Management Implications of Farm Tractor Depreciation Methods[1]

By Troy J. Dumler, Robert O. Burton, Jr., Ph.D., and Terry L. Kastens, Ph.D.

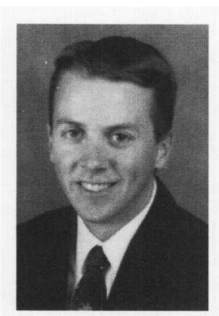
Abstract

Comparisons indicate large differences among seven depreciation methods with respect to information required, calculations, and remaining value. Depreciation for taxes usually differs substantially from economic depreciation. Farm managers typically need to use economic depreciation to measure machinery costs and values, while recognizing tax implications of machinery purchases and sales.

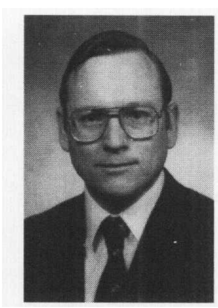
The costs of owning and operating farm machinery play a key role in the decision-making process for farmers. In the U.S. in 1995, farm machinery accounted for 13 percent of total agricultural production expenditures, and nine percent of total farm assets (U.S. Dept. of Agric. 1997). Machinery operating and ownership costs may account for more than half of the costs of crop production (Kastens 1997a). Therefore, having an accurate estimate of farm machinery costs is important for producers. Variable or operating costs, which depend on the amount a machine is used, typically include items such as fuel, oil and lubrication, and repairs. Fixed or ownership costs will exist whether a machine is used or not used and regularly include depreciation, taxes, interest, insurance, and housing (Kay and Edwards 1999).

Depreciation, usually the largest annual ownership cost of machinery (Langemeier and Taylor 1997), is the decline in value of an asset over time because of age, physical wear, technical obsolescence, and changes in the market supply and demand for the asset. Depreciation defined in this manner is sometimes called "economic" depreciation to distinguish it from depreciation used for income tax purposes. Estimated 1995 U.S. farm machinery depreciation (in 1975 dollars) was over $5 billion, over $1 billion greater than farm machinery capital expenditures (U.S. Dept. of Agric. 1997). Because depreciation is a significant cost to farm managers, and because tractors are the primary machines used on most crop farms, this paper focuses on how farm tractor depreciation is estimated. In the U.S., capital expenditures on farm tractors increased by 8 percent between 1993 and 1995 and were expected to be at least $2.9 billion in 1996 (U.S. Dept. of Agric. 1997).

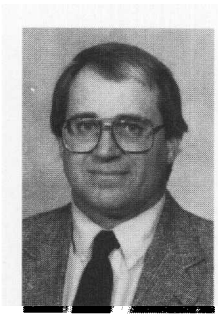
Typically, farm managers and applied economists have categorized depreciation as a fixed cost. However, because of increased wear, most crop farm machinery depreciates faster with higher rates of use, making some portion of depreciation a variable cost. Thus, treating a portion of tractor depreciation as a variable cost may increase the accuracy of depreciation and remaining value estimates.



Troy J. Dumler



Robert O. Burton, Jr.



Terry L. Kastens

Troy J. Dumler is an extension agricultural economist in the Department of Agricultural Economics at Kansas State University. He received his B.S. and M.S. degrees from Kansas State University. As the Southwest Kansas area agricultural economist, he is involved in delivering an extension program and conducting research centered in farm management.

Robert O. Burton, Jr. is a professor in the Department of Agricultural Economics at Kansas State University. He received his B.S. and M.S. degrees from Virginia Polytechnic Institute and State University and a Ph.D. from Purdue University. At Kansas State, he is involved in research and teaching in farm management.

Terry L. Kastens is an assistant professor in the Department of Agricultural Economics at Kansas State University. He holds a B.A. in Economics from the University of Kansas and a Ph.D. in Agricultural Economics from Kansas State University, where he works in research and extension in farm management.

Knowing annual depreciation rates and remaining values of farm tractors allows producers to make more informed decisions regarding enterprise selection, financial planning, income tax management, and optimal machinery replacement. However, numerous methods for estimating the remaining value and annual depreciation of farm tractors are available to farm managers. These methods require different information and calculations resulting in varying estimates. Consequently, a comparison of farm tractor depreciation methods is warranted.

