# AN ECONOMIC ANALYSIS OF THE DAIRY ENVIRONMENTAL COOPERATIVE IN NORTHEAST KANSAS

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# ABSTRACT OF "AN ECONOMIC ANALYSIS OF THE DAIRY ENVIRONMENTAL COOPERATIVE IN NORTHEAST KANSAS"

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In 1997, the Black Vermillion Dairy Environmental Cooperative (DEC) was started with an EPA 319A grant. Ten Kansas dairies located in the Kansas Black Vermillion Watershed were studied to evaluate the on-farm manure structures cost-shared by the DEC. Net present value (NPV) analysis was used to evaluate the profitability associated with the manure structures. The NPV analysis showed that in most cases, investing in a manure storage structure is a worthwhile venture and can be profitable for the dairy. However, cost-share assistance often will be needed in order to have positive pre-tax and after-tax NPVs.

*Key words:* Dairy Environmental Cooperative (DEC), manure management, Net Present Value (NPV) analysis, cost-share, concrete manure storage.

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## Introduction

In 1993, David Key, Nemaha County Extension Agriculture Agent, and Joseph Harner III, Kansas State Research and Extension Biological and Agricultural Engineer began to assist Marshall and Nemaha County dairies in developing plans for expanding current facilities and developing waste management structures to improve manure management and reduce pollution from dairy manure. Although many of the dairies were using sand bedding to improve herd health and milk quality, but waste management problems were emerging because sand-laden manure does not stack well.

In 1995**,** Governor Bill Graves targeted the Black Vermillion River Watershed, located in Marshall and Nemaha Counties, with funds from the Governor's Water Quality Initiative to improve water quality in the area. However, this initiative was not developed to reduce the costs of constructing waste management structures for livestock facilities. Therefore, in 1996, an EPA 319A grant was submitted to target dairies in the Black Vermillion Watershed. This grant would provide money for cost-share assistance with the construction of dairy waste management structures, the wages/salaries of extension personnel, equipment, and an educational component to participants in the program in the Black Vermilion Watershed. According to the original 319A grant application, it was estimated that there were 37 dairies in the Black Vermilion Watershed, generating at least 30,000 tons of manure per year. The grant was entitled the Dairy Environmental Cooperative in the Black Vermillion Watershed. The grant was approved by the EPA and funded for three years for $300,000 (Harner, 1997).

Once approved and funded, the Dairy Environmental Cooperative (DEC) began partnering with dairy cooperators. Cost-share money was available for waste management structures along with assistance on how to use the manure nutrients in cropping practices. Prior to the formation of the DEC, most of the participating dairies were scraping manure daily and storing manure for about a week. That new manure storage facilities would lead to less frequent manure hauling, which was an important motivation for producers to consider constructing manure structures with DEC cost-share assistance. A typical DEC waste management structure is a concrete storage basin that allows the liquid portion to drain into a lagoon and/or a wetland cell(s) where plants use the nutrients. Once the cooperator agrees to participate in the DEC, a storage structure is designed and built to hold 120 days of manure. This means that the stored manure needs to be applied to fields only three times a year (if the structure is filled to capacity) and applying only three times per year potentially avoids applying the nutrients during environmentally sensitive times of the year, i.e., during May to July.

An important benefit of storing and applying manure is the nutrients that the manure supplies to subsequent crops. However, there can be a great deal of variation in manure due to species, feed rations, time of year, and method of storage. Based on manure samples from 10 of the participating DEC dairies, Table 1 (Strahm, 1999) displays the average levels of nutrients.

Table 1. Summary of Manure Samples Taken from Basins of DEC Dairies

| Nutrient | Feb. 1999 (lbs./ton) | April 1999 (lbs./ton) | Aug. 1999 (lbs./ton) | Jan. 2000 (lbs./ton) | Avg. Analysis (lbs./ton) |
|---|---|---|---|---|---|
| Total Nitrogen | 10.15 | 9.18 | 8.19 | 10.17 | 9.42 |
| NH-N | 3.26 | 2.33 | 2.56 | 4.07 | 3.06 |
| Organic-N | 6.88 | 6.84 | 5.63 | 6.10 | 6.36 |
| Phosphorus P2O5 | 4.61 | 4.49 | 5.33 | 4.21 | 4.66 |
| Potassium K2O | 7.54 | 7.28 | 7.46 | 7.55 | 7.46 |
| Calcium | 8.04 | 7.98 | 8.53 | 5.87 | 7.60 |
| Carbon | 109.09 | 107.24 | 95.13 | 91.55 | 100.75 |
| Magnessium | 3.14 | 3.07 | 3.77 | 3.30 | 3.32 |
| Sulfur | 1.27 | 1.25 | 1.33 | 1.26 | 1.28 |
| Sodium | 1.82 | 1.84 | 1.95 | 2.10 | 1.93 |
| Zinc | 0.05 | 0.05 | 0.06 | 0.05 | 0.05 |
| Iron | 1.40 | 1.47 | 1.56 | 2.18 | 1.65 |
| Manganese | 0.08 | 0.09 | 0.02 | 0.10 | 0.07 |
| Copper | 0.01 | 0.02 | 0.02 | 0.01 | 0.01 |
| Boron | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

Notes: Nutrients listed above the line are those used in this research.

This research examines the profitability associated with manure storage facility construction for ten dairies in the DEC. Because the DEC dairies typically expanded in cow numbers in compensation with manure facility construction, simulations were used to create hypothetical expanded dairies had the dairies not built new manure storage facilities.

