Evaluating Tractor Ownership With the OwnTractor Spreadsheet

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Background

The trend towards larger, more sophisticated, more productive, and higher cost tractors makes the tractor purchase decision especially important. This paper accompanies the *OwnTractor* computer spreadsheet, which was developed as a decision aid to help individuals think through the tractor ownership decision. Thus, most of the underlying assumptions and formulas are simply asserted rather than developed here. For a more comprehensive treatment of machinery costs than provided here, and for development of the mathematical formulas underlying *OwnTractor*, the reader is directed to *Farm Machinery Operation Cost Calculations, MF-2244* and *Leasing vs. Buying Farm Machinery, MF-2953*. Supporting research references are contained therein. Both publications can be found at the website *www.AgManager.info*. The reader is pointed also to the *OwnSprayer*, *OwnBaler*, *OwnCombine, and OwnTruck* spreadsheets available at the same website. Finally, a user web-search will reveal other useful machinery cost related articles by faculty from other universities.

Machinery investment decisions are inherently complex because they involve time, and a dollar today is worth more than a dollar tomorrow – because it can earn interest. A few examples of time issues regarding machinery are a) machinery depreciates over time; b) tax depreciation and market depreciation typically occur at different rates; c) repairs tend to increase as a machine ages; and d) as machines age they become less dependable (more prone to breakdowns), leading to owner concerns about timeliness. Although *OwnTractor* accommodates most relevant time-dimensioned issues related to tractor ownership, it does not explicitly deal with timeliness issues. For example, quantifying lost profit from reduced crop yields due to excessive breakdowns is not handled by *OwnTractor*. Such potentially important considerations are left to the user to assess.

In an economic analysis, machinery ownership and operating costs often are classified into the following categories: 1) interest; 2) depreciation; 3) repair and maintenance; 4) labor; 5) fuel and lubrication; and 6) property taxes, insurance, and shelter (TIS). Although the timing of tax depreciation does impact overall costs and profitability, the depreciation ultimately of interest here is market depreciation. Market depreciation is the change in machine market value over time, which represents a real loss in asset value. Although based on prevailing lender interest rates, the interest cost considered most important here is opportunity interest, rather than the interest associated with an actual loan arising from an owner's financing decision. That is, because equity could be invested elsewhere, it is considered to bear interest just as does debt (and at the same rate – see *MF2244*). Because a machine could have been sold at the end of last year, with the proceeds invested elsewhere, this year's opportunity interest cost is calculated by multiplying last year's machine market value by the prevailing lender interest rate.

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OwnTractor is not a comprehensive tractor analysis program where tractor capacity is considered against specific amounts and types of field operations. Rather, it assumes the user knows the size of tractor needed, but that he would like to consider purchasing tractors of different brands, age, and accumulated hours. Thus, *OwnTractor* uses all of the machinery ownership and operating cost categories described above except for two: labor and fuel and lubrication. The assumption is that two tractors that are approximately the same size will have similar labor and fuel requirements. In this manner, *OwnTractor* results in a "dollars per hour" cost number that

makes it easy to compare alternative tractors being considered in a tractor purchase. Additionally, the cost per hour number can be directly compared with per hour tractor rental and leasing rates from machinery dealers.

The goal of machinery investors is assumed to be maximizing after-tax (i.e., income tax) profits. Thus, wherever necessary, *OwnTractor* computes after-tax values. However, because decision makers are used to comparing observed costs, which intrinsically are pre-tax (e.g., tractor rental rates), *OwnTractor* converts after-tax to pre-tax values in the final analysis.

Following a discussion around tractor valuation, this paper proceeds directly into a description of using the *OwnTractor* spreadsheet. A brief discussion of underlying concepts and assumptions, on an issue-by-issue basis, is provided in that section.

Market Valuation (Depreciation)

A key requirement of the tractor investment decision is a reasonable expectation of market valuation (depreciation) over time. That is, how much will a new or used tractor purchased for *X* dollars today be worth *Y* years from now, after being used for *Z* hours each year? To be most reliable, machinery market valuation formulas should be based on many years of observed market data. Consequently, the market valuation formulas in *OwnTractor* were developed using information extracted from Iron Solutions, The Official Guide of the Equipment Industry (the Guide). The Guide is essentially the "Blue Book" of the North American Equipment Dealers Association (NAEDA). It shows expected market values for many brands of tractors, from new to 20+ years old. It shows the typical hours expected on a tractor and has formulas for adjusting market value if the hours are different from expected. Additionally, it shows how to value numerous tractor options, for example tire duals, 3 point hitches, power-take-offs, and mechanical front wheel drive. The Guide is designed so that a machinery dealer can look up the value for a particular used tractor today. Since tractors depreciate over time, it is important for the dealer to have access to the most recent information, and consequently, the Guide is published quarterly.

