Putting together an ideal machinery system is not easy. Equipment that works best one year may not work well the next because of changes in weather conditions or crop production practices. Improvements in design may make older equipment obsolete. And, the number of acres being farmed or the amount of labor available may change.

Because many of these variables are unpredictable, the goal of the good machinery manager should be to have a system that is flexible enough to adapt to a range of weather and crop conditions while minimizing long-run costs and production risks. To meet these goals several fundamental questions must be answered.

**Machine Performance**
First, each piece of machinery must perform reliably under a variety of field conditions or it is a poor investment regardless of its cost.

Tillage implements should prepare a satisfactory seedbed while conserving moisture, destroying early weed growth, and minimizing erosion potential. Planters and seeders should provide consistent seed placement and population as well as properly apply pesticides and fertilizers. Harvesting equipment must harvest clean, undamaged grain while minimizing field losses.

The performance of a machine often depends on the skill of the operator, or on weather and soil conditions. Nevertheless, differences among machines can be evaluated through field trials, research reports, and personal experience.

**Machinery Costs**
Once a particular type of tillage, planting, weed control, or harvesting machine has been selected, the question of how to minimize machinery costs must be answered. Machinery that is too large for a particular farming situation will cause machinery costs to be unnecessarily high over the long run. On the other hand, machinery that is too small may result in lower crop yields or reduced quality.

**Ownership Costs**
Machinery ownership costs include charges for depreciation, interest on investment, property taxes, insurance, and machinery housing. These costs increase in direct proportion to machinery investment and size.

**Operating Costs**
Operating costs include fuel, lubricants, and repairs. Operating costs per acre change very little as machinery size is increased or decreased. Using larger machinery consumes more fuel and lubricants per hour, but this is essentially offset by the fact that more acres are covered per hour. Much the same is true of repair costs. Thus, operating costs are of minor importance when deciding what size machinery is best suited to a certain farming operation.

A detailed procedure for estimating machinery ownership and operating costs can be found in *Estimating Farm Machinery Costs*.

**Labor Cost**
As machinery capacity increases, the number of hours required to complete field operations over a given area naturally declines. Estimates of time requirements for completing machinery operations are found in *Estimating the Field Capacity of Farm Machines*.

If hourly or part-time hired labor operates machinery, it is appropriate to use the wage rate paid, plus the cost of any other benefits which may be provided, as the labor cost. If the farmer-owner or a hired worker who is paid a fixed wage operates machinery, then it is proper to value labor at its...
opportunity cost, or the estimated return it could earn if it were used elsewhere in the farm business, such as in livestock enterprises.

**Timeliness Costs**
In many cases, crop yields and quality are affected by the dates of planting and harvesting. This represents a “hidden” cost associated with farm machinery, but an important one nevertheless. The value of these yield losses is commonly referred to as “timeliness costs.”

**Total Machinery Costs**
Figure 1 illustrates the effect that changes in machinery size have on each type of cost in a typical situation. For very small machinery (relative to crop acres), a slight increase in machinery size can lower timeliness and labor costs significantly, enough to more than offset the higher fixed costs. However, as machinery size continues to increase, the timeliness cost savings diminish, and eventually total costs begin to rise. One objective of machinery selection, then, is to select machinery in the size range where total machinery costs are lowest.

**Figure 1. Effect of increasing machinery size on machinery costs.**

![Figure 1. Effect of increasing machinery size on machinery costs.](image)

**Figure 2. Estimated corn yield as percent of maximum, by planting date.**

![Figure 2. Estimated corn yield as percent of maximum, by planting date.](image)

Source: Pm1155, Replanting or Late Planting Decisions with Corn and Soybeans.

**Planting and Harvesting Dates**
Long-term studies indicate that corn yields typically start to decline significantly when planting occurs after May 10 to 14, as shown in Figure 2. The exact dates will vary from year to year. About 50 percent of Iowa’s corn is normally planted by this time. One reason for the decline in yield for late-planted corn is that fewer “heat units” are available during the growing season, and this influences the rate of crop development.

How early to start planting requires considerable judgment. Ideal conditions would be a soil temperature of 50°F (10°C) or above at planting depth and a favorable 5-day weather forecast. In most of Iowa, if soil conditions and temperatures are favorable, starting to plant the last 10 days of April should be advantageous. In May, the major consideration should be the condition of the seedbed.

There is some risk with early planting. Replanting may occasionally be required, but the long-term benefits far outweigh this cost. An added benefit from early-planted corn is lower grain moisture levels at harvest and reduced drying costs.
Most of the same things can be said about planting soybean varieties. The ideal time for planting adapted soybean varieties is between May 1 and May 15. Yields can be expected to decline in most years if planting occurs after about May 20, as Figure 3 shows.

Timeliness losses at harvest are due primarily to more dropped ears, field shattering, and cracked beans. These losses must be balanced against the cost of artificially drying grain harvested at a moisture level higher than that required for safe storage. Some harvesting losses occur because combining speed is too high or the machine is poorly adjusted.