## Literature Review

Bennett, Fulhage, and Osburn (1993) studied two dairy waste management systems (lagoon and liquid tank), which were typically used in Missouri dairies. They constructed budgets that simulated Missouri dairy farms' annualized (operating and fixed) costs pertaining to these two waste management systems. The authors estimated the manure value for crop production, which is viewed as a benefit of these systems and reduces the net annual cost of these two systems. The authors evaluated economies of scale effects by simulating 100, 200, 300, 500, 750, and 1,000 cow dairies. The simulation caused the authors to conclude there were cost advantages for waste management systems as dairy cow numbers increased. However, simulated costs were approximately equal for 750 and 1,000 cow dairies. They discovered that, though waste from the liquid tank system is more concentrated and valuable as a fertilizer, this system's net cost is 2.4 times greater than the lagoon system's cost for 100 cows, 1.8 times greater for 300 cows, 1.5 times greater for 500 cows and 1.6 times greater for 1,000 cows. The lagoon system is more economical chiefly because it requires less capital investment per cow. Another outcome the simulation showed was that a liquid tank system requires a 5 to 10 times larger per cow plant filter area for waste distribution than the lagoon system.

Borton, et al. (1995) modified a forage system model called DAFOSYM to include submodels for production, collection, storage, and application of dairy manure. DAFOSYM simulates crop plant growth, feed composition and consumption, milk production, and animal growth. DAFOSYM was modified so that six manure management systems could be evaluated. In their simulation of Upper Midwest dairies, manure systems using long-term storage with spreading, injection, or irrigation have greater direct costs to the farmer than the daily haul system. The authors evaluated dairies that had up to 250 cows. If long-term storage systems are required to protect the environment, the annual net cost of manure handling will increase up to $65/cow for small (60 cow) and $45/cow for large (250 cow) dairy farms.

Similar to those cited in the previous paragraphs, other researchers have found that increased nutrient conservation and decreased labor costs did not offset the increased cost of a manure storage structure. (Christensen, et al., 1981; Cason and McAuslan, 1974; Lessley and Via, 1976; White and Forster, 1978; Safley, et al., 1979; and Heimlich, 1982). In short, the literature has not been particularly indicative of profitability associated with long-term manure storage structures.

Garsow, Connor, and Nott (1992) conducted a whole farm simulation analysis of Michigan dairies using the FINPACK financial analysis (University of Minnesota). They compared two liquid manure storage systems to the daily haul system, three farm debt-to-asset ratios, free stall versus stanchion stall housing, and varying numbers of cows. The authors found that investments in manure storage facilities yielded a negative annual return of 2.9 to 6.6 percent. In their research, "farms currently using daily haul, carrying medium debt, and having 60, 120, or 250 cows would see profitability decrease by $7,100, $9,900, and $9,200 per year, respectively." (Garsow, et al., 1992) Improved nutrient conservation and labor savings were not able to overcome the added cost of manure storage structures. In this simulation, they also observed an economies of scale effect associated with manure management costs.

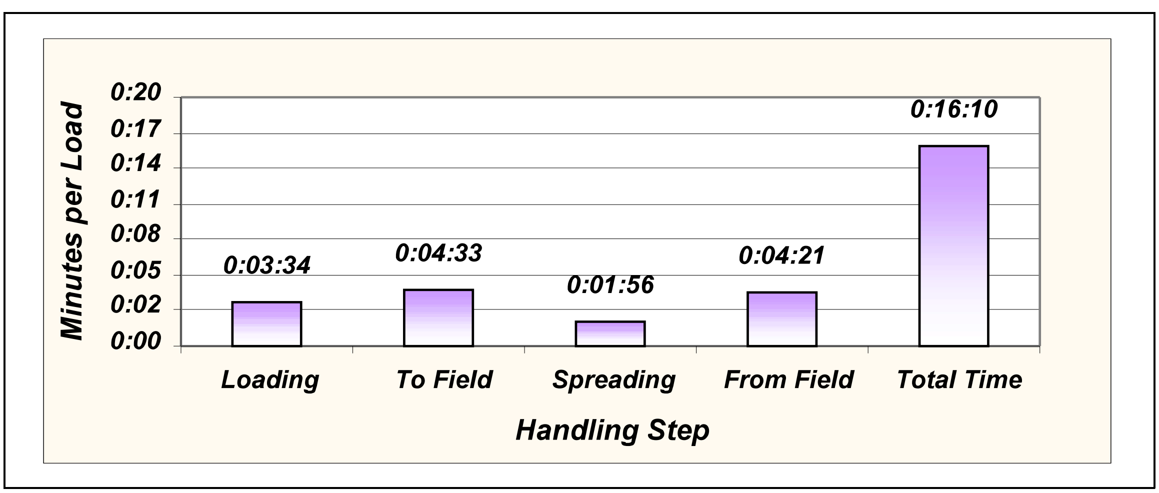
## Survey Information

The financial and dairy operation information from ten DEC dairies located in the Black Vermillion Watershed was obtained through interviews. Information was obtained from ten dairies. A 49-question qualitative survey was developed and used as the basis of the interview with each DEC dairy. It was hoped that the qualitative survey would allow more information to be shared and would not bias the interviewee's responses. The first 17 questions dealt with how the dairy producers operated their dairies and managed their manure in past years prior to the installation of their waste management system through the DEC. The last 32 questions dealt with the installation, cost-share assistance, dairy operation, opinions on waste management policy, and how the operators manage manure with the waste management system through the DEC. Appointments were scheduled and interviews with DEC cooperators were held during April 2000.

To discover custom rates for manure handling, names of custom manure applicators were solicited from Kansas county extension agricultural agents. The 16 identified custom manure applicators were sent an 11-question survey in January 2000 that could be completed and returned. The questions asked were related to the rate charged for hauling, handling, and/or pumping manure for customers, services provided to customers, hours it takes to handle manure for customers, and type of manure handled.

Manure sample data and data from a time-motion study presented by Strahm, et al. (2000) were summarized and used in valuing manure and calculating total manure handling costs. Figure 2 shows a summary of the average times of each step of manure handling from storage to the field and back.