Although it would be conceptually possible to construct a large computer lookup program based on information from the Guide, that would be most cumbersome and would require constant updating with each new issue. To overcome such problems, *OwnTractor* does two things. First, it uses only *rate of depreciation* information extracted from the Guide, and does not depend on using the Guide's actual value predictions. Second, *OwnTractor* depends on an expected tractor purchase price that is provided by the user. In addition to always being current, that expected purchase price embodies a great deal of other information. For example, a mechanical front wheel drive (MFWD) tractor will have a higher purchase price than a straight two wheel drive. Thus, it is left up to the user to be sure "apples" are not being compared with "oranges." In the MFWD example, tractors with and without MFWD should not be directly compared unless the user is willing to make an expected price adjustment to the purchase price. All in all, relying on the Guide for only depreciation rate information, and relying on the user for a reliable purchase price, means *OwnTractor* should be reasonably reliable for several years to come.

It should be noted that the tractor market price series from the Guide used in *OwnTractor* is the series referred to as the Resale Cash Value. As defined in the Guide, it "is a reference point for what the unit will be worth on the lot, after reconditioning, on a cash basis. It does not take into account the added dealer costs of offering interest-free financing, extended warranty, etc."

Essentially, this price series embodies all repair and rebuilding costs to ensure the tractor is in top running condition given its age and hours. We considered using an alternative price series, referred to as the Trade Value Premium series, which is typically about 90% of the Resale Cash Value for 1-year-old tractors and diminishes to 60%-70% of the Resale Cash Value series for 20-year-old tractors. However, the engineering type formulas we use for repair calculations (described later) assume tractors are kept in top condition with all of the necessary repair and rebuilding costs. Thus, if a user is accustomed to thinking of used tractor value being that which he can obtain from a dealer given the dealer will do some reconditioning when he gets the tractor in, then *OwnTractor* might slightly overstate expected future market value for a used tractor. However, given the engineering-type repair calculations, the spreadsheet will probably slightly overstate repairs for such users. Consequently, on the balance, the two overstatements should offset each other, providing a reasonable measure of total tractor costs.

In the analysis behind *OwnTractor*, we fundamentally considered depreciation as a separate function of age and of hours of use. That is, aging a tractor without putting hours on it will cause it to depreciate at a certain rate and putting more hours on a tractor without making it any older will cause it to depreciate at a different rate. We also tested a number of more complex relationships. For example, we examined whether the depreciation due to age might change due to hours and vice versa. We also tested whether tractors with different horsepower depreciate at different rates. Although adding complexity to the depreciation formulas always resulted in predicting market value more accurately for some tractors, when we tried to generalize the formulas across different tractors, it would cause other tractors' market value to be predicted less accurately. Consequently, *OwnTractor* uses the more simple depreciation relationship, where only age and hours are considered independently.

Considering the tradeoff between predictive accuracy and the generality that fosters usability of *OwnTractor*, we settled on six classes of tractors, with each class having its own age and hours depreciation factors:

Class 1: John Deere 2wd or MFWD
Class 2: Case-IH 2wd or MFWD
Class 3: AGCO 2wd or MFWD
Class 4: John Deere full time 4wd
Class 5: Case-IH full time 4wd
Class 6: Cat or John Deere track tractors

Based on the analysis undertaken, we believe that *OwnTractor* will be reasonably reliable for 2wd tractors (with or without MFWD) in the 150-250 pto hp range and 4wd or track tractors in the 200-400 hp range. We do not consider tractor options (e.g., 3 point hitch, power shift transmission, pto) to be particularly problematic for the analysis – though the user is cautioned to compare tractors with similar options. For tractor classes not explicitly considered, the user should simply insert the class he believes is most like the tractor being considered.

Using the *OwnTractor* Spreadsheet

The *OwnTractor* spreadsheet calculates ownership and operating costs for tractors using internal calculations based on inputs provided by the user. Blue numbers in the spreadsheet are user inputs and black numbers are calculated from the blue numbers. Simply put, if the user wants a black number to change, he must change a blue number. The spreadsheet accounts for both time-dimensioned variables as well as those that are fixed over time. This section of the paper

describes each of the spreadsheet inputs, assumptions, and related calculations. The end result is an annually amortized pre-tax cost per hour that can be compared across alternative tractor ownership strategies as well as directly with rental rates.

