## Introduction

Economic pressures are requiring farmers to pay more attention to managing their machinery resources. The long-standing trend of substituting financial capital for labor by adding more productive and higher capacity machinery has resulted in large amounts of capital being used annually to acquire and operate farm machinery.

On today's commercial farm, substantial components of both capital investment and annual production costs are machinery related. As a result, farmers must not overlook effective strategies to manage their machinery resources. Effectively managing machinery resources requires having adequate answers on a continuing basis to the following questions:

- What size of machinery is most economical?
- How much machinery is needed for a given acreage and/or crop mix?
- Should machinery be leased, rented, custom-hired, or purchased?
- Should new or used machinery be purchased?
- How long should machinery be kept before it is replaced?

A farmer needs to know machinery costs to deal effectively with these management questions. Yet, many farmers do not keep adequate records of machinery costs. Moreover, because extensive information is required, farmers without records often find it difficult to make cost projections.

Recognizing the importance and general unavailability of information on machinery costs, this publication reports estimated costs of owning and operating farm machinery commonly used in the Pacific Northwest. Specific objectives are:

- To identify average prices for new machinery purchased in Idaho and Washington in late 2010 and early 2011.
- To estimate the annual and per-hour costs of owning and operating new machinery purchased for 2011, based on hours of annual use.
- To identify how machinery usage levels affect annual and per-hour costs.

## Survey Methods

Twenty-three farm machinery dealers located in Washington and Oregon were contacted in late 2010 via phone then sent surveys via regular or electronic mail. Thirteen dealers returned questionnaires, for a response rate of 56 percent. Another 11 dealers were contacted via phone. In total, data were provided by 24 machinery dealerships located mainly in Washington and Idaho, with one quote from an Oregon dealership and a few from national manufacturers (appendix C).

Machinery dealers were asked to provide quotes based on full retail prices and assuming common specifications. Dealers will typically offer discounts from full retail along with a trade-in discount. In the survey, dealers were questioned about their typical retail discount, but only three responded. Discount rates ranged from 10 percent to 23 percent, with an average discount rate of 15 percent.

## Machinery Costs

Machinery costs fall in two basic categories: (1) ownership costs and (2) operating costs. The specific cost items within each of these two categories are identified and briefly characterized below. Procedures used to derive the costs presented in this publication are also noted.

### Ownership Costs

Ownership costs are those costs that do not vary with machine use. Another term commonly used interchangeably with ownership costs is fixed costs. Regardless of the terminology used, these costs include depreciation, property taxes, housing, interest, and insurance.

#### *Depreciation*

Depreciation is the change in the value of farm machinery because of age, use, and obsolescence. It also is an accounting procedure to recover the costs of an asset over time. As machinery ages, it not only wears out, but also becomes obsolete because of improvements in technology. Consequently, age has been shown to be the overriding factor in explaining losses in the value of farm machinery.

Depreciation can be calculated using either the straight-line or declining balance method. The method that is used depends on the reason for calculating depreciation. If average annual cost of owning a machine is desired for accounting and management purposes, then the straight-line method is used. This concept of management depreciation will differ from depreciation as defined by the Internal Revenue Service (IRS) for tax purposes. The usual tax depreciation method is a form of declining balance and may use different useful lives and salvage values than should be used for management accounting.

While it is impossible to precisely determine the loss in value of used machinery until it has actually been sold, researchers have been able to identify a relationship between machinery value and its age and use. This relationship has been specified for several different groups of

**Calculating depreciation**

RFV values found in table 1 and appendix A along with the following formula are used to calculate average annual depreciation costs in this study.

$$\text{Depreciation} = \frac{\text{New cost - [New cost x (RFV} \div \text{100)]}}{\text{Useful life}}$$

For example, the average annual depreciation for a 1-ton hay baler (see cost table on page 68) to be used 10 years and with a new cost of $135,000 is:

$$\text{Depreciation} = \frac{\$135{,}000 - [\$135{,}000 \times (28.24 \div 100)]}{10}$$

$$= \$9{,}688$$

Note: The RFV of 28.24 is from table 1 on page 2.

machinery by examining prices farmers received for used machinery of varying ages. Table 1 lists these remaining on-farm values (RFV), expressed as a percentage of new cost, for seven groups of machinery commonly used in the Pacific Northwest. RFVs for tractors and other self-propelled equipment are listed in appendix B (tables B1-B5).