Figure 2. Average Time-Motion Data



## Data Organization and Procedures

This research uses three simulation scenarios. The first scenario developed was the old system, which would include practices and cow numbers prior to the installation of a manure storage structure. DEC dairies typically added cows in conjunction with manure facility construction. The first scenario was not used in the NPV analysis of manure structures. The second scenario, referred to as simply the DEC scenario, involved the DEC dairies as they currently operate in the DEC program and after environmental compliance through new manure facility construction. In most cases relative to the old system, dairy cows have been added and the manure is stored 60-120 days prior to land application. Actual manure sample data from the DEC dairies will be used in this analysis. The DEC dairies' manure was adjusted to 87% moisture for comparison with the other scenarios. The third scenario evaluates the impact of a dairy expanding without building a new manure storage system. To arrive at the values needed, the values calculated in the old system will be divided by total cow numbers and then multiplied times the current number of cows under the DEC system. The third scenario is important for comparison to the DEC system. Since the system has the same expanded number of cows, any differences due to economies of scale were removed.

Budgets were developed to summarize and calculate the information gathered from the DEC and custom manure applicator surveys and the data collected by Strahm, (2000). Most of the budgets were formatted in a budgetary format similar to the work conducted by Bennett, Fulhage, and Osburn (1993). Each budget summarizes and calculates data for each scenario and summarizes differences among the scenarios. These budgets were useful in summarizing the data that were necessary for the NPV analysis. The data used in the NPV analysis were based on DEC dairies' actual manure data, values of nutrients on a per pound basis, manure handling costs, and each dairy's manure facility net purchase price (after cost-share is deducted).

Net present value (NPV) analysis is a useful tool for decision makers to decide whether to invest in a project by taking the positive and negative values (cash flows) and discounting then back to the present. The basic idea is that a NPV that is greater than zero is a project to consider because the project is able to generate discounted cash flows that cover the initial purchase of the project. Simulation analysis will be useful in projecting results based on the actual data for each dairy under various situations and the impact on pre-tax and after-tax NPV. In addition, simulation analysis will be useful in developing a spreadsheet to work with other dairy producers that might be interested in participating in the DEC cost-share program.

For each individual dairy, the storage structure-related NPV was calculated using the dairy's net purchase price (NPP) of the storage structures and its individual yearly manure values. Net purchase price is defined as the cost of the manure storage structures after subtracting the cost-share money that each dairy received. The NPV was calculated by depreciating the net investment by either use the Section 179 provision or depreciating using the IRS schedule for 20 year 150% Declining Balance with half year convention. The Section 179 provision allows the dairy to utilize a maximum of $19,000 for the first year depreciation or the amount of the net investment if less than $19,000. In addition, if the NPP amount was greater than $19,000, the first year $19,000 was deducted and in the following years the balance was depreciated according to the IRS schedule for 20 year 150% Declining Balance with half year convention (Department of the Treasury, 1999, p. 48).

Annual values for the nitrogen, phosphorus, potassium, calcium, and carbon contained in the manure are treated as income and are "taxed" and discounted for NPV calculation purposes. Nutrient price ranges used in simulations are reported in Table 2, along with other simulation rates. The manure value is "taxed" because the dairies lost the tax deduction from purchasing commercial fertilizer. The medium manure nutrient prices selected are based on prices of nitrogen, phosphorus, potassium, and calcium in the 1999 Kansas Farm Management Guide (Dhuyvetter, Smith, Harner, and Brouk, 1999). The average (medium) carbon price is based on carbon sequestration research that placed a value on the carbon sequestered at $.09/lbs. or $.20/kg (Lal et al., 1998). The low and high prices in Table 2 were selected based on the medium price and basically doubled, halved, set to zero, or arbitrarily selected. Tax and interest rates were selected based on the same method. The low price of zero used in simulations is to simulate situations when manure nutrients are not valued in manure.

Table 2. Nutrient Prices and Rates used in Simulation

| Rate | Price N $/lb | Price P $/lb | Price K $/lb | Price Ca $/lb | Price C $/lb | Income Tax Rate | Interest Rate | Section 179 yes=1 |
|---|---|---|---|---|---|---|---|---|
| Low | $0.10 | $0.22 | $0.00 | $0.00 | $0.00 | 15% | 6% | 1 |
| Medium | $0.20 | $0.30 | $0.14 | $0.01 | $0.09 | 30% | 9% | 0 |
| High | $0.30 | $0.38 | $0.18 | $0.05 | $0.18 | 45% | 12% | |

To arrive at pre-tax and after-tax NPVs the following procedure was used. The cash flows from the depreciation, manure values, and net handling cost are calculated at an after-tax value. Each dairy's after-tax annual value (ATAV) is derived from the after-tax value after discounting back to the present and summed over 21 years due to using the 150%

Double Declining Balance with half year convention used for depreciating the manure storage structures. Twenty-one years was used because for some of the dairies, NPP is greater than the $19,000 used for the one year Section 179 deduction. So, the balance is depreciated according to the IRS schedule for 20 year 150% Declining Balance with half-year convention, which depreciates the final amount in year 21. The ATAV is amortized annually to facilitate understanding—and referred to as ATAV. Then the ATAV is adjusted by the income tax rate to arrive at a pre-tax annual value (PTAV). Both pre-tax and after-tax values are useful in demonstrating the impact that different variables can have on the investment decision. The PTAV and ATAV are calculated over various combinations of nutrient prices and financial rates. Finally, in net present value analysis any project such as constructing a dairy manure storage structure that has a positive NPV is a project that will cover total and opportunity cost and is worth considering.