In *OwnTractor*, the time a purchase decision is made is considered year 0. The first year a tractor is actually used is considered to be year 1, and so on. Although income taxes typically are not paid until early in the year after they are accrued, for simplicity, we assume taxes are paid in the same year as accrued. This should result in little distortion overall, and potentially none for those paying income tax estimates quarterly. Thus, with these assumptions, because the tractor is considered purchased in year 0, that is also the first year that tax depreciation is taken. Conceptually, for a tractor that is to be used for 3 years, it is probably best to think of purchasing it on December 31 in year 0, using the tractor for farming operations throughout the year-1, year-2, and year-3 seasons, and subsequently selling the machine on December 31 in year 3.

Notice that *OwnTractor* assumes the tractor is explicitly sold following the last year of use rather than traded in. Because trading a machine results in a change in tax basis rather than in depreciation recapture, results would be different than those calculated in the spreadsheet. However, as long as treatment of exiting machines is consistent (as it is here, where exiting machines are always considered sold), then using *OwnTractor* to evaluate different tractors is still appropriate – whether or not a tractor is in fact sold or traded.

The *OwnTractor* spreadsheet has three main sections: 1) user input and related calculations section, 2) time and tax (TT) section, and 3) analysis summary section. User inputs are entered in the user input section. This section also shows related calculations for use elsewhere or otherwise of interest to the user. The time and tax section displays the time-dimensioned variable values over time, ultimately leading to a computation of after-tax net present value of costs. The tractor analysis summary section condenses the results of the analysis into a breakdown of pre-tax tractor ownership and operating costs by year and by hour, providing costs that easily can be compared across alternative ownership strategies and directly with rental rates.

The *OwnTractor* spreadsheet has three main sections: 1) user input and related calculations section, 2) time and tax (TT) section, and 3) analysis summary section.

The following is a step-by-step discussion of the inputs required in the *User Input* section.

Step 1. Select the tractor's class, age, and accumulated hours at the time of purchase

Step 2. Select the tractor's expected purchase price
This is the dollar amount expected to be paid for a tractor in question (without a trade-in).

Step 3. Select the tractor's market price
The tractor's market value determines a number of costs in the spreadsheet. First, it determines a new equivalent price (*NEP*), which is used to determine accumulated repair costs over time and thus annual repair costs. Additionally, it is used to initialize the market value series that ultimately determines annual market depreciation, opportunity interest costs, and TIS (property taxes, insurance, and shelter) annual costs. Intuitively, these annual costs should not vary based on whether a tractor buyer happened to get an especially good or especially bad deal on the

tractor purchase. Consequently, the spreadsheet needs to isolate the purchase price from the market price of the tractor in question.

In practice, the tractor's purchase price and market price typically should be the same. At least a user should start that way. Then, the user can examine the impact of "talking the dealer down" simply by inserting a lower purchase price in that cell. On the other hand, a buyer might believe that "paying over the market" is appropriate for a tractor in especially good condition. Inserting a market price that is lower than the purchase price means that the resultant dollars of annual depreciation will be lower than it would have been had it been keyed off of the purchase price (since, given a tractor usage rate, depreciation is a constant *percent* of market value) – precisely what is desired for someone purchasing a mint condition tractor, for example.

Step 4. Select a cash downpayment

As already discussed, there is an opportunity interest cost associated with an investment whether or not money is actually borrowed – because equity funds could just as well be invested elsewhere to earn a return. Thus, for a tractor investment, the choice of financing does not impact profitability or cost. However, to aid understanding, *OwnTractor* allows for a user-selected downpayment. Then, *OwnTractor* shows (in the TT section) the cash flows associated with an interest-only loan, followed by a balloon principal payment at the end of the last year of use for the tractor. Other loan structures, such as an annually amortized loan, are not considered in *OwnTractor*. Of course, such alternative structures would not impact profitability or cost. Users might select different downpayment amounts to see that tractor costs do not change.

Step 5. Select the number of seasons (years) the tractor will be used before it is sold

Step 6. Select the number of hours the tractor is expected to be used annually

Step 7. Select the Repair Adjustment Factor (RAF)

To allow for repairs that increase as tractors age with use, *OwnTractor* calculates repairs following procedures by the American Society of Agricultural and Biological Engineers. Based on the publication ASABE D497.7 MAR2011 Agricultural Machinery Management Data, obtained from ASABE's website, which describes the standards as of March, 2011, accumulated repairs are described by the formula:

$$\text{Accumulated repairs} = NEP * RF1 * (\text{Accumulated hours}/1000)^{RF2},$$

where *NEP* is the new equivalent price of the machine, and *RF1* and *RF2* are repair factors. Then, annual repairs is calculated by subtracting last year's accumulated repairs from this year's accumulated repairs. According to the ASAE publication, the *RF1* factor should be 0.007 for 2wd and 0.003 for 4wd and crawler tractors. *RF2* is 2.0 for all three tractor classes. Since many tractors today are mechanical front wheel drive (MFWD), and such were actually the tractors whose depreciation was modeled in the background research for *OwnTractor*, we arbitrarily set *RF1* = 0.005 for the first three classes of tractors considered, which is halfway between that recommended for 2wd and 4wd tractors by the ASAE.

