HOW TO USE THIS SPREADSHEET

- **The accompanying spreadsheet allows you to estimate the true cost of owning a Cross Slot® machine and what crop yield difference is necessary to justify owning such a machine.**
- **It is compiled in both metric units and imperial units. Simply select the page at the bottom left that you want to work with.**
- **If using the metric sheet, click on the grey cell at E13. An arrow will appear on the right hand side of the cell. Click on the arrow to reveal the currency you wish to work in (€ $ £).**
- **Most people think only about costs when sowing seeds. And even then they are unlikely to factor in such variables as the speed of drilling (Cross Slot is a high-speed drill) or the ownership costs associated with machines designed with a 10,000 – 20,000 hour life. Cross Slot has a design life that is similar to most tractors.**
- **Most competing no-tillage drills do not have 10,000 – 20,000 hour design lives. Many will require replacing after perhaps 5 years. Most Cross Slot machines will last up to 20 years.**
- **Longer-lasting machines cost more to buy, but their repair bills are likely to be lower than cheaper drills and their resale values are likely to be higher, even as a percentage of the new cost. The spreadsheet factors these variables in.**
- **With no-tillage, operators should be thinking about returns as well as costs.**
- **No-tillage drills and planters can have a profound effect on the final yield of crops and pastures, which dictates returns.**
- **Comparing both the machine costs and the effects that each machine might have on yield and other costs, produces a true cost-benefit.**
- **Feel free to alter any of the values in the BLUE CELLS and see what effects they have on the comparative cost-benefits of each machine. If you are unsure on how to do this please see the "Help" section below.**
- **The calculator gives you a method of estimating how much (if any) additional crop yield you will need to get from a Cross Slot machine compared with an alternative machine.**
- **The results may surprise you!**
- **Independent tests in New Zealand, USA, Canada, Europe and Australia have recorded yield advantages for Cross Slot of 10 - 50%. The calculator will show that the true costs of owning and operating a Cross Slot drill or planter (the cost-benefits) are very favourable indeed.**

MORE HELP?

Here is how to insert new data in the blue cells, for those who do not know how to operate Excel.

- **You can change as many (or few) blue data cells as you want.**
- **Then left click anywhere on the sheet (or press the "enter" key) and the calculator will instantly calculate the new answers and display them in the cells named in the instructions above.**
- **It is as simple as that!**

IF YOU ARE UNSURE WHAT VALUES TO ENTER IN THE RESPECTIVE CELLS, PLEASE READ THE "WHAT VALUES TO ENTER" SECTION BELOW.

WHAT VALUES TO ENTER

Here is help with some of the logic behind the figures that you choose to enter.

FARM APPLICATION

Area covered. This is what you estimate will be sown by either machine in any one year. If you seed in both autumn and spring, enter the total for both seasons because many of the other costs are calculated on an annual basis. You might also want to vary this figure, to find out, for example what would happen to the operating costs if you were to increase or decrease the area seeded per year (by leasing additional land, for example) or contracting (custom seeding)?

Crop value. This is usually what you will be paid for the crop when you sell it. If you are in the habit of storing crop on the farm awaiting the best price, the costs of storage, drying and freight should be deducted from the costs of running the farming business in general. Do not add storage, drying or cartage costs to the costs of sowing the crop since they have nothing to do with sowing and will only confuse the issue. Enter the gross return per tonne.

In the case of forage crops, it is sometimes difficult to estimate their value because they pass through animals before creating a financial return in the form of milk, fibre or meat. As a guide, in New Zealand most farmers value pastures at about NZ$100/tonne of dry matter (or 10 cents/kg DM) and forage crops at about NZ$200/tonne of dry matter (or 20 cents/kg DM) although these figures will fluctuate in sympathy with changes in grain and other prices.

Average yield. This is another factor that you could vary in order to try out a range of scenarios. But initially you should enter the average crop yield that you have obtained over the past few years.

It is common for Cross Slot no-tillage to increase crop yields over time. What the calculator will tell you is how much increase in yield (if any) you would need to obtain in order to gain from owning a Cross Slot drill compared with an alternative ("brand X") machine. Almost invariably, in practice you will obtain greater crop yield increases than the calculator says are necessary to break even.

PURCHASE AND OPERATIONAL COSTS

New cost of machine. This is often the single factor that purchasers erroneously focus on, to the exclusion of all else. It can be quite misleading. It is not "cost" that is so important. It is "cost-benefit" that determines whether you should buy an expensive or a cheap machine. Nonetheless you still need to factor in the initial cost.

If you do not know the cost of a competing brand of machine ("brand X") try entering a figure that is half the cost of the comparable Cross Slot machine to see how sensitive the initial cost really is.

Drill/planter width. While this might seem like a simple factor to enter, Cross Slot machines generally require bigger tractors to pull a given width than some cheaper no-tillage drills and even more than drills used in conventional tillage. Therefore, for any give tractor size, you might expect to pull a narrower Cross Slot drill than some other brands and certainly narrower than a drill used in conventional tillage.
The effective sowing width of any seed drill is found by multiplying the number of openers by their row spacing. For example, a 25 row drill with 200 mm (8 inch) row spacing has a drilling width of 5 metres or 200 inches.