During a period of rising machinery prices, you should recognize that while the market value of your machinery may not be declining to the extent indicated in table 1, the cost of replacing this machinery is rising. Therefore, depreciation is still a relevant cost when viewed as the funds that must be set aside each year to eventually replace machinery.

### *Property Taxes*

Idaho and Oregon farmers do not pay personal property taxes on farm machinery. Washington farmers are required to pay personal property taxes on owned machinery. Differences between tax districts regarding the procedure used to value farm machinery and the levy applied to this value will cause considerable variation in the amount of taxes paid. In this publication, average annual property taxes are estimated at 1.4 percent of the average machine investment over its life (table 2). This estimate is based on a review of the taxation procedures used in several Pacific Northwest taxing districts.

### *Housing*

Many types of machinery are commonly housed by Pacific Northwest farmers to provide protection against the weather. Such protection yields benefits in the form of longer machine life, reduced repairs, better appearance, and greater convenience in working on machinery. The costs associated with the ownership and use of a machine shed should, of course, be charged against the housed machinery.

In this publication, housing was assumed to be provided by a 50-by-150-by-18-foot steel, open-front structure. Housing costs for individual items of machinery were specified as a percentage of the average machine investment over its life (table 2). The percentage estimates were obtained by multiplying the square feet of space required to store a given machine by the annual per square foot building cost, then dividing the resulting product by the average machine investment. No housing cost was assigned to machinery not commonly sheltered by Pacific Northwest farmers.

### *Interest*

Investment in machinery ties up financial capital, and an opportunity cost should be assigned. Equity capital investments carry an opportunity cost in the form of earnings foregone by not investing in the best alternative use of funds—either within or external to the farm business. Interest costs in this publication are calculated by taking 8 percent of the average machine investment (table 2).

### *Insurance*

Farmers often choose to protect their capital investments in machinery from casualty losses such as fire, theft, van-

### Calculating average machine investment

Average machine investment (AMI) used to calculate taxes, housing, interest, and insurance costs (THII), is calculated as follows:

$$AMI = \frac{\text{New cost} + [\text{New cost x (RFV in table 1} \div 100)]}{2}$$

**Table 1.** The remaining on-farm value (RFV) expressed as a percentage of new cost for tillage equipment, various harvest machines, and other miscellaneous equipment.

| Machinery life (years) | Mowers | Balers | Swathers and other harvest equipment | Plows | Disks and other tillage equipment | Planters | Manure spreaders and other misc. equip. |
|---|---|---|---|---|---|---|---|
| 1 | 47.40 | 56.36 | 48.97 | 47.22 | 61.01 | 64.77 | 69.16 |
| 2 | 43.65 | 50.23 | 43.82 | 44.37 | 54.13 | 59.69 | 61.71 |
| 3 | 40.87 | 45.76 | 40.06 | 42.23 | 49.13 | 55.93 | 56.29 |
| 4 | 38.60 | 42.16 | 37.03 | 40.48 | 45.10 | 52.85 | 51.91 |
| 5 | 36.66 | 39.11 | 34.45 | 38.96 | 41.70 | 50.22 | 48.20 |
| 6 | 34.94 | 36.45 | 32.20 | 37.61 | 38.74 | 47.89 | 44.97 |
| 7 | 33.40 | 34.08 | 30.20 | 36.39 | 36.11 | 45.80 | 42.09 |
| 8 | 31.99 | 31.96 | 28.39 | 35.28 | 33.74 | 43.90 | 39.50 |
| 9 | 30.70 | 30.02 | 26.75 | 34.25 | 31.60 | 42.15 | 37.14 |
| 10 | 29.51 | 28.24 | 25.24 | 33.28 | 29.63 | 40.52 | 34.97 |
| 11 | 28.39 | 26.60 | 23.84 | 32.38 | 27.82 | 39.01 | 32.97 |
| 12 | 27.34 | 25.08 | 22.55 | 31.53 | 26.14 | 37.59 | 31.12 |
| 13 | 26.36 | 23.67 | 21.34 | 30.73 | 24.58 | 36.25 | 29.39 |
| 14 | 25.43 | 22.34 | 20.20 | 29.96 | 23.13 | 34.99 | 27.77 |
| 15 | 24.55 | 21.10 | 19.14 | 29.23 | 21.76 | 33.79 | 26.26 |

