether the long distance travel, months of training, and great effort required to climb these peaks translates into a high visitor willingness to pay for visitors to these high elevation recreation areas. In other words, do high peaks yield high economic value? We attempt to answer this question using a data set of visitors to the 54 Colorado 14,000 foot peaks (otherwise known as Fourteeners), which also serve as a goal for peak baggers. In order to determine the value that recreationists and peak baggers place on the Colorado Fourteeners, we use an expenditure summary and a contingent valuation model to determine the regional expenditures and consumer surplus, respectively. Based upon our study, we draw implications and suggest these results may provide some insights regarding the high values of other high peaks of the Western United States.

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[1] Keske is Assistant Professor and Loomis is Professor, Department of Agricultural and Resource Economics, Colorado State University. The authors would like to thank Sarah Gorecki of the Colorado Fourteeners Initiative for assisting with the data collection and survey design. The authors would also like to thank, without implicating, two anonymous reviewers for suggestions clarifying several points in the paper.

Background Information on Colorado Fourteeners

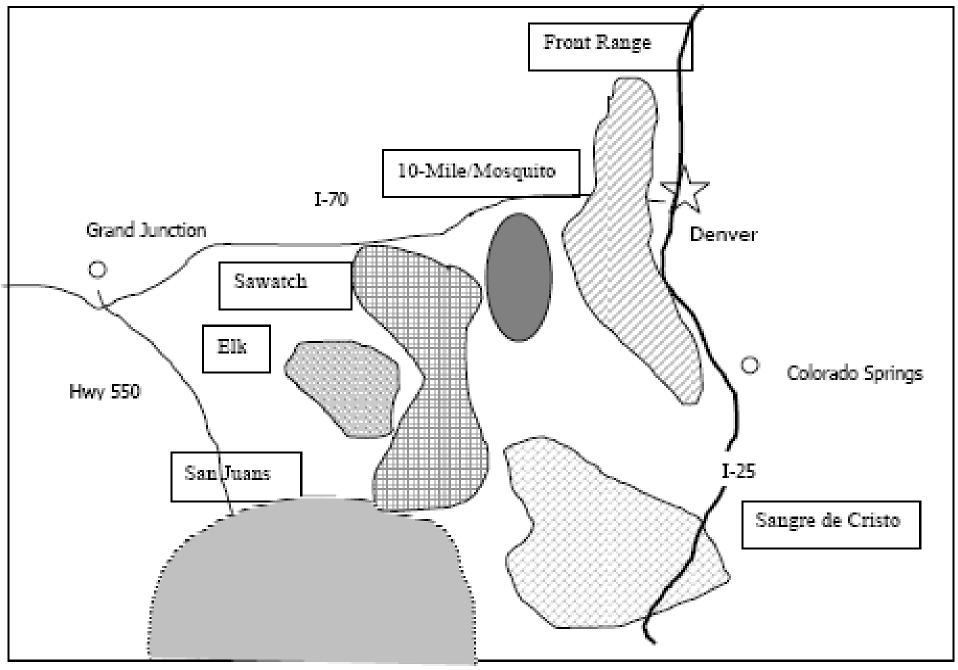
This next section describes the distinguishing features of Colorado Fourteeners, the data, methods, and results of our study. The Colorado Fourteeners are nestled in six of the state's mountain ranges. Most of the peaks are on public lands, including wilderness areas, but several peaks are located on private lands, yielding a variety of access issues, which are summarized in Table 1.

Table 1. Colorado Fourteen Thousand Foot Peaks and Degree of Accessibility.