A rule of thumb is that it takes about 8-12 tractor-engine horsepower to pull each Cross Slot opener compared with about 4 hp per opener for tillage drills and 7 hp per opener for most other no-tillage drills that do not sow fertilizer at the same time as the seed. The required power per opener is very soil dependent and decreases markedly over time as soil structure improves. A good rule of thumb is to allow 8-10 hp per opener for Cross Slot unless you know the terrain is hilly (use 12 hp) or flat and sandy (use 6 hp).

If a competing no-tillage drill is capable of sowing realistic amounts of fertilizer at the same time as the seed (not just a small amount of starter fertilizer) it is likely to require about the same engine horsepower per opener as a Cross Slot machine, and often more.

Remember also that the rate at which the ground is covered by any drill is a combination of the drill width and its operating speed. If a drill is narrow but can operate at a faster speed than another wider drill, the rates of ground coverage might be identical. This is taken into account in the next data entry.

Seeding speed. Be sure that you are entering a realistic speed. Most people over-estimate how fast they travel when seeding. For example, most shank type openers do not perform well at speeds above 8 kmph (5 mph) and many are operated at 4 - 6 kmph (3 - 4 mph). Some disc drills are capable of travelling at speeds up to 16 kmph (10 mph) but many do not perform well at these speeds. Cross Slot machines perform better at high speeds than most competing machines. Nonetheless other factors such as limitations of available engine horsepower (high speed drilling takes more power than low speed drilling) small fields and uneven or steep terrain will often limit the effective speed of even Cross Slot drills. A conservative figure to use for Cross Slot drills is 10-12 kmph (6-7.5mph) and 6-8 kmph (3.5-5mph) for most other drills.

5-yr depreciation value. Some significant differences may arise because of this factor and it is important to be fair and realistic when entering data in these cells. Just as with cars, you would expect a more expensive drill to retain its value better than a cheaper machine because it will be built to last longer (this is often the main reason why it was more expensive in the first place). It is not uncommon for a more expensive no-tillage seed drill like Cross Slot to still be operating when a cheaper competing machine has long-since stopped operating altogether and been discarded or replaced. With many no-tillage drills, because of the greater stresses that they experience (compared with tillage drills) life expectancy is often as short as 3 years and sometimes even less. Therefore, within 5 years (the time that the calculator identifies) such cheap machines can be expected to have very low (even zero) depreciated values and even their replacement machines may be well into their limited life-cycles.

There is no facility in the calculator for entering multiple machines with life-cycles that are less than 5 years. But Cross Slot machines are designed to last at least 10 (and up to 20) years. So it would not be unreasonable to enter a value of 60% (of new price) for a Cross Sot machine after 5 years and 30% for a competing machine that has a service life of 5 years or less.

Verification of these figures comes from a survey undertaken in New Zealand of the average annual depreciation of Cross Slot drills that have been traded as second-hand machines over the years. The average depreciation of these machines was 5% per year, which compares favourably with the industry figure of 15% per year.

Annual interest. When money has to be borrowed to buy either of the machines being compared, the interest rate will be the rate at which you can borrow money.

If you are able to pay cash for either machine, the interest rate should be the rate that you could obtain if you had, instead, invested that money elsewhere (i.e. the opportunity cost of using that money). The opportunity interest rate will usually be a little lower than the borrowing interest rate.

Either way, the interest rate does not necessarily have to be the same for both machines. For example, if you had enough money to pay cash for a cheaper machine that cost half as much as a Cross Slot machine, but had to borrow the balance needed to buy a Cross Slot machine, you could enter two different interest rates. As a further example, if the “borrow” interest rate was 5% and the opportunity interest rate was 3% and you had enough cash for the cheaper machine but had to borrow additional funds for the Cross Slot machine, you would enter 4% for the “brand X” machine and 4.5% for the Cross Slot machine (4.5% is the average of 4% and 5% since you used cash for half of the purchase and borrowed for the other half).

Drill consumables. This includes the cost of replacing soil-engaging parts on the openers. Generally this will include tines, discs, blades and scrapers depending on the opener design. The degree of abrasiveness of the soil will obviously impact but will be common for both machines being compared. This factor is often quite a difficult one to estimate as it is very site specific so try a few different figures to see how sensitive this cost is to the overall analysis.

Other repairs. The same logic applies here as for the initial price. More expensive machines should cost less in repairs and maintenance than cheaper machines because they are designed more robustly and with longer-lasting components such as bearings.

Once again, try some different figures to test sensitivity to this factor.

Supplemental operations. This factor is often overlooked but can have a profound effect on the results. Since Cross Slot machines undertake true one-pass no-tillage, the only supplemental operation that is usually necessary when seeding with a Cross Slot machine is to spray the field for weeds. But spraying is used with all no-tillage machines and is also often also used prior to tillage too. So the cost of spraying can either be left out altogether because it is common to all machines being compared, or the same value can be entered for each machine.