Source: American Society of Agricultural and Biological Engineers, ASABE Standards, 2009
Note: Remaining farm values for tractors, combines, and skid-steer loaders can be found in appendix B.

dalism, collisions, and so forth by purchasing insurance. The cost of insurance (premium payments) is considered a machinery ownership expense. Insurance costs will vary according to the type of insurance, the extent of coverage, and the kind of machinery insured. Rates used in this publication are expressed as a percentage of the average machine investment and are listed for major machinery categories in table 2.

Total annual costs for property taxes, housing, interest, and insurance (THII) are estimated by multiplying the sum of the percentages representing each of these cost items (table 2) by the average machine investment.

## Operating Costs

Operating costs, also referred to as variable costs, change with machine use. Repair and maintenance, fuel and lubrication, and labor are commonly considered operating costs.

### Calculating total annual THII costs

Total annual costs for property taxes, housing, interest, and insurance (THII) are estimated by multiplying the sum of the percentages representing each of these cost items in table 2 by the average machine investment. To illustrate, annual THII costs for the 1-ton hay baler valued at $135,000 are calculated as shown below:

Annual THII = AMI x (THII factor in table 2 ÷ 100)

$$= \frac{\$135{,}000 + [\$135{,}000 \times (28.24 \div 100)]}{2} \times (11.9 \div 100)$$

$$= \$10{,}301$$

### *Repair and Maintenance*

Annual repair costs for a given machine normally increase as use increases. However, accurate predictions of machinery repair costs are difficult to obtain. Even the repair costs required for identical machines used the same number of hours vary with different types of work or working conditions. For example, a tractor used for heavy work on rough terrain likely will require more repair than one used for light work on smooth terrain. In addition, the amount and effectiveness of preventive maintenance also can influence repair costs.

Despite the sizeable problems encountered in specifying repair costs, researchers have estimated accumulated repair and maintenance costs at various stages in the life of most farm machinery. The estimates are based on extensive surveys of machinery records kept by farmers.

Based on a statistical analysis of farmer records, the relationship between accumulated repairs and machine use is defined by the repair and maintenance coefficients, $RF_1$ and $RF_2$. The $RF_1$ and $RF_2$ values for different machines are listed in table 3 and include the cost of parts and labor. Repair and maintenance factors used to calculate repair costs also are reported in appendix A at the bottom of the cost table presented for each machinery item.

It should be emphasized that these repair costs are only estimates of average repair and maintenance expenditures, even though they are widely used. If available, good machinery repair records will provide a superior basis for predicting repair costs.

**Table 2.** Percentage of average machine investment (AMI) charged for property taxes, housing, interest, and insurance (THII factor).