Range	Private Peaks	Access Permitted
10-Mile/ Mosquito	Bross	Closed
	Democrat	Closed
	Lincoln	Closed
	Quandary (parts)	YES--trail re-routed to avoid private land
	Sherman	YES--but future access debated
Elk		All Public: Capitol, Castle, North Maroon, Pyramid, Snowmass, South Maroon
Front		All Public: Bierstadt, Evans, Grays, Longs, Pikes, Torreys *Note: Evans and Pikes also have paved roads to summits*
Sangre de Cristo	Culebra	Fee for Access
	Crestone Group	YES--Pending access issues across private lands
	Little Bear Peak	YES--trail re-routed to avoid private land
	Mt. Lindsey	YES
		All Public: Blanca Peak, Crestone Peak, Crestone Needle Ellingwood Point, Humbolt Peak, Kit Carson
San Juan	Wilson Peak	Closed
		All Public: El Diente, Eolus, Handies, Mt. Wilson, Redcloud, San Luis Sneffels, Sunlight, Sunshine, Uncompahgre, Wetterhorn Windom
Sawatch		All Public: Antero, Belford, Columbia, Elbert, Harvard, Huron, LaPlata Massive, Missouri, Mt. of the Holy Cross, Oxford Princeton, Shavano, Tabeguache, Yale

These mountain ranges are located in different regions of the state, presenting a unique set of physical characteristics, cultural dynamics, and recreational and economic opportunities. Figure 1 illustrates mountain range location, and the unique characteristics of the six mountain ranges are summarized below.

Figure 1. Colorado Fourteener Ranges.



Front Range
The Front Range peaks consist of six popular peaks extending from Estes Park and slightly west of Denver down to Colorado Springs. Due to their close proximity to the metropolitan communities, the Front Range peaks attract both Colorado tourists and urbanites. Two of these peaks can be accessed by paved roads as well as hiking trails.

10-Mile and Mosquito Gulch
The five peaks that make up this range are located from 5 to 30 miles southwest of the Breckenridge ski resort. All of the five peaks have areas that are privately owned; however, three peaks (Mounts Lincoln, Democrat, and Bross) were closed to the public in July 2005 by private landowners who expressed liability concerns about the large numbers of recreationists on the land. The 10-Mile and Mosquito Gulch peaks are situated in what was at one time the heart of the Colorado mining industry.

Sawatch
The Sawatch Range is centrally located in the state. The range consists of 15 peaks, including the well-known “Collegiate Peaks”, infamously named after several Ivy League schools. The Sawatch Range appeals to recreationists who are interested in more than just “peak bagging”. Camping and more diverse recreational opportunities like river rafting and off-road vehicle paths abound.

Elk
The Elk Mountains are located in north central Colorado, near the popular resort town of Aspen. Rugged and picturesque, these six Elk Mountain peaks attract serious rock climbers, as well as photographers and tourists from Aspen.

San Juans
The San Juan mountain range consists of 12 eclectic peaks that offer a range of recreation experiences, including off-highway vehicles, and railroad access. Located in the southwest corner of the state, the San Juans have less foot traffic than the Front Range peaks, but attract a number of out-of-state tourists. At this writing, one peak in the San Juans, Wilson Peak, is privately owned and is off limits to the public. The landowner also maintains that Wilson Peak is rich with mineral deposits.

Sangre de Cristo
The Sangres, as they are often called, are located in the south central to southeast region of the state. These 10 rugged peaks present varying levels of difficulty. One peak, Culebra, is privately owned. The most recent owner of this property, which includes a ranch, the Culebra Peak trail and summit, as well as a “Thirteener”, charges admission to access the peak and the rest of the property.

Data Sources

Approximately 840 mail-back surveys were distributed during the summer of 2006 in a stratified sample of Fourteener peaks throughout Colorado. The stratification follows the grouping of peaks and the mountain ranges listed above. Input from several non-profit organizations such as the Colorado Fourteeners Initiative and the Colorado Mountain Club ensured that survey peaks properly represented the mountain ranges, in both terrain and visitor use patterns. We approached hikers and other visitors at the trailhead and in the parking lot at the conclusion of their recreation activity. After providing the visitors with the Fourteener survey packet, and a postage paid return envelope, we collected follow-up information for survey mailings to non-respondents. In total 520 surveys have been returned, for a response rate of 62%.

Results

The importance of these Fourteeners as a trip destination is evident from the fact that more than two-thirds of visitors had these peaks as the sole or primary purpose of their trip from home, and 23% had it as one of many equally important trip purposes. In the authors’ experience from conducting numerous recreation surveys over the past two decades, this is a high percentage of primary purpose and equal purpose trips. In addition, one-third of the visitors to these peaks were from out of state.