The most common supplemental operation that is required for competing drills (but not Cross Slot) is fertilizing and/or mulching the residues. Fertilizing as a supplementary operation is necessary where the competing drill is incapable of banding normal rates of fertilizer alongside or below the seed at the time of seeding. In such cases, fertilizer is spread as a separate operation and this cost must be factored in as a supplementary operation.

Another common supplemental operation is one or more passes with a mulcher or light tillage machine before seeding and/or a pass with a harrow or roller after seeding. These operations may be necessary for drills that require the ground to be loosened before seeding and/or re-manipulated after seeding in order to cover the seed.

Some competing drills do not handle crop residues very well. So the residues must be mulched or stubble-harrowed before drilling. This is also a supplemental operation that should be entered for the competing machine. Even the cost of buying a stripper header for a combine harvester so as to leave more of the residues as standing stubble (which makes it easier for shank-type openers to pass through without blockage) could be added as a supplemental cost of the "brand X" drill because Cross Slot machines do not require stripper heading or mulching in order to handle residues.

The cost of any of these additional passes over the field should be entered for the competing drill and zero should be entered for the Cross Slot machine.

Labour. Note that the units are cost per hour. This will not be simply the rate you pay someone (or yourself) to drive the tractor. It should be the total cost of the labour to complete the seeding job. So any additional labour required for supplementary operations or for supporting the machine should be added. Note also that the labour cost will be greater than the drill spot work-rate per hour allowing time for filling, maintenance, transport, etc.

Fuel. Information required here is also cost per hour. Tractors pulling Cross Slot drills will typically use 20 and 40 litres of fuel per hour, depending on the size of the drill. You need to multiply this fuel-use figure by the current price of fuel in order to get a fuel-use cost.

OWNERSHIP AND OPERATIONAL COSTS

The calculator fills in all of these figures for you as part of the calculating process. If you are a contractor or intend to lease your Cross Slot drill to another party, this figure will give you a real cost per hectare, which you can use as the basis of calculating your charge-out rate. But remember the calculator does not factor in any profit margin and it does not takes account of any taxation breaks or implications. It does, however, factor in the consumption of capital in the "5-year depreciated value" line. If required, the total cost of the tractor and drill can be entered and the other input figures adjusted accordingly to reflect the cost of operation of both the tractor and drill for both machine scenarios.

MACHINE COMPARISON

The calculator makes these estimations for you.

Cost difference. This is the true difference in cost (on and area basis) between owning and operating a Cross Slot drill and the competing (brand X) that you have nominated.

Yield advantage required from Cross Slot. If this figure is positive it represents the amount of additional yield that you would need to get from the Cross Slot drill in order to make it economic compared with the other drill ("brand X").

If the figure is negative it tells you that the Cross Slot drill is already economic to own and operate (even without a yield increase) compared with the "brand X" drill. In this case the "brand X" drill would need to provide a yield benefit in order to be cheaper than the Cross Slot machine.

BUT WE HAVE NEVER KNOWN A COMPETING BRAND OF NO-TILLAGE DRILL TO OUT-YIELD A CROSS SLOT DRILL.

Yield advantage required from Cross Slot (as a percentage). This is the same information as above, expressed as a percentage of the average yield.

BACKGROUND INFOMATION

The independently-written paper copied below provides authentication of the figures used in the examples given and also provides tables of new data that you might want to insert.

Estimating Farm Machinery Costs

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Machinery and equipment are major cost items in farm businesses. Larger machines, new technology, higher prices for parts and new machinery, and higher energy prices have all caused machinery and power costs to rise in recent years.

However, good machinery managers can control machinery and power costs per acre. Making smart decisions about how to acquire machinery, when to trade, and how much capacity to invest in can reduce machinery costs as much as $25 per acre. All of these decisions require accurate estimates of the costs of owning and operating farm machinery.

Machinery Costs

Farm machinery costs can be divided into two categories: annual ownership costs, which occur regardless of machine use, and operating costs, which vary directly with the amount of machine use.

The true value of these costs is not known until the machine is sold or worn out. But the costs can be estimated by making a few assumptions about machine life, annual use, and fuel and labor prices. This publication contains a worksheet that can be used to calculate costs for a particular machine or operation.

An example problem will be used throughout this publication to illustrate the calculations. The example is a 180-PTO horsepower diesel tractor with a list price of $110,000. Dealer discounts are assumed to reduce the actual purchase price to $93,500. An economic life of 15 years and an interest rate of 8 percent are selected. The tractor is expected to be used 400 hours per year.

Ownership costs (also called fixed costs) include depreciation, interest (opportunity cost), taxes, insurance, and housing and maintenance facilities.

Depreciation

Depreciation is a cost resulting from wear, obsolescence, and age of a machine. The degree of mechanical wear may cause the value of a particular machine to be somewhat above or below the average value for similar machines when it is traded or sold. The introduction of new technology or a major design change may make an older machine suddenly obsolete, causing a sharp decline in its remaining value. But age and accumulated hours of use are usually the most important factors in determining the remaining value of a machine.