| Machinery | Taxes (%) | Housing (%) | Interest (%) | Insurance (%) | Total (%) |
|---|---|---|---|---|---|
| Wheel tractor | 1.4 | 0.3 | 8.0 | 0.9 | 10.6 |
| Crawler tractor | 1.4 | 0.2 | 8.0 | 0.9 | 10.5 |
| Combine | 1.4 | 0.5 | 8.0 | 2.1 | 12.0 |
| Potato harvester | 1.4 | 1.4 | 8.0 | 0.6 | 11.4 |
| Bean cutter | 1.4 | 1.1 | 8.0 | 0.6 | 11.1 |
| Self-propelled forage harvester | 1.4 | 1.3 | 8.0 | 2.1 | 12.8 |
| Pull-type forage harvester | 1.4 | 1.3 | 8.0 | 2.6 | 11.3 |
| Self-propelled windrower | 1.4 | 1.1 | 8.0 | 2.1 | 12.6 |
| Bean windrower | 1.4 | 1.1 | 8.0 | 0.6 | 11.1 |
| Hay rake | 1.4 | — | 8.0 | 0.6 | 10.0 |
| Hay baler | 1.4 | 1.9 | 8.0 | 0.6 | 11.9 |
| Self-propelled automatic bale wagon | 1.4 | 1.0 | 8.0 | 2.1 | 12.5 |
| Pull-type automatic bale wagon | 1.4 | 1.0 | 8.0 | 0.6 | 11.0 |
| Self-unloading forage wagon | 1.4 | — | 8.0 | 0.6 | 10.0 |
| Drills, planters | 1.4 | 2.4 | 8.0 | 0.6 | 12.4 |
| Tillage equipment | 1.4 | — | 8.0 | 0.6 | 10.0 |
| Sprayer | 1.4 | — | 8.0 | 0.6 | 10.0 |

### Calculating repair and maintenance

The repair and maintenance equation used in this study was taken from the American Society of Agricultural Engineers, *Agricultural Engineers Yearbook, 2004*.

$$\text{Annual repairs} = \text{New cost} \times \frac{\text{Total accumulated repairs (TAR)}}{\text{Years owned}}$$

Total accumulated repairs (TAR), expressed as a decimal of the machine's new cost, are calculated by the following formula:

$$TAR = RF_1[(X)^{RF_2}]$$

Where:

$RF_1$ = Repair factor #1

$RF_2$ = Repair factor #2

$$X = \frac{\text{Annual hours used} \times \text{Ownership period in years}}{1{,}000}$$

*Fuel and Lubrication*

Fuel and lubrication costs for farm machinery vary based on the number of hours the engine is operated. Fuel expenditures also depend on the fuel consumption rate and the fuel price. In turn, the rate of fuel consumption varies according to size of engine, kind of work performed (the engine load factor), and type of fuel, among other things.

Annual average fuel requirements for tractors may be used to calculate overall machinery costs. However, you should base the cost of each particular operation, such as disking or plowing, on actual fuel costs for the power required.

Fuel consumption rates per hour for tractors in this publication are calculated using the formula displayed below. This formula is based on Nebraska tractor test data adjusted to reflect engine wear. The formula predicts gasoline usage per hour, so the fuel multiplier (F) for gasoline is 1.00. The fuel multiplier for diesel is 0.73 since diesel tractors use approximately 73 percent as much fuel in volume as gasoline tractors.

Lubrication costs for all machinery are estimated to be 15 percent of the fuel expenditures, so annual fuel costs are multiplied by 1.15 to determine lubrication and fuel costs. The price for off-road diesel is assumed to be $3.25 per gallon.

### Calculating fuel costs

In this study, average annual fuel costs for tractors are estimated by the following formulas:

Average gasoline consumption per hour ($Q_{avg}$):

$Q_{avg}$= 0.06 x PTO horsepower,

where PTO horsepower = Maximum PTO horsepower, and the constant 0.06 is a factor to convert engine horsepower to average gasoline consumption per hour.

Annual fuel cost = F x $Q_{avg}$ x Fuel price x Hours used annually, where the fuel multiplier (F) = 1.00 for gasoline and 0.73 for diesel.

*Labor*

While machinery operating labor is an important operating cost, these outlays are not included in the calculations made in this publication. They are omitted because of the relative ease with which you can make labor cost estimates. For example, the hours of machinery labor can be estimated by multiplying machinery operating time by 1.1. A 10 percent factor is used to account for service and maintenance time. If the machine operator is a hired worker, the wage rate should include the full cost of labor (that is base wage, FICA, insurance, and benefits). When the machinery is operated by the owner, the wage rate should equal the earnings realizable by the operator in the best alternative use of his or her time or by wages normally paid for machinery operators.