Table 2 provides estimates of visitor expenditures shown by per group-per trip, per group-per day, and per person-per day, respectively. We asked individuals to report group expenditures for the entire state of Colorado. We then we divided by the number of people in the group to determine individual expenditure data and then by average length of stay to put it on a day basis.

Table 2. Fourteener Visitor Expenditure Patterns in Colorado**.**

Categories	Per Group - per Trip	Per Group - per Day	Per Person - per Day
Camping	$5.15	$2.58	$1.54
Equipment Rental	$7.79	$3.90	$2.34
Equipment Purchase	$44.98	$22.49	$13.48
Groceries	$36.91	$18.45	$11.06
Restaurant Food	$72.35	$36.18	$21.69
Gasoline	$55.38	$27.69	$16.60
Hotel	$95.39	$47.69	$28.60
Supplies	$8.41	$4.20	$2.52
Car Rental	$31.21	$15.60	$9.35
Total	$357.56	$178.78	$107.18

This is a substantial amount of spending by visitors, and averages about twice the per person expenditures on National Forest land according to the U.S. Forest Service National Visitor Use Monitoring data (http://www.fs.fed.us/recreation/programs/nvum/). The per party expenditures are about one and half times larger than the typical National Park Service overnight visitor (Stynes 2006). The median time spent hiking the Fourteeners is about six hours, with the average being 13.4 hours. We observed that the mean is pulled upward by several very large observations, which may be the result of individuals extending their days to summit several peaks during a day, or even an overnight while on the trail. Another fact to consider is that while most Fourteeners are day trips, many trips require an overnight stay the night before to allow for an early morning trailhead departure (e.g., 5:00 am) in order to be off the summit prior to the afternoon lightning storms. Hence, many Front Range Fourteeners that are within two hours of Denver still require an overnight stay. Furthermore, Fourteeners located in the San Juan Range in southwestern Colorado or the Sangre de Cristos in southern Colorado frequently require two-night stays for non-local residents. Thus our sample average overall length of trip from home is 1.6 days.

Unfortunately the U.S. Forest Service does not keep visitor statistics on the number of Fourteener hikers, and so we are unable to expand our sample expenditures to an annual total.

Net Willingness to Pay Analysis Using Contingent Valuation (CVM)

In order to estimate net WTP we utilize the contingent valuation method, a technique that creates a simulated market for the good in question. Most contingent valuation surveys now use a willingness to pay question format called dichotomous choice. The dichotomous choice format has the advantage of mimicking price taking behavior in the market. In our implementation of the dichotomous choice question, respondents were asked whether they would pay a predetermined increase in trip cost. While the predetermined amount is fixed for the respondent, it varies across the sample of respondents. This allows the analyst to trace out a quasi-demand function relating the probability a person will pay the dollar amount they are asked to pay. Hanemann (1984) views the respondent as evaluating the difference in utility associated with the status quo versus paying some amount ($X) to have access. If the difference in utility is positive for access, the individual is expected to respond "Yes". If the difference in utility is distributed logistically, a logit model can be used to estimate the parameters and allow for calculation of WTP.

The cumulative logistic distribution function is as follows:

(1) $\text{Prob}(Y=1) = [\exp(\beta X_i)] / [1 + \exp(\beta X_i)]$.

β is the set of parameters that reflect the impact of changes in the independent variables, X_i, on the probability of agreeing to pay, which is the binary dependent variable, Y=1 if Yes, and Y=0 if the response is No. From the cumulative distribution function, we can develop the odds ratio of paying for access (Y=1) or not (Y=0):

(2) $[\text{Prob}(Y=1)] / [1 – \text{Prob}(Y=1)] = \exp(\beta X_i)$.

By taking the log of the odds ratio, we obtain the logit model:

(3) $L = \ln \{[\text{Prob}(Y=1)] / [1 – \text{Prob}(Y=1)]\} = \beta_0 + \beta_i X_i$

The log of the odds ratio is linear in the coefficients and the independent variables. Mean willingness to pay is calculated applying Hanemann's formula (1989) for the mean:

(4) $\text{Mean WTP} = (\ln(1+\exp(B_o)))/|B_1|)$.