Before an estimate of annual depreciation can be calculated, an economic life for the machine and a salvage value at the end of the economic life need to be specified. The economic life of a machine is the number of years for which costs are to be estimated. It is often less than the machine's service life because most farmers trade a machine for a different one before it is completely worn out. A good rule of thumb is to use an economic life of 10 to 12 years for most farm machines and a 15-year life for tractors, unless you know you will trade sooner.

Salvage value is an estimate of the sale value of the machine at the end of its economic life. It is the amount you can expect to receive as a trade-in allowance, an estimate of the used market value if you expect to sell the machine outright, or zero if you plan to keep the machine until it is worn out.

Table 1a. Remaining salvage value as percent of new list price.

	30-79 hp Tractor			80-149 hpTractor			150+ hpTractor			Combine,ForageHarvestor		
Annual Hours	200	400	600	200	400	600	200	400	600	100	300	500
Age												
1	65%	60%	56%	69%	68%	68%	69%	67%	66%	79%	69%	63%
2	59%	54%	50%	62%	62%	61%	61%	59%	58%	67%	58%	52%
3	54%	49%	46%	57%	57%	56%	55%	54%	52%	59%	50%	45%
4	51%	46%	43%	53%	53%	52%	51%	49%	48%	52%	44%	39%
5	48%	43%	40%	50%	49%	49%	47%	45%	44%	47%	39%	34%
6	45%	40%	37%	47%	46%	46%	43%	42%	41%	42%	35%	30%
7	42%	38%	35%	44%	44%	43%	40%	39%	38%	38%	31%	27%
8	40%	36%	33%	42%	41%	41%	38%	36%	35%	35%	28%	24%
9	38%	34%	31%	40%	39%	39%	35%	34%	33%	31%	25%	21%
10	36%	32%	30%	38%	37%	37%	33%	32%	31%	28%	23%	19%
11	35%	31%	28%	36%	35%	35%	31%	30%	29%	26%	20%	17%
12	33%	29%	27%	34%	34%	33%	29%	28%	27%	23%	18%	15%
13	32%	28%	25%	33%	32%	32%	27%	26%	25%	21%	16%	13%
14	30%	27%	24%	31%	31%	30%	25%	24%	24%	19%	14%	12%
15	29%	25%	23%	30%	29%	29%	24%	23%	22%	17%	13%	10%
16	28%	24%	22%	28%	28%	27%	22%	21%	21%	16%	11%	9%
17	26%	23%	21%	27%	27%	26%	21%	20%	19%	14%	10%	8%
18	25%	22%	20%	26%	25%	25%	20%	19%	18%	13%	9%	7%
19	24%	21%	19%	25%	24%	24%	19%	18%	17%	11%	8%	6%
20	23%	20%	18%	24%	23%	23%	17%	17%	16%	10%	7%	5%

Table 1b. Remaining salvage value as percent of new list price.

Machine Age	Plows	Other Tillage	Planter, Drill, Sprayer	Mower, Chopper	Baler	Swather, Rake	Vehicle	Other
1	47%	61%	65%	47%	56%	49%	42%	69%
2	44%	54%	60%	44%	50%	44%	39%	62%
3	42%	49%	56%	41%	46%	40%	36%	56%
4	40%	45%	53%	39%	42%	37%	34%	52%
5	39%	42%	50%	37%	39%	35%	33%	48%
6	38%	39%	48%	35%	37%	32%	31%	45%
7	36%	36%	46%	33%	34%	30%	30%	42%
8	35%	34%	44%	32%	32%	28%	29%	40%
9	34%	31%	42%	31%	30%	27%	27%	37%
10	33%	30%	40%	30%	28%	25%	26%	35%
11	32%	28%	39%	28%	27%	24%	25%	33%
12	32%	26%	38%	27%	25%	23%	24%	31%
13	31%	24%	36%	26%	24%	21%	24%	29%
14	30%	23%	35%	26%	22%	20%	23%	28%
15	29%	22%	34%	25%	21%	19%	22%	26%
16	29%	20%	33%	24%	20%	18%	21%	25%
17	28%	19%	32%	23%	19%	17%	20%	24%
18	27%	18%	30%	22%	18%	16%	20%	22%
19	27%	17%	29%	22%	17%	16%	19%	21%
20	26%	16%	29%	21%	16%	15%	19%	20%

Estimates of the remaining value of tractors and other classes of farm machines as a percent of new list price are listed in Tables 1a and 1b. Note that for tractors, combines and forage harvesters the number of hours of annual use is also considered when estimating the remaining value. The factors were developed from published reports of used equipment auction values, and are estimates of the average "as-is" value of a class of machines in average mechanical condition at the farm. Actual market value will vary from these values depending on the condition of the machine, the current market for new machines, and local preferences or dislikes for certain models.

The appropriate values in Table 1 should be multiplied by the current list price of a replacement machine of equivalent size and type, even if the actual machine was or will be purchased for less than list price.

For the 180-hp tractor with 400 hours of annual use in the example, the salvage value after 15 years is estimated as 23 percent of the new list price:

Salvage value = current list price x remaining value factor (Table 1)
= $110,000 x 23%
= $ 25,300

Total depreciation = purchase price - salvage value
= $93,500 - $25,300
= $68,200

Interest

If you borrow money to buy a machine, the lender will determine the interest rate to charge. But if you use your own capital, the rate to charge will depend on the opportunity cost for that capital elsewhere in your farm business. If only part of the money is borrowed, an average of the two rates should be used. For the example we will assume an average interest rate of 8 percent.