## Timeliness Costs

When machinery breaks down, a cost apart from repairs may materialize. This is a "timeliness" cost and equals the returns foregone by not being able to complete the current operation (and possibly those to follow) on time. If certain operations are not performed at the most opportune time, crop yield and/or quality losses may occur. Timeliness costs vary depending on the type of operation performed, the crop in question, and whether back-up machinery is available. Such costs are likely to increase as machinery ages.

Timeliness costs also are influenced by machine size. When a machinery complement is undersized for a farm, it prolongs the performance of field operations, thereby hindering crop yields and/or quality. Performance of a field operation within a specified time interval is highly dependent on the size and capacity of the machinery complement and whether the operation was started as soon as the field was ready.

Timeliness costs associated with an undersized and/or aged machinery complement are extremely difficult to quantify. Efforts to quantify them are further complicated by unpredictable weather patterns—a major determinant of the time available for field operations. Because of the general lack of research on timeliness costs, no attempt is made to estimate these costs in this publication. Good management practices, including routine machinery maintenance, proper operation, and adequate machinery capacity will certainly reduce timeliness costs.

## Total and Per-Unit-of-Work Costs and Their Relationship to Machine Use

Adding the ownership and operating costs incurred during the year gives your total annual machinery costs. Dividing total annual costs by the units of work performed (that is hours, acres, tons, etc.) yields the average annual cost of performing a unit of work.

Both total and per-unit-of-work costs are closely related to the extent of machine use. Because of the direct relationship between operating costs and use, total annual costs will increase with increased machine use. However,