The purpose of this paper is to compare seven alternative depreciation methods with respect to the information required and calculation procedures, and to illustrate how the depreciation methods may differ in estimating remaining value. In addition, management implications are discussed.

Depreciation Methods

Depreciation methods differ in terms of how initial depreciable value is determined, factors and procedures for estimating depreciation, and difficulty of use. In order to calculate annual depreciation, each method first provides an estimate of remaining value. The remaining value of a tractor is its current market price. Although the remaining value is useful itself, annual depreciation also is needed by farm managers. For example, annual depreciation is needed when budgeting for capital replacement. Annual depreciation is the difference obtained by subtracting the remaining value in the current year from last year's remaining value. Numerous factors affect the remaining value of a tractor. These factors include age, intensity of use, condition, manufacturer, size, and the market supply and demand for that tractor. Because the depreciation methods under comparison vary in several aspects, a discussion of their differences is warranted.

The seven alternative depreciation methods being compared are those of the American Society of Agricultural Engineers 1996 (ASAE); Cross and Perry 1995 (CP); North American Equipment Dealers Association 1995 (NAEDA); Kansas Management, Analysis, and Research (KMAR) of the Kansas Farm Management Associations (Kastens 1997b); Canadian Capital Cost Allowance (Revenue Canada 1998); and two U.S. income tax methods (U.S. Department of the Treasury 1998a and 1998b). See Table 1 for a summary of the seven methods.

According to Cross and Perry (1995), ASAE depreciation formulas have provided the standards since 1971. Consequently, the ASAE method may be the most common depreciation method used by farm managers and applied economists. The CP and NAEDA methods differ from the others in several ways, most importantly, by considering intensity of use. They also use tractor size, manufacturer, condition, and market supply and demand factors to determine the remaining value of a tractor. The CP and NAEDA methods also differ from each other. The CP method is based on econometric estimates, whereas the NAEDA method is based on actual sale values of comparable equipment. The CP method uses a Box-Cox model that transforms variables, allowing the data to determine the functional form. This was done to better

Table 1. Summary of Depreciation Methods Considered

Depreciation Method	Procedures of Estimating Depreciation	Initial Depreciable Value	Data Required to Determine Depreciation
American Society of Agricultural Engineers	Geometric Model	Current List Price	Current List Price, Age, Purchase Price
Cross and Perry	Econometric Model	Current List Price	Current List Price, Age, Hours of Use, Size, Manufacturer, Condition, Region, Type of Sale, Net Farm Income, Prime Interest Rate
North American Equipment Dealers Association (NAEDA)	Comparable Sales	Purchase Price (as reported by NAEDA)	Age, Hours of Use, Model, Manufacturer, Features on Tractor
Kansas Management, Analysis and Research	Tax-like with assigned Salvage value	Purchase Price	Purchase Price, Age
Canadian Tax	Declining Balance and Tax Law	Basis or Adjusted Basis Check Tax Laws	Basis and Tax Laws
U.S. Tax "Fast"	Declining Balance and Tax Law	Basis or Adjusted Basis Check Tax Laws	Basis and Tax Laws
U.S. Tax "Slow"	Straight Line and Tax Law	Basis or Adjusted Basis Check Tax Laws	Basis and Tax Laws

reflect the actual depreciation patterns inherent in different types of farm machinery. The KMAR method is a tax-like system, but it depends on an assigned salvage value to provide reasonable estimates of remaining value.

Various studies provide additional depreciation methods and insights into farm tractor depreciation (e.g., Fraumeni 1997; Hansen and Lee 1991; Leatham and Baker 1981; McGath and Strickland 1995; McNeill 1979; Morehart, Shapouri, and Dismukes 1992; Penson, Hughes, and Nelson 1977; Penson, Romain, and Hughes 1981; Perry, Bayaner, and Nixon 1990; Perry and Glyer 1990; Reid and Bradford 1983; Unterschultz and Mumey 1996). The depreciation methods selected for exposition in this study provide a range of techniques and attributes, such as conformity to tax laws, simplicity, popularity, and thoroughness in considering factors that may influence depreciation and remaining value. A brief discussion of each method and a numerical example follow.