There are many ways to evaluate the economic impact of the DEC on participating dairies. In this case, manure storage, handling, and application operations as an enterprise were isolated from the dairy enterprise as a whole, because dairy manure does not directly impact the production of milk. Milk will be produced whether the manure is handled in these structures or not. Furthermore, to examine the benefits of manure storage construction (thus, indirectly the benefits of the DEC), only the difference s between relevant cost for the expanded and DEC scenarios need be examined. Consequently, simulations were based on *net* manure values. Net manure values are the difference in manure values from the DEC system and the expanded system to capture the added return of using the manure storage structures in the DEC program. Under the new system more manure is stored and applied, which in most cases will have a positive impact on PTAV and ATAV by increasing yearly cash flows. Similarly, the *net* manure handling cost is the difference between that of the DEC system and that of the expanded system. This is to capture the added return by going from the expanded system to the DEC system. The net manure handling costs or savings varies by dairies. Variations occur for many reasons, such as: dairies expanded the number of cows milked and have built larger facilities requiring more time and more manure to be handled. However, the expanded scenario and DEC scenario have the same number of cows, so expected differences in cost due to size have been accounted for. Another reason for variation in net manure handling costs would be potential labor savings that occurs from not having to haul manure as often due to the large storage capacity of the manure storage structure.

The pre-tax and after-tax simulation model demonstrates the added benefit of investing the capital and constructing a manure storage system built under the DEC program. The simulation equations are developed as follows.

In this analysis, the net purchase price or investment, denoted by NPP, is considered to occur in year 0, whereas tax benefits and manure-related cash flows are not considered to begin until the following year, which is year 1. Two manure-related annual cash flow series are relevant in this analysis. These include the net annual manure value (NMV) and the net manure handling costs (NHC). Equations 1 and 2 represent the cash flow series.

**(1)** $NMV = QN * PRICEN + QP * PRICEP + QK * PRICEK + QCa * PRICECa + QC * PRICEC$

Where NMV (net annual manure value) is the additional (can be negative) manure value associated with the DEC dairies (relative to their "no new facilities construction" same-size counterparts in the expanded scenario). *QN*, *QP*, *QK*, QCa, and *QC* are the net additions (in lbs.) of nitrogen, phosphorus, potassium, calcium, and carbon, respectively. Similarly, *PRICEN* … *PRICC* are the associated prices.

Using *IncT* and *IntR* to denote the expected average income tax rate and borrowing rate, respectively, applied to the investment, leads to the following after-tax interest or discount rate, *ATI*:

(2) $ATI = IntR * (1 - IncT)$,

and the associated discounting term:

(3) $d = (1 + ATI)^{-1}$.

In this notation, the discount factor applied to after-tax cash flows in future year $t$ is $d^{t}$.

Depending upon whether the Section 179 expensing deduction is taken or not, that deduction (*SEC179*) is either 0 or the maximum of [*NPP*, $19,000]. Tax benefits arising from the Section 179 deduction are assumed to accrue in year 1. After considering *SEC179*, the amount of money left to depreciate over the 21 years is *DEPR*:

(4) $DEPR = NPP - SEC179$.

Depreciation occurs at the year-specific annual rate of $DepR_t$, where $t$ ranges from 1 to 21 and is taken from the IRS tax tables.

The total after-tax annual cash flows are made up of the purchase price (year 0 only), after-tax net manure values, after-tax net manure handling costs, and income tax savings. Each year, the sum of the after-tax cash flows for that year are discounted back to the present (year 0) using the appropriate discount factor, and summed to equal the discounted after-tax cash flows, which is the traditional after-tax net present value of the investment (*ATNPV*):

$$(5)\ \ ATNPV = -NPP * d^0 + SEC179 * IncT * d^1 +$$

$$[((NMV - NHC) * (1 - IncT)) + DEPR * DepR_1 * IncT] * d^1 +$$

$$[((NMV - NHC) * (1 - IncT)) + DEPR * DepR_2 * IncT] * d^2 +$$

$$\ldots[((NMV - NHC) * (1 - IncT)) + DEPR * DepR_{20} * IncT] * d^{20} +$$

$$[DEPR * DepR_{21} * IncT] * d^{21}$$

The *ATNPV* can be amortized to equal after-tax annual values (*ATAV*) according to:

$$(6)\ \ ATAV = ATNPV * \{ATI / [1 - (1 + ATI)^{-20}]\}.$$

Finally, the amortized after-tax net present value can be converted to pre-tax by:

$$(7)\ \ PTAV = ATAV / (1 - IncT).$$

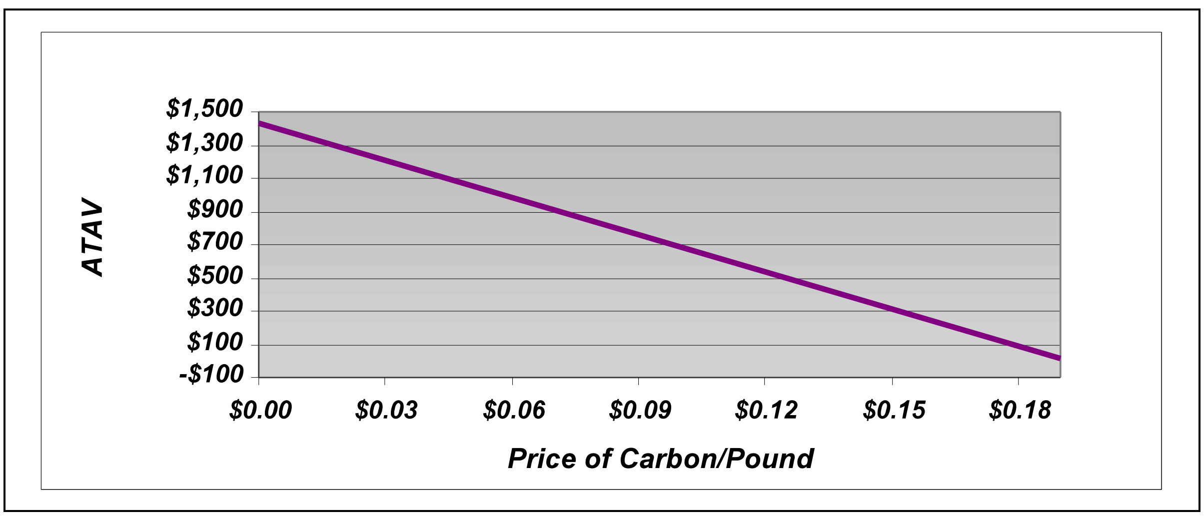
With each simulation assumption regarding manure nutrient prices, income tax and interest rates, and Section 179, the *ATAV* and *PTAV* values were calculated for each of the ten dairies in the analysis.