Inflation reduces the real cost of investing capital in farm machinery; however, since loans can be repaid with cheaper dollars. The interest rate can be adjusted by subtracting the expected rate of inflation. For our example we will assume a 3 percent inflation rate, so the adjusted or "real" interest rate is 5 percent.

The joint costs of depreciation and interest can be calculated by using a capital recovery factor. Capital recovery is the number of dollars that would have to be set aside each year to just repay the value lost due to depreciation, and pay interest costs.

Table 2. Capital recovery factors.

Int. rate	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%
Years														
1	1.020	1.030	1.040	1.050	1.060	1.070	1.080	1.090	1.100	1.110	1.120	1.130	1.140	1.150
2	0.515	0.523	0.530	0.538	0.545	0.553	0.561	0.568	0.576	0.584	0.592	0.599	0.607	0.615
3	0.347	0.354	0.360	0.367	0.374	0.381	0.388	0.395	0.402	0.409	0.416	0.424	0.431	0.438
4	0.263	0.269	0.275	0.282	0.289	0.295	0.302	0.309	0.315	0.322	0.329	0.336	0.343	0.350
5	0.212	0.218	0.225	0.231	0.237	0.244	0.250	0.257	0.264	0.271	0.277	0.284	0.291	0.298
6	0.179	0.185	0.191	0.197	0.203	0.210	0.216	0.223	0.230	0.236	0.243	0.250	0.257	0.264
7	0.155	0.161	0.167	0.173	0.179	0.186	0.192	0.199	0.205	0.212	0.219	0.226	0.233	0.240
8	0.137	0.142	0.149	0.155	0.161	0.167	0.174	0.181	0.187	0.194	0.201	0.208	0.216	0.223
9	0.123	0.128	0.134	0.141	0.147	0.153	0.160	0.167	0.174	0.181	0.188	0.195	0.202	0.210
10	0.111	0.117	0.123	0.130	0.136	0.142	0.149	0.156	0.163	0.170	0.177	0.184	0.192	0.199
11	0.102	0.108	0.114	0.120	0.127	0.133	0.140	0.147	0.154	0.161	0.168	0.176	0.183	0.191
12	0.095	0.100	0.107	0.113	0.119	0.126	0.133	0.140	0.147	0.154	0.161	0.169	0.177	0.184
13	0.088	0.094	0.100	0.106	0.113	0.120	0.127	0.134	0.141	0.148	0.156	0.163	0.171	0.179
14	0.083	0.089	0.095	0.101	0.108	0.114	0.121	0.128	0.136	0.143	0.151	0.159	0.167	0.175
15	0.078	0.084	0.090	0.096	0.103	0.110	0.117	0.124	0.131	0.139	0.147	0.155	0.163	0.171
16	0.074	0.080	0.086	0.092	0.099	0.106	0.113	0.120	0.128	0.136	0.143	0.151	0.160	0.168
17	0.070	0.076	0.082	0.089	0.095	0.102	0.110	0.117	0.125	0.132	0.140	0.149	0.157	0.165
18	0.067	0.073	0.079	0.086	0.092	0.099	0.107	0.114	0.122	0.130	0.138	0.146	0.155	0.163
19	0.064	0.070	0.076	0.083	0.090	0.097	0.104	0.112	0.120	0.128	0.136	0.144	0.153	0.161
20	0.061	0.067	0.074	0.080	0.087	0.094	0.102	0.110	0.117	0.126	0.134	0.142	0.151	0.160

Table 2 shows capital recovery factors for various combinations of real interest rates and economic lives. For the example, the capital recovery factor for 15 years and 5 percent is .096. The annual capital recovery cost is found by first multiplying the appropriate capital recovery factor by the difference between the total depreciation, then adding the product of the interest rate and the salvage value to it.

For the example values given above:

Capital recovery = (total depreciation x capital recovery factor) + (salvage value x interest rate)
= ($68,200 x .096) + ($25,300 x .05)

= $6,547 + $1,265
= $7,812 per year

Taxes, insurance, and housing (TIH)

These three costs are usually much smaller than depreciation and interest, but they need to be considered. Property taxes on farm machinery have been phased out in Iowa, except for very large inventories. For states that do have property taxes on farm machinery, a cost estimate equal to 1 percent of the purchase price is often used.

Insurance should be carried on farm machinery to allow for replacement in case of a disaster such as a fire or tornado. If insurance is not carried, the risk is assumed by the rest of the farm business. Current rates for farm machinery insurance in Iowa range from $4 to $6 per $1,000 of valuation, or about 0.5 percent of the purchase price.

There is a tremendous variation in housing provided for farm machinery. Providing shelter, tools, and maintenance equipment for machinery will result in fewer repairs in the field and less deterioration of mechanical parts and appearance from weathering. That should produce greater reliability in the field and a higher trade-in value. An estimated charge of 0.5 percent of the purchase price is suggested for housing costs.