The ASAE depreciation formulas, updated in 1993 (Flynn, Dillon, and Windham 1996), are based on nationwide averages for the remaining values of four classes of agricultural equipment. For tractors, the remaining value percentage formula is:

$$RVP = 0.68(0.920)^n, \quad (1)$$

where RVP is the remaining value percentage of current list price, and n is the age of the tractor in years. Current list price is the list price today (or in the year of sale) of the same or a comparable model tractor. To calculate the remaining value of a tractor using the ASAE method, the current list price of the tractor is multiplied by the RVP. In addition, the average annual depreciation can be determined by subtracting the remaining value from the initial purchase price and dividing by n. In the formula, it appears that the average annual depreciation percentage can be computed by subtracting the RVP from 100% and dividing by n (Am. Soc. of Agric. Eng. 1996). However, new tractors typically sell for 80-90 percent of list price (Bowers 1994). Therefore, the average annual percentage depreciation should be computed by subtracting the RVP from 85% and dividing by n.

Because the ASAE depreciation formulas do not include usage as a factor affecting remaining value, Cross and Perry in 1995 published an extensive study in which intensity of use was a variable in estimating remaining value. The objective of their study was to calculate the remaining value of used equipment in order to examine the effects of age, intensity of use, care, manufacturer, region, auction type, and macroeconomic variables on depreciation.

The data Cross and Perry used to estimate their remaining value formulas were auction sales prices for farm equipment reported from 1984 to 1993 in the *Farm Equipment Guide*. These data contained information on used machinery prices, age, hours of use, condition, auction type, size, manufacturer, and region. The authors also obtained list price information in order to compute used machinery price as a percent of list price in the year of sale. They subsequently determined the relationship of each of these variables, plus national real net farm income and the prime interest rate, to auction sale equipment value.

Because of their selected Box-Cox functional forms, with many estimated parameters, the Cross and Perry formulas allow analysts to apply a high level of precision regarding factors that may affect remaining value. The Cross and Perry RVP equation used in this study is based on their econometrically estimated parameters for tractors with 150 and greater PTO horsepower (hp); an intercept; usage and age parameters for tractors manufactured by John Deere; parameters associated with tractors in good condition sold at farmer retirement auctions in the middle Great Plains; a parameter for prime interest rate multiplied by the prime interest rate for 1998; parameters for current, 1-year lagged, and 2-year lagged U.S. real net farm income multiplied by 1998 projected, 1997, and 1996 U.S. real net farm income, respectively; a parameter for hp category; and a hp adjustment (Kastens 1997a, p.8) for tractors with 150 and greater hp. Once the remaining value is calculated, average annual depreciation can be estimated by subtracting it from 0.85 the current list price, and dividing by n.

The CP method uses a Box-Cox flexible functional form to reflect the actual depreciation patterns observed in different types of machinery. Separate equations for tractors with 30-79 PTO hp, 80-149 PTO hp, and 150+ PTO hp are used to calculate RVP. With estimated parameters in hand, the Cross and Perry equation can be used in its reduced form. For example, the reduced-form remaining value function for John Deere tractors over 150 hp is:

$$RVP = (1.24699 - 0.22231AGE^{0.35} - 0.00766HPY^{0.39})^{2.22222}, \quad (2)$$

where RVP is the remaining value percent (of current list price), AGE is tractor age in years, and HPY is the average hours of use per year since it was new (Cross and Perry 1995).

A third method of depreciation and remaining value estimation is based on comparable age and model machinery values from the North American Equipment Dealers Association (NAEDA) quarterly book of values for primary farm machinery such as tractors and combines. Past versions of this book have been called the *Official Guide* (e.g., North American Equipment Dealers Association 1995), but current versions may be called *Guides2000* (e.g., Wallace and Maloney 1998). The NAEDA collects sales price data from its member equipment dealers and compiles them into a list of representative values for used tractors. For each tractor model, prices are listed for older tractors in that model series and previous models that are comparable in size. The result is a list of prices for each year a specific model of tractor is produced. The differences in prices from year to year can be used to estimate annual depreciation. The book also allows users to adjust the price of used tractors according to the number of hours the tractors have accumulated and the tractors' features.