**Results**

This NPV simulation can prove useful in working with dairy producers who are trying to decide whether to construct and operate a dairy manure storage structure. The NPV simulation also gives us some insight into how the prices of nitrogen, phosphorus, potassium, calcium, and carbon; income tax, interest rates, Section 179 deduction, and cost-share variables impact pre-tax and ATAV. In the results of the analysis, the values are averaged for each dairy and variables have either a constant value or may vary for each dairy depending on what variables are analyzed. These averages are then averaged for the ten DEC dairies as a group.

First, each manure nutrient price has a linear relationship with PTAVs and ATAVs in this simulation. For example, Figure 2 demonstrates carbon's negative linear relationship. If the price of carbon increases by $0.01/lb., the increase will have an impact on the PTAV of -$74.79 and the ATAV of -$106.84. These results occurred because DEC dairies produce less total carbon (relative to the expanded scenario) due to sand bedding being used, and sand does not contain as much carbon as organic bedding. However, if carbon is not valued in the manure, then positive PTAVs and ATAVs occur.

Figure 2. Price per Pound of Carbon's Impact on ATAV




When examining the impact of nitrogen and phosphorus prices on PTAVs and ATAVs, a positive linear relationship can be seen instead of the negative linear relationships with carbon. On average, across the ten farms, every $0.01 per pound increase in the price of nitrogen causes a PTAV increase of $79.88 and an ATAV increase of $55.92. For phosphorus a $0.01 per pound increase in the price of phosphorus causes a PTAV increase of

$13.41 and an ATAV increase of $9.39 on average across the ten farms. Figures 3 and 4 demonstrate the positive linear relationship nitrogen and phosphorus have with ATAV.