Table 2 provides the results of a simple logit model in Equation (3). While non-bid independent variables are often included in these logit models as independent variables, since these coefficients are typically multiplied by their respective means, and then added to the constant term, a simple logit usually gives the same mean WTP as a more complex one.

Table 2. Simple Logit Dichotomous Choice CVM Model for Fourteener Visitors.

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Constant	1.1322	0.1357	8.342	0.0000
Bid Amount	-0.0046	0.0005	-8.264	0.0000

Mean dependent var	0.567	McFadden R-squared	0.1623
Log likelihood	-276.288	LR statistic (1 df)	107.094
Restr. log likelihood	-329.835	Probability(LR stat)	0.0000
Obs with Dep=0	209	Total obs	482
Obs with Dep=1	273		

As shown by the p-value this simple logit model has a highly significant bid coefficient. The negative sign is in accordance with economic theory, in that the higher the dollar amount the visitor was asked to pay the less likely they will pay. This suggests some internal validity of the dichotomous choice CVM responses. Nonetheless, there is always the potential for hypothetical bias in any stated choice question. It is less likely when asking recreation use values, as Carson et al. (1996) multiple Travel Cost Method-CVM comparisons show. There also could be some unknown amount of protest responses as well, due to U.S. Forest Service exploration of instituting entrance fees to popular Fourteeners. Using equation (4) and the coefficients in Table 2, the mean WTP per trip was calculated at $307, with a median of $246. The 90% confidence interval on mean WTP is $266 to $361 per trip.

Compared to typical values in the recreation economics literature, the $307 willingness to pay value is fairly large, even compared to more specialized activities such as rock climbing. The most similar climbing study is one in Colorado by Ekstrand (1994). He asked rock climbers at Eldorado Canyon outside of Boulder what they would pay to do similar climbs but in remote wilderness locations. His value of $27.95 per day in 1991 is equivalent to $40 in 2006, the year of our data. Grijalva and Berrens (2003) also estimated a value of rock climbing in Texas at between $47 and $56 per day trip. More comparable is the study by Grijalva et al. (2002) that involves climbing in wilderness areas, where they found a WTP of only $20 to $25 per person to avoid closing climbing sites in several National Forest, National Park and Bureau of Land Management wilderness areas.

While our consumer surplus values are strikingly high compared to other recreation studies, there is some validation of a high WTP using other information from Culebra Peak, one Fourteener that is contained entirely on private land. The private landowners charge a $150 per person access fee for Culebra. While this is about half our estimate of maximum WTP, the fact our consumer surplus is larger than a uniform access fee charged by a private land owner is sensible, since only a perfectly price discriminating monopolist could extract all the consumer surplus from hikers. Based on our median WTP, half the hikers would pay $246 or more of an entrance fee, but half would not. Of course it would be desirable to expand our study to include this privately owned peak, but private ownership makes it difficult to access visitation data.

In summary, this is the first study to quantify the value to visitors from hiking Colorado Fourteeners, and the regional expenditures resulting from these excursions. The consumer surplus value indicates that indeed hikers place a high value on the Fourteeners of Colorado—even more so than other mountain-related recreation activities. Climbing Fourteeners is a high value activity, both when it comes to per-dollar visitor expenditures and consumer surplus. While the Colorado Fourteeners might present a unique list of peaks to “conquer”, increases in visitor use of high western peaks suggest that recreationists may place a high value on accessing these summits, as well. Hence, it is very possible that some of the benefit estimates from the Colorado peaks may transfer to other western summits like Mt. Whitney and Mt. Shasta. While high peaks clearly provide high value to recreationists, how westerners manage these national treasures will likely become the focus for future recreation management as some of these peaks are close to being loved to death.

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The Farm Level Impacts of Operating the Current Farm Bill at Reduced Federal Budget Spending Levels

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Introduction

Reduced federal spending on farm programs is a reality that U.S. producers will likely face in the near future as the debate over the next farm bill looms. Less money will likely be available in the federal budget for farm program spending under the next farm bill. Also, additional players will potentially be involved as issues such as WTO compliance of farm programs come to the forefront of the debate. In essence, more players will be competing for a shrinking pool of funds allotted for federal farm program spending.