A fourth depreciation method, KMAR, is the one used by the Kansas Farm Management Associations. The KMAR method uses a tax-like system to value farm tractors. A committee of KMAR economists estimated that the remaining value (salvage value) of an average 10-year-old tractor was 35 percent of its original outright (market value) purchase price. They then used the 10-year tax-like deprecation schedule from the initial new or used purchase price (cash boot plus trade in value, if applicable) that came the closest to reaching the 35 percent salvage value in 10 years. The 100 percent 10-year declining balance method most precisely arrives at the 35 percent remaining value in 10 years (Kastens 1997b). The decision that 10 years and 35 percent salvage best characterized tractor depreciation indicates that the KMAR method implicitly assumes a constant average or typical, general rate of price inflation. Thus, RVP for KMAR is based on initial purchase price.

A method used to depreciate farm tractors in Canada (Revenue Canada 1998) is the fifth reviewed. For Canadian tax purposes, the depreciation deduction is called capital cost allowance (CCA). It was assumed that the maximum amount of CCA allowed is taken. This involves use of the declining balance method with a depreciation rate of 30 percent.

The final depreciation methods to be compared are two used to compute depreciation deductions for U.S. income tax purposes (U.S. Dept. of the Treasury 1998a and 1998b). Because these methods depreciate tractors to zero, they most likely do not accurately represent economic depreciation. However, these methods will be useful in illustrating the difference between economic and tax depreciation. The two methods are part of the Modified Accelerated Cost Recovery System (MACRS) and provide farm managers the means for depreciating farm tractors with the fastest and the slowest methods allowed in the U.S. tax code. The two methods are the 150 percent declining balance with the General Depreciation System (GDS) recovery period, and the straight line with the Alternative Depreciation System (ADS) recovery period. The recovery period for a farm tractor is 7 years under GDS and 10 years under ADS. The declining balance method switches to straight line in year four.

Numerical Example

To illustrate how each method differs in estimating the average annual depreciation and remaining value of farm tractors, two identical model tractors with different total hours of use were selected from the classified advertisement section of the February 22, 1999 edition of the *High Plains Journal* (High Plains Publishers, Inc.). Each tractor was a 1995 John Deere (JD) model 8300 (200 hp) with mechanical front-wheel drive (MFWD). One tractor had accumulated 2,600 hours and the other 570 hours of use. The difference will illustrate how intensity of use affects remaining value and, in turn, average annual depreciation. The remaining values derived by the previously presented depreciation methods will be compared to the prices of the tractors listed in the *High Plains Journal*. The first step was to convert each advertised price to a typical selling price. This conversion was based on the ratio of the resale cash price to the retail advertised price for 1995 John Deere 8300 tractors from the Fall 1998 *Guides2000* (Wallace and Maloney 1998). The computed December 1998 selling prices for the 2,600 hour and 570 hour JD 8300s were $66,183 and $81,203, respectively.

With the exception of the NAEDA method, all of the methods to be compared require a current list price or an actual purchase price. Remaining value is estimated as a percentage of either current list or actual purchase price with these methods. Because the original (when new) purchase prices for the tractors were not available, an estimate for a 1995 John Deere 8300 was obtained from the Spring 1995 NAEDA *Official Guide*. In the Guide, the actual new purchase price was $99,650 for each of the two tractors. The current list price for a 1998 John Deere 8300 was $122,729. In recent years, suggested retail prices have replaced list prices as reference prices. Because empirical research to date has centered on list price, we converted the suggested retail price (in the Fall *Guides2000* book) to a list price by dividing it by 0.85.