**Factors That Affect the Size of Machinery Needed**

Machinery recommendations must be based on the characteristics of each individual farm. The following factors influence machinery selection, and are discussed in order of importance.

**Number of Crop Acres**

As more crop acres are farmed, larger-scale machinery is needed to ensure that planting and harvesting are completed in a timely fashion. An alternative is to acquire a second unit of some machines, if an additional tractor and operator are available.

**Labor Supply**

The number of acres that can be completed each day is the most critical measure of machinery capacity than are machine width or acres completed per hour. Increasing the labor supply by hiring extra operators or by working longer hours during critical periods may be a relatively inexpensive way of stretching machinery capacity. In addition, the cost of additional labor only needs to be incurred in those years in which it is actually used, while the cost of investing in larger machinery becomes “locked in” as soon as the investment is made. On the other hand, extra labor may not always be available when needed, and working long hours over several days can present a safety hazard.

**Tillage Practices**

The number of field days needed before planting is completed depends partly on the number of separate operations completed on each acre. Reducing the number of tillage practices performed or performing more than one practice in the same trip effectively decreases the amount of machinery capacity needed to complete field operations on time. Of course, machinery cost savings from reduced tillage must be compared to possible increased chemical costs and effects on yields.

**Crop Mix**

Diversification of crops tends to spread out the periods when timely completion of field operations is critical. For example, yield reductions due to late planting begin later for soybeans than for corn. Harvesting can also be completed over a longer time period. Thus, growing more than one or two crops reduces the machinery capacity needed for a given number of crop acres. However, it may also require purchasing additional types of machinery, especially for harvesting.

**Weather**

Weather patterns determine the number of days suitable for fieldwork in a given time period each year. Although actual weather conditions cannot be predicted far enough in advance to be used as an aid to machinery selection, past weather records can be
used as a guide. Decision File *Fieldwork Days in Iowa* lists the number of suitable field days expected for different periods of the year in each of the 9 crop reporting districts in Iowa. As a rule of thumb, weather is suitable for field work about 60 percent of the time in the spring and about 75 percent of the time in the fall. This does not take into account time off for holidays, Sundays, or other occasions. Machinery selection should be based on long-run weather patterns even though it results in excess machinery capacity in some years and insufficient capacity in other years.

**Risk Management**

Fluctuations in the number and occurrence of suitable field days from year to year cause timeliness costs to vary even when the machinery set, number of crop acres, and labor supply do not change. Investing in larger machinery can reduce the variability of net machinery costs by ensuring that crops are planted and harvested on time even in years in which there are few good working days. Machinery fixed costs would be higher with larger machinery, but they would not fluctuate as long as the machinery set did not change. Farmers with high fixed cash flow needs, such as land mortgage payments, may be willing to pay more (in higher fixed machinery costs) than other operators for the “insurance” of not suffering substantial yield losses due to late planting and harvesting in certain years.

**How Large Should Machinery Be?**

One way to measure the capacity of a set of machinery is by the number of work days required to complete field operations. This depends on the number of crop acres, machinery operations performed, size of the machinery in use, and availability of labor.

In research conducted recently at ISU, total machinery costs for Iowa grain farms, including the value of timeliness losses, were estimated for a number of different machinery combinations. The effects of variations in the number of crop acres and labor supply, were compared.

Under each set of circumstances the machinery set for which total costs including yield losses due to poor timeliness, were lowest was identified. In some cases, several machinery sets gave nearly identical minimum costs. In approximately 80 percent of the cases tested, the least-cost machinery sets were able to complete all tillage and planting operations in about 20 to 25 field days. A good rule of thumb for farmers who wish to have sufficient machinery capacity to reduce risk, as well as maintain total costs at a low level, is to be able to complete tillage and planting in about 20 field days.

Where less than one full-time person is available to operate machinery, a goal of 25 to 30 days for completing planting and tillage will most often minimize costs. On the other hand, farms with 2 or 3 full-time machinery operators available could aim to complete this work in less than 20 days.

The machinery sets which minimized total machinery costs were most often able to complete harvesting of corn and soybeans in 25 to 30 field days. As with spring work, operators for whom risk reduction is important should use the lower end of this range as a goal, although yield losses from late harvesting are generally not as severe as from late planting.

A number of different machinery combinations may allow fieldwork to be completed in the same number of days. In putting together a machinery set, it is also important to correctly match machinery sizes and tractor power. Using tractors with horsepower in excess of that required for the implement being pulled results in excessive depreciation and interest costs, while using too little horsepower may cause faster engine wearout.

Some farms may not have enough crop acres to justify owning a full line of machinery, particularly for harvesting. Custom hiring or leasing certain machinery operations may lower total costs as well as provide more flexibility in the amount of machinery capacity. For a detailed discussion of custom hiring, leasing, and renting farm machinery see Decision Files, *Combine Ownership or Custom Hire* and *Acquiring Farm Machinery Services.*