One response to the current budget reality is to allow the current farm program structure to remain in place while reducing support to producers. Westhoff and Brown (2006) found that this type of reduction has only slight impacts on commodity markets at the sector level; however, the manner in which government spending is reduced will likely have very different impacts on different types of farms across the United States.

The purpose of this study is to quantify the probable economic impacts of a $5 billion reduction in direct payments, countercyclical payments, or marketing loan benefits on representative crop farms. The result will suggest which program reduction would be better for different commodities, or if they will all agree on which program to use for saving $5 billion.

Data and Methods

A two step approach was utilized to quantify and compare the impacts of alternative methods of saving $5 billion over the 2008 to 2017 budget period by reducing direct payments, countercyclical payments, and marketing loan benefits. In the first step, a model for projecting annual farm program payments to nine major crops is used to determine the reductions necessary to save $5 billion over the 10 year projection period. The second step in the methodology calls for simulating representative crop farms with the reduced payments identified in the first step for each policy alternative in order to determine the farm level impact of these potential changes.

Stochastic Optimal Control Model

The March 2007 Congressional Budget Office (CBO) Baseline for CCC and FCIC Outlays (Hull, Langley and Hitz 2007) provides a projection of annual CCP, DP, and LDP program payments for feedgrains, wheat, rice, upland cotton, soybeans, and peanuts. The CBO Baseline was used to develop a stochastic simulation model that calculates annual payments for these

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program crops over 2008-2017. The model uses the same stochastic framework as CBO to calculate program payments over the complete range of possible crop prices and weights these costs by the probability of price falling in the associated range. The model includes a production response to changes in target prices, DP rates, and loan rates through own supply elasticities.

Extensions in the model beyond the model used to develop the CBO Baseline include an update of the probability distributions for prices based on the January 2007 FAPRI Stochastic Baseline and the inclusion of minor feed grains (sorghum, barley, and oats). These minor feed grains were added to the model using the January 2007 FAPRI Baseline projections of prices, acres, yields, DPs, CCPs, and LDPs for these crops. The CBO Baseline reports total payments to the three minor feed grains. The proportion of payments in FAPRI's Baseline paid annually to each crop was used to apportion CBO's projected payments to the minor feed grains. The mix of payments (CCP, DP, and LDP) to the minor feed grains was estimated using the fraction of payments for these programs in the FAPRI Baseline.

An optimal control mechanism (Solver in Microsoft® Excel) was used to estimate program participation fractions implicit in the CBO Baseline. After calibrating the model to the March 2007 CBO Baseline, the difference in total payments (error) for the nine program crops over the 2008 to 2017 period between the two models was less than five tenths of one percent on a $74 billion budget forecast.

Total government expenditures for 2008-2017 in the CBO Baseline assume continuation of the 2002 farm bill through 2017. Three alternative policy scenarios were analyzed assuming the government saved $5 billion over 10 years, relative to the Baseline, for each policy. Savings were achieved by withholding a percentage of direct payments, countercyclical payments, and marketing loan benefits. It is important to note that direct payment rates, target prices, and loan rates remained at 2002 farm bill levels to calculate initial payment levels. These initial payment levels were then reduced by the specified percentages across all program crops to reduce government program spending by $5 billion. These scenarios analyzed and compared to the **Base** situation are:

- **Base** – Current farm bill legislation (2002 farm bill) remains in effect with no alterations throughout 2017, the end of the study period.
- **Reduce DP** – Spending on direct payments over the 2008-2017 is reduced from $52.1 billion to $47.1 billion, a 9.6% cut for each program crop.
- **Reduce CCP** – Spending on countercyclical payments is reduced from $11 billion to $6 billion, a 45.5% reduction for each program crop.
- **Reduce MLB** – Spending on marketing loan benefits (including loan deficiency payments and marketing loan gains) is reduced from $7.1 billion to $2.1 billion, 70.5% reduction for each program crop.