When the ASAE approach is used to estimate remaining value and depreciation, both tractors would be valued the same and have the same annual average depreciation. A summary of the depreciation and remaining value estimates reported in this section is reported in Table 2. In this case,

$$RVP = 0.68(0.920)^4 = 0.48715, \quad (3)$$

meaning that these 4-year-old tractors are worth 48.7% of their current list price. Thus, the 1995 John Deere 8300s with new purchase prices of $99,650 and new list prices of $122,729 would each have a market value of $59,787 today using the ASAE method. Using equation 4, average annual depreciation (AAD) for each tractor would equal $9,966 ([99,650 - 59,787]/4), according to the ASAE formula:

$$AAD = (\text{Purchase Price} - RV)/\text{Age}. \quad (4)$$

With the Cross and Perry formula, the RVPs for the tractors with 2,600 hours and 570 hours are

$$RVP = [1.24699 - 0.22231\,(4^{0.35}) - 0.00766\,([2600/4]^{0.39})]^{2.22222} = 0.59237, \text{ and} \quad (5)$$

$$RVP = [1.24699 - 0.22231\,(4^{0.35}) - 0.00766\,([570/4]^{0.39})]^{2.22222} = 0.66603. \quad (6)$$

To determine remaining values, each RVP is multiplied by the $122,729 list price. The corresponding remaining values are $72,701 and $81,741 for the 2,600-hour and 570-hour tractors, respectively. The average annual depreciation for the 2,600-hour and 570-hour tractors are:

Table 2. Depreciation Methods, 1995 through 1998 Depreciation, Remaining Value at the End of 1998, and Actual Market Value in December 1998 for 1995 John Deere 8300 Tractors with 2,600 and 570 Hours of Use.

Depreciation Method	Depreciation 1995–1998 2,600 hrs.	570 hrs.	Remaining Value at End of 1998 2,600 hrs.		570 hrs.		Average % of Actual
	$	$	$	% of Actual	$	% of Actual	
American Society of Agricultural Engineers	39,863	39,863	59,787	90	59,787	74	82
Cross and Perry	26,949	17,909	72,701	110	81,741	101	106
North American Equipment Dealers Association	21,515	14,613	78,135	118	85,037	105	112
Kansas Management, Analysis and Research	34,270	34,270	65,380	99	65,380	81	90
Canadian Tax, Declining Balance with 30% rate[a]	70,597	70,597	29,053	44	29,053	36	40
U.S. Tax, 150% Declining Balance MACRS, GDS[b]	56,920	56,920	42,730	65	42,730	53	59
U.S. Tax, Straight Line[b] MACRS, ADS	34,877	34,877	64,773	98	64,773	80	89
Actual Market Value	33,467	18,447	66,183	100	81,203	100	100

a For the Canadian Tax method, we used the 50% rule in year one and assumed that no investment tax credit was used and that the maximum capital cost allowance was taken.

b Modified Accelerated Cost Recovery System (MACRS) consists of two systems used to calculate depreciation for U.S. income tax purposes. The two systems are General Depreciation System (GDS) and Alternative Depreciation System (ADS). Of the alternatives available under current tax laws, the 150% declining balance method using GDS takes the most depreciation earliest in the asset's useful life, and the straight line method using ADS takes the most depreciation latest in the asset's useful life. Calculations for U.S. income tax methods were based on the half-year convention and no Section 179 deduction.

$$AAD = ([99{,}650 - 72{,}701] / 4) = 6{,}737, \text{ and} \quad (7)$$

$$AAD = ([99{,}650 - 81{,}741] / 4) = 4{,}477. \quad (8)$$

To find the remaining values of the two tractors using the NAEDA method, one needs to look up the base value (in 1998) of a 1995 John Deere 8300. The Fall 1998 *Guides2000* lists average 1995 8300 models with 1,200 hours for $75,195. However, that edition of *Guides2000* required an adjustment of $3.40/hour for each hour less than or greater than 1,200. Also, a $7,700 adjustment must be added for the MFWD option (Wallace and Maloney 1998). Therefore, the 2,600-hour tractor has a value of $78,135, and the 570-hour tractor has a value of $85,037, according to the NAEDA method.

The KMAR method using a 100% 10-year declining balance yields an RVP of 65.61 ($[1 - 0.10]^4$) for both 4-year-old tractors. With an initial new purchase price of $99,650, the remaining value of both tractors would be $65,380.