To simplify calculating TIH costs, they can be lumped together as 1 percent of the purchase price where property taxes are not significant.

TIH = 0.01 x purchase price

For our tractor example, these three costs would be:

TIH = 0.01 x $93,500
= $935 per year

Total ownership cost

The estimated costs of depreciation, interest, taxes, insurance, and housing are added together to find the total ownership cost. For our example tractor this adds up to $8,747 per year. This is almost 10 percent of the original cost of the tractor.

Total ownership cost = $7,812 + $935
= $8,747 per year

If the tractor is used 400 hours per year, the total ownership per hour is:

Ownership cost per hour = $8,747 / 400 hours
= $21.87 per hour

Operating costs (also called variable costs) include repairs and maintenance, fuel, lubrication, and operator labor.

Repairs and maintenance

Repair costs occur because of routine maintenance, wear and tear, and accidents. Repair costs for a particular type of machine vary widely from one geographic region to another because of soil type, rocks, terrain, climate, and other conditions. Within a local area, repair costs vary from farm to farm because of different management policies and operator skill.

The best data for estimating repair costs are records of your own past repair expenses. Good records indicate whether a machine has had above or below average repair costs and when major overhauls may be needed. They will also provide information about your maintenance program and your mechanical ability. Without such data, though, repair costs must be estimated from average experience.

Table 3. Accumulated repair costs as a percent of new list price.

	Accumulated hours									
	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,.000	9,000	10,000
Type of Machinery										
Two-wheel drive tractor	1%	3%	6%	11%	18%	25%	34%	45%	57%	70%
Four-wheel drive tractor	0%	1%	3%	5%	8%	11%	15%	19%	24%	30%
	200	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000
Moldboard plow	2%	6%	12%	19%	29%	40%	53%	68%	84%	101%
Heavy-duty disk	1%	4%	8%	12%	18%	25%	32%	40%	49%	58%
Tandem disk	1%	4%	8%	12%	18%	25%	32%	40%	49%	58%
Chisel plow	3%	8%	14%	20%	28%	36%	45%	54%	64%	74%
field cultivator	3%	7%	13%	20%	27%	35%	43%	52%	61%	71%
Harrow	3%	7%	13%	20%	27%	35%	43%	52%	61%	71%
Roller-packer, mulcher	2%	5%	8%	12%	16%	20%	25%	29%	34%	39%
Rotary hoe	2%	6%	11%	17%	23%	30%	37%	44%	52%	61%
Row crop cultivator	0%	2%	6%	10%	17%	25%	36%	48%	62%	78%
	200	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000
Corn picker	0%	2%	4%	8%	14%	21%	30%	41%	54%	69%
Combine (pull)	0%	1%	4%	7%	12%	18%	26%	35%	46%	59%
Potato harvester	2%	5%	9%	14%	19%	25%	30%	37%	43%	50%
Mower-conditioner	1%	4%	8%	13%	18%	24%	31%	38%	46%	55%
Mower-conditioner (rotary)	1%	3%	6%	10%	16%	23%	31%	41%	52%	64%
Rake	2%	5%	8%	12%	17%	22%	27%	33%	39%	45%
Rectangular baler	1%	4%	9%	15%	23%	32%	42%	54%	66%	80%
Large square baler	1%	2%	4%	7%	10%	14%	18%	23%	29%	35%
Forage harvester (pull)	1%	3%	7%	10%	15%	20%	26%	32%	38%	45%
	300	600	900	1,200	1,500	1,800	2,100	2,400	2,700	3,000
Forage harvester (SP)	0%	1%	2%	4%	7%	10%	13%	17%	22%	27%
Combine (SP)	0%	1%	3%	6%	9%	14%	19%	25%	32%	40%
Windrower (SP)	1%	2%	5%	9%	14%	19%	26%	35%	44%	54%
Cotton picker (SP)	1%	4%	9%	15%	23%	32%	42%	53%	66%	79%
	100	200	300	400	500	600	700	800	900	1,000
Mower (sickle)	1%	3%	6%	10%	14%	19%	25%	31%	38%	46%
Mower (rotary)	0%	2%	4%	7%	11%	16%	22%	28%	36%	44%
Large round baler	1%	2%	5%	8%	12%	17%	23%	29%	36%	43%
Sugar beet harvester	3%	7%	12%	18%	24%	30%	37%	44%	51%	59%
Rotary tiller	0%	1%	3%	6%	9%	13%	18%	23%	29%	36%
Row crop planter	0%	1%	3%	5%	7%	11%	15%	20%	26%	32%
Grain drill	0%	1%	3%	5%	7%	11%	15%	20%	26%	32%
Fertilizer spreader	3%	8%	13%	19%	26%	32%	40%	47%	55%	63%
	200	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000
Boom-type sprayer	5%	12%	21%	31%	41%	52%	63%	76%	88%	101%
Air-carrier sprayer	2%	5%	9%	14%	20%	27%	34%	42%	51%	61%
Bean puller-windrower	2%	5%	9%	14%	20%	27%	34%	42%	51%	61%
Stalk chopper	3%	8%	14%	20%	28%	36%	45%	54%	64%	74%
Forage blower	1%	4%	9%	15%	22%	31%	40%	51%	63%	77%
Wagon	1%	4%	7%	11%	16%	21%	27%	34%	41%	49%
Forage wagon	2%	6%	10%	14%	19%	24%	29%	35%	41%	47%

The values in Table 3 show the relationship between the sum of all repair costs for a machine and the total hours of use during its lifetime, based on historical repair data. The total accumulated repair costs are calculated as a percent of the current list price of the machine, since repair and maintenance costs usually change at about the same rate as new list prices.