Representative Farm Analysis

The farm level analysis uses primary representative farm data in a whole farm simulation model to project the economic impacts of reduced federal spending at the farm level. The Agricultural and Food Policy Center (AFPC) at Texas A&M University maintains a set of sixty-four representative crop farms located in nineteen states that are developed using a focus group interview process. Information relevant to these farms is updated through follow-up meetings every two to three years. The representative farms are located in critical agricultural production centers of the country and include nineteen feedgrain and oilseed farms, eleven wheat farms, twenty cotton farms, and fourteen rice farms. Characteristics of the representative farms analyzed are available in AFPC Working Paper 2007-1 (Outlaw et al. 2007). The first two letters for the name of each representative farm indicate the state where it is located, while the numbers in the name indicate size of the farm (in acres). Farm classification by commodity type is determined by the commodity or commodities comprising the majority of receipts for the farm.

The impact of alternative farm policies on these farms is analyzed utilizing the whole farm simulation model (FLIPSIM) developed by Richardson and Nixon (1986). The model incorporates price and yield risk by utilizing a multivariate empirical (MVE) distribution. Random crop yields and commodity prices are drawn from a MVE distribution to apply the effects of risk to the analysis, thus allowing a range of outcomes for analysis rather than a single point estimate. The description for this random value simulation procedure is available in Richardson, Klose and Gray (2000).

Following are three key assumptions made in this study: (1) long-term and intermediate-term debt beginning the study period in 2004 is 20% of the beginning market value of assets for the representative farms, (2) the framework and provisions of the 2002 farm bill are assumed to remain constant through the end of the study period (2012), and (3) crop mixes, payment yields, and program crop base acreages are assumed to remain constant throughout the study period (2008-2012). The alternative policy scenarios were analyzed for the representative farms by simply reducing the direct, countercyclical, or loan deficiency payments by their respective fractions defined above.

Changes in CCPs and DPs are not expected to result in modifications to crop mixes on the representative farms, as these payments are decoupled. Reductions in MLBs are expected to result in modest changes in crop mixes on farms that grow crops heavily dependent on MLBs. The methodology used assumed no crop mix change over the planning horizon, so the net cash farm income (NCFI) projections reflect lower bounds for farms growing cotton and rice.

Results

Preferences for each alternative are ranked based on 2008-2012 average projected NCFI. The 2008-2012 period was chosen because this would be the first five years of the next farm bill. NCFI is equal to total cash receipts minus total cash expenses. It is important to note that NCFI does not include all cash outflows, as family living, principal payments on loans, cash difference required for machinery trade-ins, and income and employment taxes must be paid from NCFI. Table 1 provides the average projected NCFI (2008-2012) for the base situation and the three policy alternatives for all sixty-four representative crop farms. As expected, the **Base** situation is clearly the preferred scenario for all of the representative farms since each alternative involves a different way to reduce government payments. Following is a detailed description of the probable impacts of reduced government spending on the representative farms by commodity type.

Feedgrain/Oilseed Farms

The majority (thirteen of nineteen) of the representative feedgrain and oilseed farms prefer the **Reduce CCP** scenario over the **Reduce MLB** and **Reduce DP** scenarios, indicating that most of the farms are more willing to give up 45.5% of countercyclical payments than 70.5% of marketing loan benefits or 9.6% of direct payments. Strong projected grain prices result in low expected countercyclical payments over the 2008-2012 projection period, thus most representative feedgrain and oilseed farms are more willing to give up the specified percentage of those payments than the specified portions of direct payments or marketing loan benefits. The remaining six farms prefer the **Reduce DP** scenario over the **Reduce CCP** and **Reduce MLB** scenarios. The common link among these six farms is they all either produce cotton or have cotton base acreage, thus they receive government payments associated with cotton. As cotton is expected to experience relatively weak prices over the study horizon, it is not surprising that grain producers growing cotton would prefer to forfeit fixed direct payments for potentially higher payments that depend on uncertain market conditions. The **Reduce MLB** scenario is the least preferred option for eighteen of the nineteen feedgrain and oilseed farms because a $5 billion savings using only the marketing loan benefits would require reducing these payments 70.5%. In addition, when market conditions trigger a marketing loan benefit, the payment is on 100% of actual production rather than 85% of a historical payment yield used to calculate direct and countercyclical payments.