For the Canadian tax method, we used the 50% rule in year one and assumed that the maximum capital cost allowance (i.e., depreciation) allowed was taken (Revenue Canada 1998). The declining balance method was used with a 15% depreciation rate in year 1 and a 30% depreciation rate in years 2, 3, and 4. This resulted in a remaining value (called undepreciated capital cost in Canada) at the end of 4 years of $29,053.

Calculation of remaining value associated with the two U.S. income tax depreciation methods is based on the assumption that no Section 179 deduction was taken and use of the half-year convention (U.S. Dept. of the Treasury 1998a). The RVPs after 4 years are 42.88% when the 150% declining balance with GDS method is used and 65.00% when the straight line with ADS method is used. These methods result in market values of $42,730, and $64,773, respectively.

Management Implications

The seven alternative depreciation methods offer farm managers several different options to estimate the economic and/or tax depreciation of their tractors. Estimates of economic depreciation and remaining value are important for enterprise selection, financial planning, and optimal replacement strategies. The appropriate method is often farm-specific, and depends on how it is used. Tax depreciation methods are restricted by law. Under tax laws optional methods of depreciation are allowed; however, the farm manager must determine which method to use.

Practically, the choice of economic depreciation method often can be viewed as a trade off between simplicity and accuracy. For example, market value balance sheet machinery valuation may require one of the simpler methods, because tracking values on individual machinery items may be too costly, and a more complex, machine-specific method may result in less accuracy if it is used for a different machine class. On the other hand, analysis of machinery replacement strategies for a particular machine merits use of a more accurate, machine-specific method to determine economic depreciation and remaining value.

In general, accuracy is a major issue of machinery valuation for management purposes. Accurate machinery values are essential for measurement of asset values and, ultimately, net worth on the market value balance sheet. A measure of net worth is important for credit analysis.

Accurate annual depreciation is essential for short-run issues such as accurate measurement of costs of production. Costs of production are necessary to measure net farm income on an accrual basis income statement. Also, accurate costs of production, including economic depreciation, are needed to construct enterprise budgets that measure the economic profit of an enterprise. Accurate measurement of depreciation is particularly important when comparing enterprises that are more or less machinery-intensive. Typically, determining depreciation for income tax purposes results in inaccurate measurement of economic depreciation. Table 2 shows that the two most inaccurate methods for the two example tractors are the Canadian and U.S. declining balance tax methods. Moreover, because depreciation is a non-cash cost, it may be an insidious cost for those who base measurement of net income on cash transactions.

Accurate estimates of depreciation are also essential for long-run issues such as evaluation of strategies for acquiring machinery services. Inaccurate depreciation could bias comparisons for machinery replacement strategies and also could bias comparisons of machinery purchase alternatives with lease and custom-hire alternatives.

Understanding the importance of measurement of depreciation for tax management requires careful consideration of the independence and interdependence of the selection of depreciation procedures for economic and tax purposes. Economic depreciation focuses on measures of a machine's annual decline in market value and the resulting accurate measurement of current and future market values. In contrast, for the individual taxpayer, selection of annual tax depreciation deductions focuses on use of tax laws to accomplish financial goals. Although the opportunity to claim less than the maximum depreciation deduction allows Canadian farmers flexibility to reduce the difference between depreciation deductions and economic depreciation, the accelerated nature of depreciation for tax purposes required in the U.S., and allowed in Canada, is expected to result in depreciation deductions for tax purposes that are larger than economic depreciation.

Selection of procedures for calculating economic depreciation is usually independent of selection of procedures for calculating depreciation for tax purposes. Farmers have the freedom to calculate economic depreciation in a way that will reflect the actual decline in value, whereas they are constrained by tax laws and influenced by their taxable income situations and tax management goals when calculating depreciation for income tax purposes. Thus, depreciation procedures for measuring economic depreciation are seldom, if ever, expected to be identical to depreciation procedures for income tax purposes. Nonetheless, both economic and tax depreciation of a tractor must be calculated to determine the net present value of after-tax cash flows and market value.