Figure 3. Price per Pound of Nitrogen's Impact on ATAV

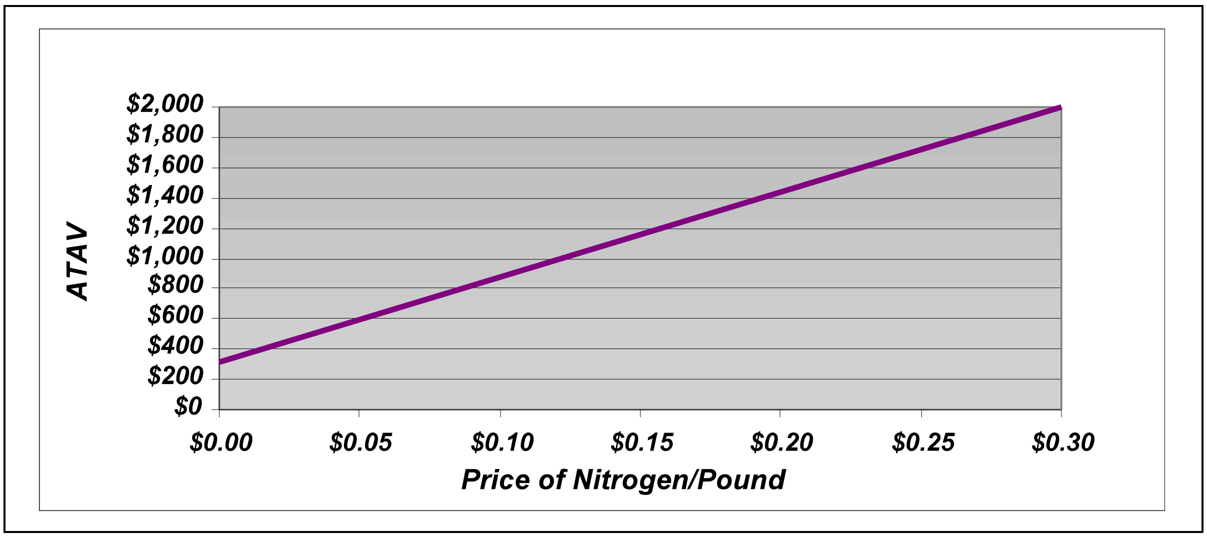



Figure 4. Price per Pound of Phosphorus' Impact on ATAV

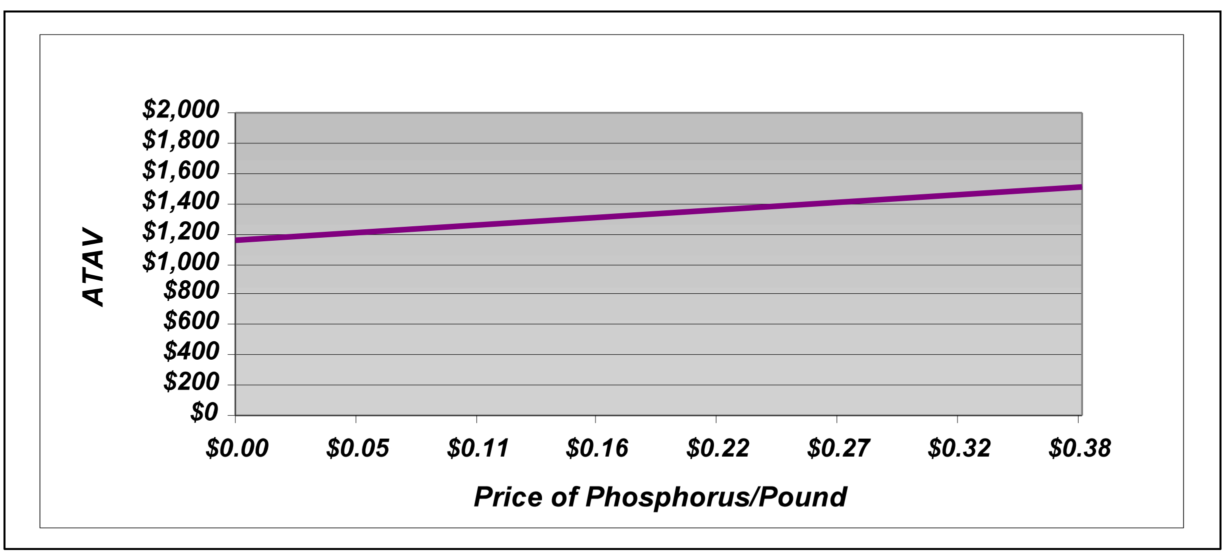
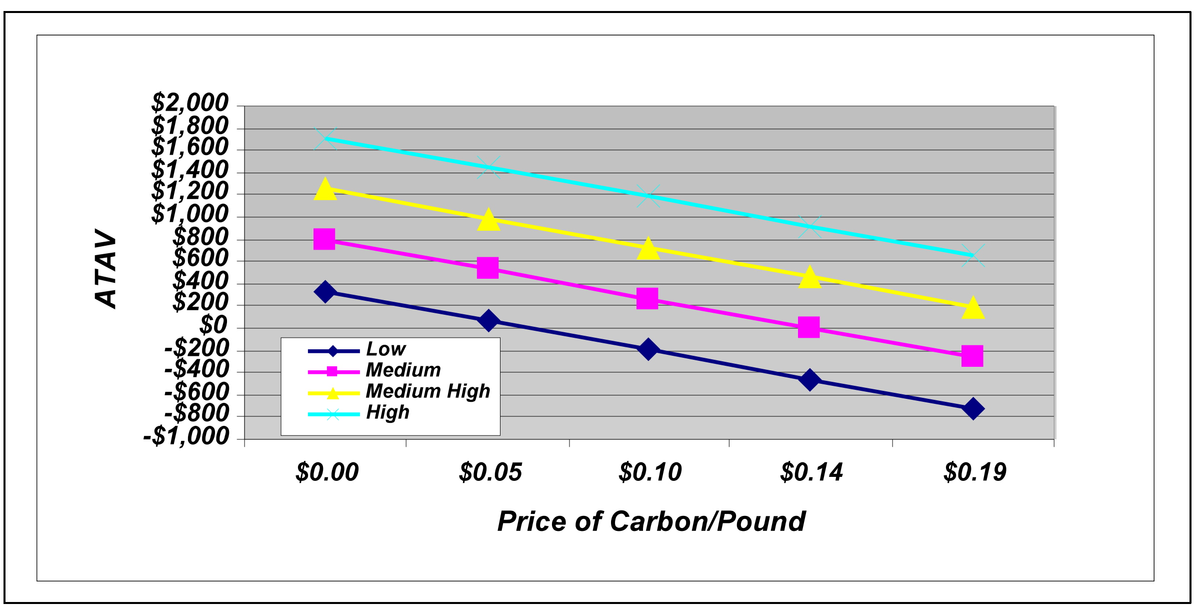


Figure 5 demonstrates the impact of carbon price on ATAV, evaluated at four price levels of nitrogen, phosphorus, potassium, and calcium. In this evaluation there were four nutrient price levels (low, medium, medium high, and high) for the non-carbon nutrients. Carbon was valued at $0, $0.05, $0.09, $0.14, and $0.19 per pound in each of the five nutrient price levels. When carbon had a value of zero in each of the four levels there was, on average, a positive ATAV of $1,021.35. The overall average of $493.65 for carbon is when valued greater than zero. The ATAVs decrease over the carbon price range, but remain positive until the low and medium price levels are at $0.10 per pound and $0.14 per pound of carbon respectively. The negative effect carbon has on ATAV is due to more carbon retained by the expanded dairies, causing many of the dairies to have negative carbon values (recall that nutrient values are net, i.e. DEC less expanded). If carbon has a value of zero, and nitrogen, phosphorus, potassium, and calcium are allowed to vary, the average ATAV is $1,205 and the PTAV is $1,721.

Figure 5. Impact of Carbon Price on ATAV at 4 Price Levels of Other Nutrients



Other variables such as income tax rates and interest rates have an impact on the PTAVs and ATAVs. The nutrient values are held at the mean level when variables such as income tax rates or interest rates are simulated. Figures 6 and 7 demonstrate the inverse relationship that occurs due to changes in interest rates and tax rates.