**Table 3.** Field efficiency, field speed, useful life, and repair and maintenance cost parameters.

| | Field efficiency | | Field speed | | Estimated life | Total life repairs | Repair factors | |
|---|---|---|---|---|---|---|---|---|
| | Range (%) | Typical (%) | Range (mph) | Typical (mph) | (hours) | (% of list price) | $RF_1$ | $RF_2$ |
| Tractors | | | | | | | | |
| 2-wheel drive & stationary | | | | | 12,000 | 100 | 0.007 | 2.0 |
| 4-wheel drive & crawler | | | | | 16,000 | 80 | 0.003 | 2.0 |
| Tillage & planting | | | | | | | | |
| Moldboard plow | 70-90 | 85 | 3.0-6.0 | 4.5 | 2,000 | 100 | 0.29 | 1.8 |
| Heavy-duty disk | 70-90 | 85 | 3.5-6.0 | 4.5 | 2,000 | 60 | 0.18 | 1.7 |
| Tandem disk harrow | 70-90 | 80 | 4.0-7.0 | 6.0 | 2,000 | 60 | 0.18 | 1.7 |
| (Coulter) chisel plow | 70-90 | 85 | 4.0-6.5 | 5.0 | 2,000 | 75 | 0.28 | 1.4 |
| Field cultivator | 70-90 | 85 | 5.0-8.0 | 7.0 | 2,000 | 70 | 0.27 | 1.4 |
| Spring tooth harrow | 70-90 | 85 | 5.0-8.0 | 7.0 | 2,000 | 70 | 0.27 | 1.4 |
| Roller-packer | 70-90 | 85 | 4.5-7.5 | 6.0 | 2,000 | 40 | 0.16 | 1.3 |
| Mulcher-packer | 70-90 | 80 | 4.0-7.0 | 5.0 | 2,000 | 40 | 0.16 | 1.3 |
| Rotary hoe | 70-85 | 80 | 8.0-14.0 | 12.0 | 2,000 | 60 | 0.23 | 1.4 |
| Row crop cultivator | 70-90 | 80 | 3.0-7.0 | 5.0 | 2,000 | 80 | 0.17 | 2.2 |
| Rotary tiller | 70-90 | 85 | 1.0-4.5 | 3.0 | 1,500 | 80 | 0.36 | 2.0 |
| Row crop planter | 50-75 | 65 | 4.0-7.0 | 5.5 | 1,500 | 75 | 0.32 | 2.1 |
| Grain drill | 55-80 | 70 | 4.0-7.0 | 5.0 | 1,500 | 75 | 0.32 | 2.1 |
| Harvesting | | | | | | | | |
| Corn picker sheller | 60-75 | 65 | 2.0-4.0 | 2.5 | 2,000 | 70 | 0.14 | 2.3 |
| Combine | 60-75 | 65 | 2.0-5.0 | 3.0 | 2,000 | 60 | 0.12 | 2.3 |
| Combine (self-propelled) | 65-80 | 70 | 2.0-5.0 | 3.0 | 3,000 | 40 | 0.04 | 2.1 |
| Mower | 75-85 | 80 | 3.0-6.0 | 5.0 | 2,000 | 150 | 0.46 | 1.7 |
| Mower (rotary) | 75-90 | 80 | 5.0-12.0 | 7.0 | 2,000 | 175 | 0.44 | 2.0 |
| Mower-conditioner | 75-85 | 80 | 3.0-6.0 | 5.0 | 2,500 | 80 | 0.18 | 1.6 |
| Mower-conditioner (rotary) | 75-90 | 80 | 5.0-12.0 | 7.0 | 2,500 | 100 | 0.16 | 2.0 |
| Windrower (self-propelled) | 70-85 | 80 | 3.0-8.0 | 5.0 | 3,000 | 55 | 0.06 | 2.0 |
| Side delivery rake | 70-90 | 80 | 4.0-8.0 | 6.0 | 2,500 | 60 | 0.17 | 1.4 |
| Rectangular baler | 60-85 | 75 | 2.5-6.0 | 4.0 | 2,000 | 80 | 0.23 | 1.8 |
| Large rectangular baler | 70-90 | 80 | 4.0-8.0 | 5.0 | 3,000 | 75 | 0.10 | 1.8 |
| Large round baler | 55-75 | 65 | 3.0-8.0 | 5.0 | 1,500 | 90 | 0.43 | 1.8 |
| Forage harvester | 60-85 | 70 | 1.5-5.0 | 3.0 | 2,500 | 65 | 0.15 | 1.6 |
| Forage harvester (SP) | 60-85 | 70 | 1.5-6.0 | 3.5 | 4,000 | 50 | 0.03 | 2.0 |
| Sugar beet harvester | 50-70 | 60 | 4.0-6.0 | 5.0 | 1,500 | 100 | 0.59 | 1.3 |
| Potato harvester | 55-70 | 60 | 1.5-4.0 | 2.5 | 2,500 | 70 | 0.19 | 1.4 |
| Cotton picker (SP) | 60-75 | 70 | 2.0-4.0 | 3.0 | 3,000 | 80 | 0.11 | 1.8 |
| Miscellaneous | | | | | | | | |
| Fertilizer spreader | 60-80 | 70 | 5.0-10.0 | 7.0 | 1,200 | 80 | 0.63 | 1.3 |
| Boom-type sprayer | 50-80 | 65 | 3.0-7.0 | 6.5 | 1,500 | 70 | 0.41 | 1.3 |
| Air-carrier sprayer | 55-70 | 60 | 2.0-5.0 | 3.0 | 2,000 | 60 | 0.20 | 1.6 |
| Bean puller-windrower | 70-90 | 80 | 4.0-7.0 | 5.0 | 2,000 | 60 | 0.20 | 1.6 |
| Beet topper/stock chopper | 70-90 | 80 | 4.0-7.0 | 5.0 | 1,200 | 35 | 0.28 | 1.4 |
| Forage blower | | | | | 1,500 | 45 | 0.22 | 1.8 |
| Forage wagon | | | | | 2,000 | 50 | 0.16 | 1.6 |
| Wagon | | | | | 3,000 | 80 | 0.19 | 1.3 |

Source: ASAE standards, 2004

the average annual cost per unit of work initially decreases, reaches a minimum, and finally increases as machine use increases.

Per-unit costs initially decline as use increases because ownership costs are spread over more units of work. Eventually, however, a level of use is reached where dilution of ownership costs is offset by rising per-unit repair and dependability costs, resulting in very little change in overall per-unit costs. Stability in per-unit costs beyond a certain range of use also occurs because of a decline in the rate at which machine values drop with advancing age (table 1).