In that farm managers maximize the present value of expected after-tax income, depreciation procedures for both economic and tax purposes are highly interdependent for some management decisions. For example, machinery replacement strategies depend on accurate measures of economic depreciation so that projections of future selling/buying machinery prices are accurate. Yet, the after-tax cash flows, whose discounted sums are maximized, depend on the selected tax depreciation method.

Using the two-tractor example in the previous section, the CP method provided the most accurate economic depreciation and remaining value for the 4-year-old tractor with 570 hours, whereas the KMAR method was the most accurate for the tractor with 2,600 hours. On average, these two methods are the most accurate, given the example used. However, the KMAR method underestimated the remaining value of both tractors whereas the CP method overestimated the remaining value of both tractors. As expected, the methods used for income tax purposes overstated economic depreciation and, therefore, underestimated remaining value.

The NAEDA method provides users with different options to value tractors. For each tractor, *Guides2000* reports a retail advertised price, resale cash value, trade value premium, trade value rough, and average wholesale price. In this analysis, the resale cash value was used to calculate the remaining value of the two tractors for the NAEDA method. However, in some cases, using one of the other options may be more appropriate. For instance, the trade value rough or average wholesale prices may provide more accurate remaining values for the example tractor with 2,600 hours, because it was used more intensively and, therefore, may be in poorer condition. The decision of which option to use should be made by the farm manager, or another decision maker, who can evaluate the condition of the tractor and is accountable for the consequences of purchasing and selling decisions.

Although the example suggests that the CP and KMAR methods might predict remaining value closest to actual market value, they may not be the most suitable methods for all farm managers. For example, farm managers may not have access to the NAEDA *Guides2000*. Likewise, farmers may not know the KMAR, ASAE and Cross and Perry formulas, or find them too difficult to use. Therefore, they may prefer, or find it less costly to use the simple tax methods. To the extent that farmers do not have NAEDA information, they may be at a disadvantage when trading with or purchasing from dealers who do have that information. Because the NAEDA method is based on comparable sales, it is likely quite useful for estimating current tractor prices but less useful for estimating future prices. Custom operators or farmers whose tractor use is significantly above or below average will likely want to use a depreciation method such as CP or NAEDA that considers intensity of use. Also, because this paper considers only one size, brand, and age of tractor, farmers may find that another method is more accurate for their tractors.

Above all, farm managers should devote significant time and thought when deciding which depreciation method to use. For purposes of measuring machinery values and machinery costs, they should use a depreciation method that accurately reflects economic depreciation. For income tax purposes, they should anticipate taxable income levels over the depreciation periods allowed by tax laws in order to select tax depreciation procedures and machinery replacement strategies that will maximize the present value of after-tax net income.

Conclusion

Farmers need an accurate representation of farm tractor depreciation in order to make informed decisions about enterprise selection, financial planning, and strategies for acquiring machinery services. The many methods available to estimate depreciation and remaining value differ in required information, calculation procedures, and accuracy in estimating remaining value. Farm managers should consider the accuracy of economic depreciation estimates in order to measure costs of production and remaining value. With current U.S. and Canadian tax rules, depreciation for tax purposes will likely differ substantially from economic depreciation. Therefore, farm managers will usually need to use economic depreciation methods to measure depreciation costs and machinery values, while recognizing the tax implications associated with machinery purchases and sales.

Endnote

[1] Kansas Agric. Exp. Stn. Contribution No. 98-440-J. Appreciation is expressed to Fredrick D. DeLano and Jeffrey R. Williams for helpful comments on an earlier version.

References

American Society of Agricultural Engineers. *ASAE Standards*. 43rd ed. St Joseph, MI. 1996.

Bowers, W. *Machinery Replacement Strategies*. Moline, Il: Deere & Company. 1994.

Cross, T. L. and G. M. Perry. "Depreciation Patterns for Agricultural Machinery." *Amer. J. Agr. Econ.* 77(February 1995):194-204.

Flynn, A. G., C. R. Dillon, and T. Windham. "The Effects of the Revised 1993 ASAE Equipment Coefficients on Cost Estimates." *J. Amer. Soc. Farm Man. and Rural Appraisers* 19(1996):60-64.