Figure 6. Tax Implications Impact on ATAV

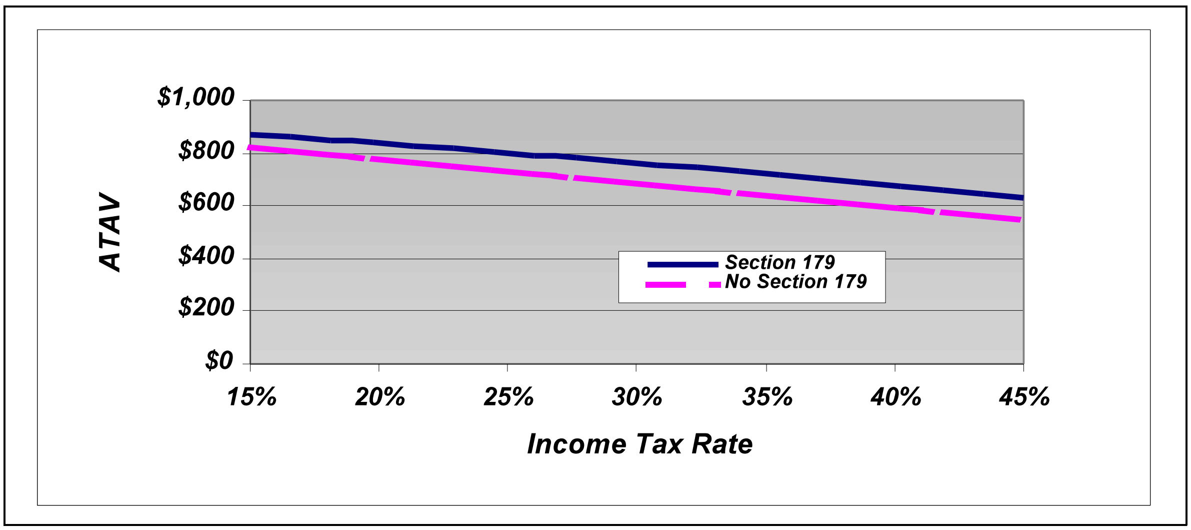
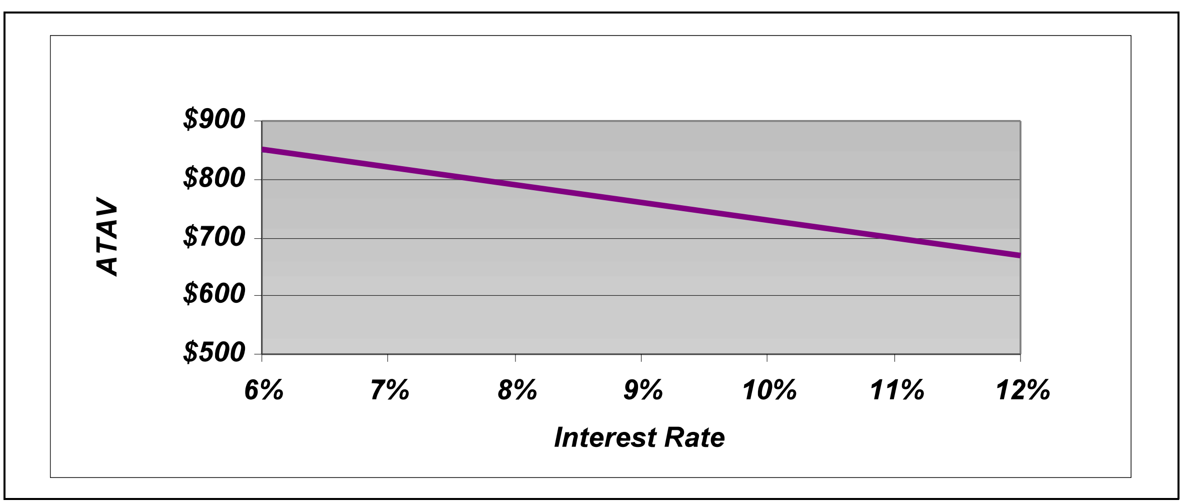



Figure 7. Interest Rates Impact on ATAV



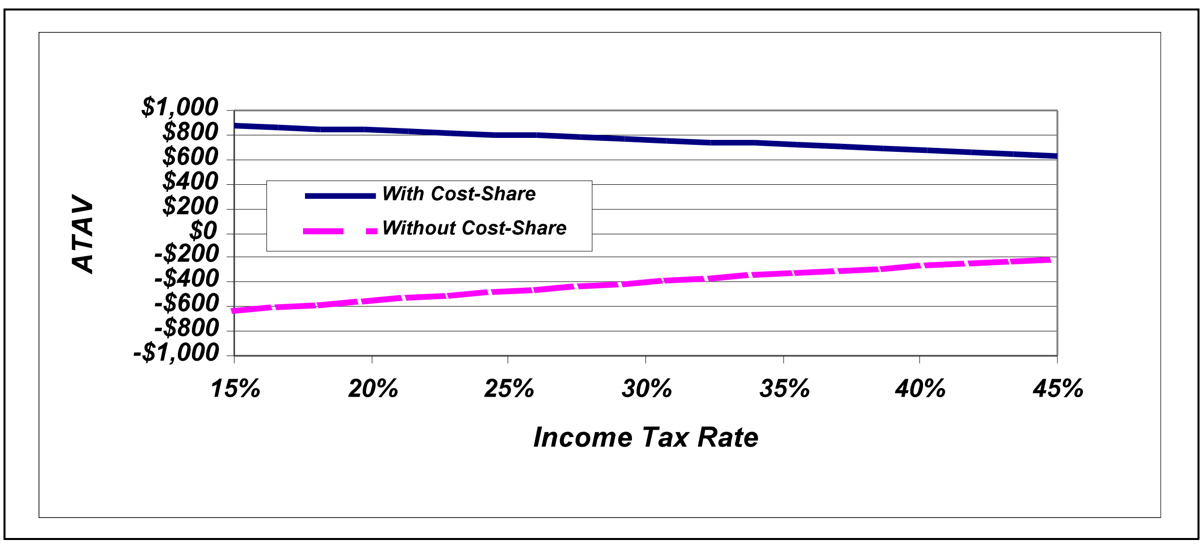
In Figure 6, across the simulated tax rates, the average advantage in favor of using the expensing Section 179 deduction was $67.41. A second result seen in Figure 6 is that, as the income tax rate increases, the ATAV decreases. Higher tax rates imply are associated with lower after-tax profitability with an investment with or without using the Section 179 deduction. For Section 179 deduction, the ten dairies average -$7.86 change in ATAV for every one percentage point increase in income tax and -$9.10 for every one percentage point increase in income tax when not using Section 179. However, the rate of decrease in ATAV is not a constant across the 15% to 45% income tax rates. The figure clearly shows that using the expensing deduction is more important for dairy producers that are in higher tax brackets.