Figure 1. Accumulated repair costs for two-wheel drive tractor.

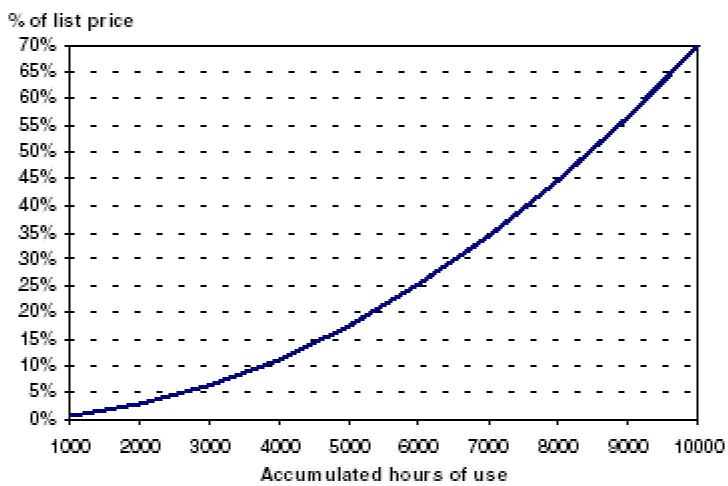

Figure 1 shows how repair costs accumulate for two-wheel drive tractors. Notice the shape of the graph. The slope of the curve increases as the number of hours of use increases. This indicates that repair costs are low early in the life of a machine, but increase rapidly as the machine accumulates more hours of operation.

Because the tractor in the example will be used about 400 hours per year, it will have accumulated about 6,000 hours of operation by the end of its 15-year economic life (400 hours x 15 years = 6,000 hours). According to Table 3, after 6,000 hours of use, total accumulated repair costs will be equal to about 25 percent of its new list price. So, total accumulated repairs can be estimated to be:

Accumulated repairs = 0.25 x $110,000
= $27,500

The average repair cost per hour can be calculated by dividing the total accumulated repair cost by the total accumulated hours:

Repair cost/hour= $27,500 / 6,000 hours
= $4.58/hour

Fuel

Fuel costs can be estimated in two ways. *Information File* **Fuel Required for Field Operations** lists average fuel use in gallons per acre for many field operations. Those figures can be multiplied by the fuel cost per gallon to calculate the average fuel cost per acre.

For example, if the average amount of diesel fuel required to harvest an acre of corn silage is 3.25 gallons, at a cost of $1.00 per gallon, then the average fuel cost per acre is $3.25.

Average fuel consumption (in gallons per hour) for farm tractors on a year-round basis without reference to any specific implement can also be estimated with these equations:

0.060 x maximum PTO horsepower for gasoline engines
0.044 x maximum PTO horsepower for diesel engines

For our 180-horsepower diesel tractor example:

Average diesel fuel consumption =
0.044 x 180 horsepower = 7.92 gallons/hour

Average fuel cost per hour =
7.92 gallons/hour x $1.00/gallon = $7.92/hour

Lubrication

Surveys indicate that total lubrication costs on most farms average about 15 percent of fuel costs. Therefore, once the fuel cost per hour has been estimated, you can multiply it by 0.15 to estimate total lubrication costs.

For our tractor example, average fuel cost was $7.92 per hour, so average lubrication cost would be:

Lubrication = 0.15 x $7.92 = $1.19/hour

Labor

Because different size machines require different quantities of labor to accomplish such tasks as planting or harvesting, it is important to consider labor costs in machinery analysis. Labor cost is also an important consideration in comparing ownership to custom hiring.

Actual hours of labor usually exceed field machine time by 10 to 20 percent, because of travel and the time required to lubricate and service machines. Consequently, labor costs can be estimated by multiplying the labor wage rate times 1.1 or 1.2. Using a labor value of $10.00 per hour for our tractor example:

Labor cost per hour = $10.00 x 1.1= $11.00

Different wage rates can be used for operations requiring different levels of operator skill.

Total operating cost

Repair, fuel, lubrication and labor costs are added to calculate total operating cost. For the tractor example, total operating cost was $24.69 per hour:

Total operating cost =
$4.58 + $7.92 + $1.19 + $11.00 =
$24.69 per hour

Total cost

After all costs have been estimated, the total ownership cost per year can be added to the operating cost per hour to calculate total cost per hour to own and operate the machine. Total cost per hour for our example tractor was:

Total cost = $21.87 + $24.69=
$46.56 per hour

Implement costs

Costs for implements or attachments that depend on tractor power are estimated in the same way as the example tractor, except that there are no fuel, lubrication, or labor costs involved.