Fraumeni, B. M. "The Measurement of Depreciation in the U.S. National Income and Product Accounts." *Survey of Current Business* 7(1997):7-23.

Hansen, L. and H. Lee. "Estimating Farm Tractor Depreciation: Tax Implications." *Can. J. Agr. Econ.* 39(November 1991):463-479.

High Plains Publishers, Inc. *The High Plains Journal.* Dodge City, KS, February 22, 1999.

Kastens, T. L. Farm Machinery Cost Calculations. MF-2244, Kansas State Univ. Agr. Exp. Sta. and Coop. Ext. Serv., May, 1997a.

Kastens, T. L. Machinery Costs: Selected Topics. Paper presented at School of Rural Banking, Wichita, KS, 4 June, 1997b.

Kay, R. D. and W. M. Edwards. *Farm Management.* 4th ed. New York: McGraw-Hill, Inc., 1999.

Langemeier, L. N. and R. K. Taylor. "A Look at Machinery Cost." Dept. of Agr. Econ. KSU Farm Man. Guide MF-842, Kansas State Univ. Agr. Exp. Sta. and Coop. Ext. Serv., 1997.

Leatham, D. L. and T. G. Baker. "Empirical Estimates of the Effects of Inflation on Salvage Value, Cost, and Optimal Replacement of Tractors and Combines." *N. C. J. of Agr. Econ.* 3(July 1981):109-117.

McGath C. and R. Strickland. "Accounting for the Cost of Capital Inputs." *Agricultural Income & Finance.* Washington DC: U.S. Dept. of Agr., AIS-58, September 1995, pp. 33-36.

McNeill, R. C. "Depreciation of Farm Tractors in British Columbia." *Can. J. Agr. Econ.* 27(February 1979):53-58.

Morehart, M. J., H. Shapouri and R. Dismukes. *Major Statistical Series of the U.S. Department of Agriculture Volume 12: Costs of Production.* Washington DC: ERS, Agr. Handbook No. 671, March 1992.

North American Equipment Dealers Association. *Official Guide Tractors and Farm Equipment.* St. Louis, MO. Spring, 1995.

Penson, J. Jr., D. Hughes, and G. Nelson. "Measurement of Capacity Depreciation Based on Engineering Data." *Amer. J. Agr. Econ.* 59(May 1977):321-329.

Penson, J. B. Jr., R. F. J. Romain, and D. W. Hughes. "Net Investment in Farm Tractors: An Econometric Analysis." *Amer. J. Agr. Econ.* 63(November 1981):629-635.

Perry, G. M., A. Bayaner, and C. J. Nixon. "The Effect of Usage and Size on Tractor Depreciation." *Amer. J. Agr. Econ.* 72(May 1990):317-325.

Perry, G. M. and J. Glyer. "Durable Asset Depreciation: A Reconciliation between Hypotheses." *The Rev. Econ. and Stat.* 72(August 1990):524-529.

Reid, D. W., and G. L. Bradford. "On Optimal Replacement of Farm Tractors." *Amer. J. Agr. Econ.* 65(May 1983):326-331.

Revenue Canada. 1998. *Farming Income.* Ottawa, ON. T4003 (E). 1998.

Unterschultz, J. and G. Mumey. "Reducing Investment Risk in Tractors and Combines with Improved Terminal Asset Value Forecasts." *Can. J. Agr. Econ.* 44(November 1996):295-309.

U.S. Department of Agriculture. *Agricultural Resources and Environmental Indicators, 1996-1997.* ERS, Agr. Handbook No. 712. Washington DC, July, 1997.

U.S. Department of the Treasury. *How to Depreciate Property.* IRS Pub. 946, Washington DC, 1998a.

U.S. Department of the Treasury. *Farmer's Tax Guide.* IRS Pub. 225, Washington DC, 1998b.

Wallace, J.A. and J. R. Maloney, eds. *Guides2000: Northwest Region Official Guide.* Vol. 4, Issue 3. North American Equipment Dealers Association, St. Louis, MO., September 1998.