Wheat Farms

All eleven representative wheat farms prefer the **Reduce CCP** scenario over the **Reduce DP** and Reduce **MLB** scenarios, indicating they are all more willing to give up a portion of countercyclical payments before giving up marketing loan benefits than direct payments. For the wheat farms, giving up 45.5% of countercyclical payments results in a very small reduction in average NCFI because high price projections will not result in significant countercyclical payments over the next five years. All representative wheat farms prefer the **Reduce DP** scenario over the **Reduce MLB** scenario.

Cotton Farms

All representative cotton farms, with the exception of the two Texas northern high plains farms (TXNP3000 and TXNP7000) prefer the **Reduce DP** scenario, indicating they are more willing to give up 9.6% of their direct payments rather than 45.5% of their countercyclical payments or 70.5% of their marketing loan benefits. The two Texas northern high plains farms have no cotton base acres (the practice of growing cotton in this part of Texas is a relatively recent trend, and base acreage was only able to be updated based on planted acres from 1998-2001 under the last farm bill) and are unable to receive countercyclical payments on cotton, so they would prefer to preserve their marketing loan benefits. Cotton producers are more willing to give up direct payments than countercyclical payments or marketing loan benefits in an environment of low projected prices. Thirteen of the representative cotton farms would least prefer giving up a portion of their countercyclical payments, the **Reduce CCP** scenario. The **Reduce MLB** scenario ranks second in preference for thirteen of the twenty representative cotton farms.

Rice Farms

Thirteen of fourteen representative rice farms in this study prefer the **Reduce CCP** over the **Reduce DP** and **Reduce MLB** scenarios, indicating they would rather forfeit a portion of their countercyclical payments than give up direct payments. The northern Louisiana rice farm (LANR2500) has 325 acres of cotton base, thus making it somewhat less willing to give up a portion of its countercyclical payment. The **Reduce MLB** scenario is the least favorable alternative for all fourteen representative farms, while giving up a portion of direct payments (**Reduce DP** scenario) ranks as the second preferred alternative for thirteen of fourteen representative rice farms analyzed.

Conclusions

As expected, producers of different commodities clearly have different preferences concerning how they would prefer the government reduce spending, if necessary. The current grain price outlook suggests that countercyclical payments will be less critical for grain producers, thus strengthening their preference to accomplish savings through reducing this program. In contrast, for cotton producers, the MLB and CCP programs are likely to remain a critical market safety net, meaning they are generally more willing to give up a portion of their smaller direct payment. This will likely lead to interesting debates as well as the formation of some previously unexpected alliances as the next farm bill debate gets underway. For example, wheat and rice share almost identical preferences in methods for the government saving money over the 2008-2017 period. Cotton and rice, two crops traditionally considered southern crops, display considerably different preferences regarding direct payments and countercyclical payments. These results highlight the challenges that exist in making potential reductions in federal spending equitable across all commodities.

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Table 1. Average Net Cash Farm Income for Representative Feedgrain/Oilseed, Wheat, Cotton, and Rice Farms Under Current Policy Situation and Three Alternative Policy Options, 2008-2012.

	Base[1]	Reduce DP[2]	Reduce CCP[3]	Reduce MLB[4]
	--$1,000--	--$1,000--	--$1,000--	--$1,000--
Feedgrain/Oilseed				
IAG1350	205.8	203.0	204.6	185.9
IAG3400	578.9	571.9	576.2	529.0
NEG1960	425.4	420.5	423.6	392.5
NEG4300	846.4	836.5	843.1	780.2
NDG2180	229.9	227.6	229.3	219.1
NDG7500	1190.7	1181.6	1188.9	1122.6
MOCG2050	434.0	430.9	432.7	413.2
MOCG3630	778.2	773.5	776.3	744.0
MONG1850	320.0	317.0	318.8	300.2
TXHG2000	51.4	48.4	45.0	39.4
TNG900	59.6	58.4	59.1	49.5
TNG2750	387.3	383.6	386.0	354.9
SCG1500	223.6	218.1	190.7	206.8
SCG3500	508.6	498.9	484.6	474.2
ING1000	120.2	118.1	119.5	106.0
ING2200	356.8	352.5	355.4	326.3
TXWG1400	38.6	36.2	29.2	29.2
TXUG1200	9.2	5.9	-3.2	-11.3
TXPG3760	132.2	123.0	98.1	64.0
Average	**363.0**	**358.2**	**355.7**	**332.9**
Std. Dev.	**313.1**	**311.2**	**315.8**	**299.5**
Wheat				
WAW1725	79.4	75.8	78.9	69.6
WAW5000	181.1	171.3	179.9	151.5
WAAW3500	80.3	77.7	79.9	75.9
KSCW1600	59.4	57.3	59.1	53.8
KSCW4000	231.3	226.6	230.7	214.0
KSNW2800	82.2	79.2	81.6	74.7
KSNW5000	268.8	263.6	267.7	247.9
COW3000	168.7	167.2	168.4	163.3
COW5640	218.2	214.9	217.8	208.1
MTW4500	199.1	194.7	198.6	192.9
ORW4000	115.5	112.7	115.1	110.3
Average	**153.1**	**149.2**	**152.5**	**142.0**
Std. Dev.	**72.7**	**71.7**	**72.5**	**68.4**