Used Machinery

Costs for used machinery can be estimated by using the same procedure shown for new machinery. However, the fixed costs will usually be lower because the original cost of the machine will be lower. And repair costs will usually be higher because of the greater hours of accumulated use. Therefore, the secret to successful used machinery economics is to balance higher hourly repair costs against lower hourly fixed costs. If you misjudge the condition of the machine such that your repair costs are higher than you anticipated, or if you pay too high a price for the machine so that your fixed costs are not as low as you anticipated, the total hourly costs of a used machine may be as high or higher than those of a new machine. See *Information File* **Buying Used Machinery** for more information.

As an example of estimating costs for a used machine, assume you just bought a 28-foot tandem disk that was 6 years old for $11,000. It appeared to be clean and in good mechanical condition. Since you do not know for sure how many hours of accumulated use it has, you can estimate by multiplying its age (6 years) by your own expected annual use (100 hours per year), or 600 hours.

What is the estimated total cost of the disk over the next 8 years? From Table 1, the expected salvage value at the end of 13 years is 24 percent of the current list price of an equivalent machine (estimated to be $30,000), or $7,200.

The capital recovery factor for 8 years and a 5 percent real interest rate is .155 (Table 2). Capital recovery costs are:

Capital recovery= .155 x ($11,000 - $7,200) + ($7,200 x .05)
= $589 + $360
= $949 per year.

For taxes, insurance and housing:

TIH = 0.01 x $11,000
= $110 per year

Total fixed costs = $949 + $110
= $1,059 per year

If the disk is used an average of 100 hours per year:

Ownership cost/hour = $1,059 / 100 hours
= $10.59 per hour.

To estimate average repair costs, use Table 3. If you intend to keep this disk for 8 more years, the accumulated hours of use after that time will be:

Accumulated hours = 600 + (100 hours/yr x 8 years) = 1,400 hours

Now, using Table 3, note that the accumulated repair cost for a tandem disk after 600 hours is 8 percent of the new list price. After 1,400 hours it is estimated at 32 percent. Thus, the accumulated costs from 600 to 1,400 hours can be estimated at 32 percent minus 8 percent, or 24 percent of the new list price. If the list price for a 28-foot tandem disk is $30,000, the repair costs for the next 8 years are estimated to be:

Repair costs =.24 x $30,000 = $7,200

The repair cost per hour is estimated to be:

Repair cost per hour = $7,200 / (1,400 - 600) hours
= $7,200 / 800 hours
= $9.00 per hour

Other variable costs, such as fuel, lubrication, and labor, have already been included in the variable costs for the tractor, so the total cost per hour for the disk is simply the sum of the ownership costs per hour and the repair costs per hour:

Total cost= $10.59 + $9.00 = $19.59 per hour.

When estimating future costs for a machine that you have already owned for several years, start with your best estimate of the current market value of the machine instead of its original purchase price, or use the salvage value factors in Table 1 to estimate its current value.

Total Costs per Operation

Tractor costs must be added to the implement costs to determine the combined total cost per hour of operating the machine. Total costs in the example are:

Total cost = $46.56 + 19.59 = $66.15 per hour

Finally, total cost per hour can be divided by the hourly work rate in acres per hour or tons per hour to calculate the total cost per acre or per ton.

The hourly work rate or field capacity of an implement or self-propelled machine can be estimated from the effective width of the machine (in feet), its speed across the field (in miles per hour), and its field efficiency (in percent). The field efficiency is a factor that adjusts for time lost due to turning at the end of the field, overlapping, making adjustments to the machine, and filling or emptying tanks and hoppers.

Field capacity (in acres per hour) is calculated by:

(width x speed x field efficiency) / 8.25

For example, if the 28-foot disk can be pulled at 6.0 miles per hour with a field efficiency of 79 percent, the estimated field capacity is:

Field capacity = (28 x 6.0 x 79%) / 8.25
= 16 acres per hour

Information File **Estimating Field Capacity of Farm Machines**, has typical accomplishment rates for different types and sizes of farm machines.

If the 28-foot disk in the example can cover 16 acres per hour, the total cost per acre for disking is:

Total cost per acre = $66.15 / 16 acres
= $4.13 per acre.

Costs for operations involving self-propelled machines can be calculated by treating the self-propelled unit as a power unit, and the harvesting head or other attachment as an implement.

Income Tax Considerations

The tax treatment of different methods of acquiring machine services is a major factor in evaluating machine costs. If a machine is purchased, all variable expenses except unpaid labor are deductible when determining income tax liability. Housing expenses, taxes, insurance, and interest payments made on a loan to finance the machine purchase are also tax deductible.

Depreciation for tax purposes is calculated quite differently from economic depreciation due to the actual decline in value of a machine. Tax depreciation methods reduce salvage value to zero after a few years for most machines. Tax depreciation expense is useful for calculating the tax savings that result from a machinery purchase, but should not be used to estimate true economic costs.

Specific rules and regulations on deductible costs and depreciation are discussed in the *Farmer's Tax Guide*, published by the Internal Revenue Service.