With extremely high rates of annual use, per-unit costs may increase as the rise in repair and dependability costs more than offsets the dilution of ownership costs. Because of the close relationship between machine use and costs, cost information in this publication is developed for different levels of annual machine use.

## Machinery Cost Projections

The machinery costs presented in appendix A are computer-generated using the assumptions and procedures outlined above. Each page includes two or three tables that project average annual costs at different levels of use for specific machinery. To ensure the correct interpretation of the cost projections, the first table, which is for a 425-horsepower four-wheel-drive tractor at various rates of annual use, is explained below.

The first column of the table lists the hours the tractor is assumed to be used each year. The second column lists the total years the tractor is kept before it is traded. Average annual costs for the various ownership and operating outlays are in columns 3 through 6. Column 7 is the sum of all ownership and operating costs, representing the total annual machinery cost for the tractor, assuming the hours of annual use and years owned noted in columns 1 and 2. In column 8, total annual costs are divided by the annual hours of use noted in column 1 to obtain the total cost per hour. Remember, this does not include labor costs.

## Adjusting Costs to Fit Your Situation

Basic assumptions used in developing machinery costs are shown at the bottom of each table in appendix A. In the event these assumptions do not accurately reflect your situation, the costs can be readily adjusted to reflect your circumstances. For example, the purchase price may differ from that noted at the bottom of the table. Depreciation, THII, and repair costs can be adjusted to reflect the actual purchase price by first calculating the percentage difference between the actual and the purchase price shown in the table. Then adjust the table costs either up or down by the same percentage difference.

There also may be a reason for using a different THII factor than indicated for the table calculations. To use a different factor, first divide the table THII cost by the table THII percentage factor to get the cost for each 1 percent of the THII factor. Next multiply this cost by the desired THII rate to get the adjusted THII cost.

You can adjust fuel and lubrication costs to reflect different fuel consumption rates by inserting the appropriate information in the formulas on page 4. To adjust for a different fuel price, divide the desired price by the price indicated at the bottom of the table and multiply the result by the fuel and oil cost appearing in the table. For example, the fuel price indicated for the 425-horsepower tractor in the first table is $3.25 per gallon. The fuel and oil cost at 500 hours of annual use ($34,787) can be adjusted to a fuel price of $4.00 per gallon by first dividing $4.00 by $3.25 and then multiplying the result, 1.23, by $34,787 to obtain the adjusted cost of $42,815.

### Calculating acres per hour

Acres covered per hour for farm equipment can be estimated based on your own experience or by using the following formula.

$$\text{Acres per hour} = \frac{\text{mph x Machine width (ft) x Field efficiency (\%)}}{8.25}$$

For example, if a machine 30 feet wide travels at 5 miles per hour and has a field efficiency of 70 percent, the calculation is:

$$\text{Acres per hour} = \frac{\text{5 mph x 30 feet x 70 percent}}{8.25}$$

$$= \text{12.73 acres per hour}$$

Typical field efficiencies for farm machinery are shown in table 3. Field efficiency is less than 100 percent because of overlap, turning time, and time required to adjust and service machinery and fill hoppers.

## Estimating Costs for Operations Involving Two or More Machines

When you need the cost to perform an operation that requires two or more machines, you must summarize cost information appearing in different tables. The mechanics of making this type of calculation can best be explained by using an example.

Suppose you want to know the cost per acre of seeding using a 425-horsepower, four-wheel-drive tractor (page 7) pulling a 30-foot no-till drill (page 46). Assume an annual use for the tractor and drill of 500 and 150 hours, respectively. By turning to the appropriate tables, you find the per-hour costs at the designated annual use are $150.47 for the tractor and $133.13 for the no-till drill, a total of $283.60. Assuming 1.1 hours of labor for each machine hour, labor at $16.00 per hour would add another $17.60 (1.1 x $16.00). The total per-hour cost is

$283.60 + $17.60 = $301.20.

If it takes 0.08 hour to seed 1 acre with this tractor-drill combination, the cost per acre is

0.08 x $301.20 = $24.10.