Table 1. (Continued)

	Base[1]	Reduce DP[2]	Reduce CCP[3]	Reduce MLB[4]
	--$1,000--	--$1,000--	--$1,000--	--$1,000--
Cotton				
CAC4000	391.2	385.0	351.7	365.6
TXNP3000	-70.9	-76.3	-72.1	-102.8
TXNP7000	96.4	84.5	93.3	25.5
TXSP2239	-16.4	-20.4	-41.3	-29.8
TXSP3745	-34.8	-41.7	-76.3	-57.1
TXRP2500	61.6	59.0	48.8	52.4
TXCB2250	71.5	66.5	48.7	50.2
TXCB5500	38.3	27.5	-10.5	-11.5
TXVC4500	322.7	312.4	277.2	277.7
TXPC2500	177.4	169.8	151.2	148.5
TXMC1800	109.9	105.2	94.1	90.3
TXEC5000	230.1	221.6	168.3	193.0
GAC2300	271.2	260.1	205.8	230.1
TNC1900	322.3	318.2	300.9	299.9
TNC4050	-111.3	-121.7	-178.3	-173.3
LAC2640	159.5	148.8	115.4	122.3
ARC6000	-240.1	-263.1	-311.6	-327.1
ARNC5000	-67.1	-78.2	-171.6	-139.6
ALC3000	22.7	13.6	-30.7	-6.6
NCC1100	-56.3	-59.4	-78.0	-71.2
Average	**83.9**	**75.6**	**44.3**	**46.8**
Std. Dev.	**165.5**	**166.9**	**171.6**	**173.9**
Rice				
CAR550	-156.3	-163.3	-161.3	-163.5
CAR2365	1150.4	-1182.0	-1175.8	-1185.3
CABR1100	-506.3	-520.0	-516.3	-520.7
CACR715	-390.5	-400.0	-397.5	-401.1
TXR1350	-85.4	-91.3	-89.6	-92.3
TXR2400	-165.0	-175.5	-172.6	-180.1
TXBR1800	-113.4	-122.2	-119.6	-125.3
TXER3200	-339.8	-355.4	-350.7	-359.4
LASR1200	-191.0	-195.9	-195.1	-199.5
LANR2500	-148.6	-161.2	-167.4	-180.1
ARSR3640	113.6	100.1	103.7	81.7
ARWR1200	-286.6	-293.6	-291.4	-303.3
ARHR3000	-422.7	-440.0	-437.3	-463.2
MOWR4000	285.9	265.4	269.2	231.7
Average	**-89.7**	**-266.8**	**-264.4**	**-275.7**
Std. Dev.	**413.3**	**335.4**	**334.5**	**331.0**

[1] Base: Current (2002) farm bill legislation remains in effect through 2012.
[2] Reduce DP: Direct payments are reduced by 22.2% for all government program crops to save $5 billion over the 2008-2012 projection period.
[3] Reduce CCP: Countercyclical payments are reduced by 47.1% for all government program crops to save $5 billion over the 2008-2012 projection period.
[4] Reduce MLB: Marketing loan benefits are reduced by 38.0% for all government program crops to save $5 billion over the 2008-2012 projection period.

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