If a user considers the expected future annual repairs calculated by the spreadsheet to be inconsistent with other information he might have, then he can set the RAF factor at some value other than 1.0. The RAF factor does a simple proportionate scaling. That is RAF = 0.90 and

RAF = 1.10 imply annual repairs that are 10% lower or 10% higher, respectively, than what would be predicted using the ASAE formula.

Given the related discussion in the Market Valuation section, the user is cautioned against setting the RAF to something below 1.0 merely because he believes the projected repairs are too high. Rather, he should look also at the expected future market value, which might also be too high by his assessment, and thus the two values would more-or-less offset each other. Additionally, it is easy for a farmer who does his own repairs to forget the cost of his labor and the cost of keeping up his shop. It is also easy to forget to prorate large and infrequent overhaul charges across years. In either case, the farmer's intuition about repair costs might be on the low side.

Step 8. Select the property tax, insurance, and shelter (TIS) percentage
The cost associated with property taxes, insurance, and shelter is considered to be a fixed percent of tractor market value. Assuming no property taxes, *MF2244* suggests a value of 1.5%.

Step 9. Select a bank interest rate, income and self-employment tax rates
The selected bank interest rate should be the typical borrowing rate expected from lenders. The combined state and federal income tax rate should be the rate expected on the next taxable dollar earned. Typically, federal income tax rates for sole proprietors are either 15% or 28%, with state rates around 4% to 5%. For many users, a dollar of expense saves both income tax and self-employment tax. Thus, *OwnTractor* allows for including self-employment tax (currently 15.3%). Further, because tax depreciation saves income and self-employment tax, yet depreciation recapture when a used tractor is sold garners only income tax, *OwnTractor* distinguishes income tax from self-employment tax rates.

Step 10. Enter tax depreciation information
OwnTractor allows for the Section 179 expensing deduction for depreciable assets. The Section 179 deduction reduces taxable income by that amount in the year of purchase. This deduction is taken before any IRS formula-based tax depreciation schedule is applied. Under the Small Business Jobs Act, passed in 2010, the maximum allowed was $500,000 in 2010 (up from the previous value of $250,000) and is also $500,000 in 2011, but is scheduled to decline to $25,000 in 2012. The Section 179 deduction also diminishes on a dollar-for-dollar basis after eligible annual purchases exceed $2,000,000 (up from $800,000 in the past). For example, a farm with $2,100,000 purchases in 2008 could not expense more than $400,000 using Section 179; at $2,500,000, the expensing deduction would be $0.

After accounting for the Section 179 and 50% bonus depreciation deductions, *OwnTractor* uses the MACRS tax depreciation percentages for 7-year property to play out tax depreciation across the years that a tractor is considered owned. As the spreadsheet is currently structured, faster depreciation (if applicable) can be accommodated by changing the cell values appropriately, with some cells perhaps set to 0. When changing, care should be taken that the values sum to 100%.

Cash flows and economic variable calculations over time (understanding the TT section)
The time and tax (TT) section of the *OwnTractor* spreadsheet calculates the expected values for those variables that change over time. Some columns are not strictly needed, but are included to aid understanding (e.g., loan interest and loan principal, as discussed in Step 4, or the annual breakdown of per hour repairs). Most columns are self-explanatory, while others can be understood by examining the formulas they contain. Essentially, this section tracks all cash

flows over time, with future cash flows appropriately discounted to year 0 (the present). Tax savings due to business expenses and tax depreciation is considered a cash flow because it would reduce taxes paid.

After discounting for time, all cash flows in this section are summed to provide the after-tax net present value of costs (NPVc). Since the only time-dimensioned variables considered in *OwnTractor* are interest, depreciation, repairs, and TIS, the NPVc value must be prorated among these four cost categories. Because opportunity interest and market depreciation are ultimately the relevant interest and depreciation cost categories, prorating NPVc is not immediately straightforward. *OwnTractor* handles this as follows. First, though they do not impact cash flows, market depreciation and opportunity interest columns are included in the TT section. Then, the after-tax discounted NPV for each of these two columns, along with that of the repairs and TIS columns, is calculated. Finally, the relative share that each of the four values is of the total of all four, determines the NPVc proration portions.

Tractor analysis and summary section

First, this section repeats a few of the underlying user inputs and calculated values to facilitate printing a report. Second, based on after-tax amortization of values from the TT section, followed by conversions to pre-tax values, this section reports the ownership and operating costs associated with the tractor analyzed. To facilitate cost and rental rate comparisons, categorical costs are reported as annual costs and as per hour costs.