Figure 7 shows that interest rates have an inverse relationship with ATAV. However, like the income tax rate, the rate of change with respect to a one percentage point increase in interest rates is not constant. The rate of change varies with interest rates. Therefore, as interest rates increase through this range of values, PTAV and ATAV will decline. On average for the ten DEC dairies, every one percentage point increase in interest rates leads to a decrease of $29.89 in ATAV and $42.70 in PTAV.

Using NPV analysis, an evaluation of the impact of using cost-share assistance on PTAV and ATAV was conducted. In this simulation, the income tax rate is varied from 15% to 45%, the nutrient prices are held at their mean prices, and cost-share is either used or not used to reduce the net purchase price. With cost-share assistance being used to reduce the net purchase price, the ATAV is positive throughout the income tax range (see figure 8). The average PTAV and ATAV when using cost-share assistance were $1,088.57 and $758.46 respectively. Without using cost-share assistance, the average PTAV was -$562.48, and the

ATAV -$403.59. With cost-share assistance, as the income tax rate increases the ATAV decreases. Also, without cost-share assistance the negative ATAVs become less negative with each increase in income tax rate. The improvement in the negative ATAV occurs because more tax savings occurs at the higher income tax rates. It is easy to see in Figure 8 that the cost-share assistance typically was the deciding factor on the decision to invest in manure storage facilities. Without cost-share, the average return on the investment would have been negative, indicating that many dairies may not have actually made the investment in manure facilities.

Figure 8. Cost-Share Impact on ATAV




In the data, there are three dairies that have more negative net nutrient values than the other dairies. These negative net nutrient values occur with nitrogen, phosphorus, potassium, carbon, and calcium. Two of the dairies in particular had negative nutrient values for all five nutrients. The other dairy had negative nutrient values for phosphorus, potassium, and carbon. Negative net nutrient values would mean that more manure and nutrients were retained under the expanded system than under the DEC system. These negative nutrient values can have an impact on the PTAV and ATAV depending on income tax rate, interest rate, and depreciation. For two of the dairies that had negative nutrient values, the PTAV and ATAV were negative. The other dairy had positive PTAVs and ATAVs. In these three cases, the dairies had positive and negative PTAVs or ATAVs depending on the selected values of income tax rate, interest rate, as well as the depreciation method used.

The question is why were there dairies not retaining nutrients and increasing the value of the manure? In examining these three dairies, it was found that two of the dairies used wetland cells to handle the liquid manure. The third dairy is one that a government agency designed so the liquid manure goes to terraces in a brome field. With the manure storage facilities, all three dairies are losing more in nutrient values than is gained associated in reduced handling costs. With all of the variables at their mean values, the dairies that used some form of wetland cell had an average PTAV of -$2,108.99 and an ATAV of -$1,476.29, versus the average for all ten DEC dairies of a PTAV of $1,088.92 and an ATAV of $762.24. Therefore, the negative ATAVs for these three dairies occur due to fewer nutrients being retained in the DEC scenario than in the expanded scenario

**Conclusions**

Calculating NPV for the investment in a manure storage structure is a useful tool for dairy producers to evaluate whether it is beneficial for them to make the investment in a manure storage structure or not. The NPV simulation evaluated the difference between the DEC scenario and the expanded scenario and was able to show each variable’s expected impact on pre-tax and after-tax return to an investment in manure storage structures, which could be important. For example, the impact that the price of nitrogen has on investment return could be especially important when nitrogen prices rise drastically, which could make manure a more viable option for fertilizing a crop. In the future, being able to value carbon could be useful in calculating the soil improvement qualities of manure or useful in calculating and receiving carbon sequestration payments. Knowing the expected impact that net purchase prices, interest and income tax rates, cost-share versus no cost-share, and the Section 179 deduction options have on manure storage structure returns will help individual producers with the decision to modify their current manure handling facilities

The DEC-Expanded simulation model showed that under various situations most dairies would have a positive return to investing in a concrete manure storage system under the DEC program. Even when nitrogen, phosphorus, potassium, calcium, and carbon have low per unit values, the average for the ten DEC dairies involved positive investment returns. There are situations when it may not be profitable to invest in a manure storage structure. These include a high net purchase cost, a high tax rate, a high interest rate, not using any cost-share assistance, and/or not utilizing the Section 179 deduction. Also, such investments may not pay when carbon is valued. This occurs because the expanded scenario was still using organic bedding and the DEC system uses sand bedding. The organic bedding has higher carbon content while sand bedding is low in carbon. This caused negative net carbon values for the simulation. However, when carbon was not valued, the additional nitrogen and phosphorus retained by the DEC system would lead to positive returns on manure facility investment. Some systems that use wetland cells were found to have negative investment returns, due to not retaining and applying nutrients on cropland. These systems were designed with different goals, which this simulation analysis did not address. However, in most cases positive returns should occur. The DEC-expanded simulation showed that in most cases investing in a manure storage structure is a worthwhile venture and can be profitable for the dairy. However, cost-share assistance often will be needed. The simulation model itself will be useful in working with dairy producers, who might be considering constructing a manure storage structure through the DEC program.

Overall, the DEC program and constructing manure storage structures has had a positive economic impact on the participating DEC dairies. This was demonstrated in the net present value analyses. This program, which applies the latest research with a cost-share program and an educational program, improves the probability of the long-term adoption of manure management techniques. The DEC program protects and, eventually, may help to improve water quality in the Black Vermillion Watershed, Tuttle Creek Lake, and the Kansas River.

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