AGRICULTURAL EQUIPMENT: CHOICE AND OPERATION

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Summary

The proper choice and use of equipment is very important for the efficient production of much needed food and fiber. Agriculturalists obtain access to equipment from manufacturers and distribution systems in a variety of ways. Usage costs include both fixed and variable components. Machinery should be selected and operated in a manner such that it is compatible with the crop production system and the other machinery, while maximizing productivity. Automation, especially through the use of electronics has aided the selection and use of agricultural machinery.

1. Importance of Agricultural Equipment Choice and Operation

Other articles in this encyclopedia describe the great need for food, economic development, and environmental protection. Due to requirements to produce adequate amounts of food or fiber, to produce high quality food, to protect the environment, or to release labor for other needs, agricultural equipment is required in all but the least-developed societies. The need for the equipment is widely accepted, but the questions as to how much equipment, what its characteristics should be, and how it should be used do not have obvious answers. Although there are some general principles which can be

applied widely, the results of the application of those principles depends greatly upon local situations. The purpose of this article is to identify some of the concepts of equipment choice and operation.

This subject area is often referred to by equipment specialists as machinery management. Because equipment costs are very significant in most agricultural production systems and because the performance and efficiency of the production systems are greatly affected by the machinery selected and its operation, this is a very important topic in agriculture. Machinery management generally has not received the attention it deserves. The equipment manufacturers generally produce individual items which are sold on the basis of price or individual item theoretical productivity. Some analyses have been done in governmental and educational institutions, and this is the basis for the limited published literature in the field.

Agricultural equipment is used in all types of agricultural production systems. The amount and type of equipment varies widely based upon geographic area, economic factors, and the particular plant or animal being raised. Although the concepts discussed can be applied to a wide variety of plant or animal systems, the focus will be on field crops for ease of exposition. Cereal crops will be used for most of the examples due to their importance in the global food system.

2. Methods of Obtaining Access to Equipment

The agricultural equipment industry is very large as its products are needed in every country and region of the world. The industry itself is diverse. The manufacturers can be classified by the extent of their market as being multinational, regional, or local.

The multinational manufacturers sell their equipment on a global basis. The larger firms produce billions of US dollars worth of equipment annually. They utilize the latest technological advances in both design and manufacturing and often have manufacturing facilities on several continents. The products sold in different countries are often identical, although some customization may be made for local markets. And the relative sales volumes of particular products will change greatly from region to region. For example, one tractor manufacturer produces large tractors in North America, medium tractors in Europe, and small tractors in Asia. Although they are willing to sell any size on any continent, this manufacturing concentration reduces transportation by locating the manufacture in the regions of greatest use. Another strategy is to produce the product in different countries to insulate the production from political, social, or economic upheavals or to reduce tariffs and taxation.

Regional manufacturers may produce either for a region of a country or for a continental region including several smaller countries. They effectively compete with the multinationals by offering a product designed and manufactured for the specific local conditions. They often have lower fiscal overheads. Their products tend to be of moderate technical sophistication. Many such companies are successful producing equipment for horticultural and specialty crops in which there is insufficient global market for the multinationals to be interested. Others produce machinery especially suited for regional cultural practices or soils.

Local manufacturers produce machines for a small geographic region, generally within a single country. A small fraction of the local manufacturers in developed countries produce technologically sophisticated machines for high value crops. But most local manufacturers produce less sophisticated machines. Some manufacturers in economically-depressed areas provide a product at a price which is substantially less than the machines of the larger manufacturers.

Some farmers buy their agricultural equipment direct from the manufacturers. However, this generally occurs only when the farmer is very large or the manufacturer is small. In the frequent case when the manufacturer is relatively large and distant, the more common mode is for the farmer to purchase the equipment from a dealer. The dealer helps the farmer with equipment selection, arranges the equipment's transportation to the farm, and supplies service and repairs. Some dealers only sell one manufacturer's products while others are multi-line. The quality of the dealership organization can greatly affect the success of a farm equipment manufacturer. There may also be distributors or other intermediaries between the manufacturer and the dealers, especially if the manufacturer is in another country.

Most farmers obtain equipment to use by purchasing it from the dealer or the manufacturer. If the farmers are sufficiently wealthy, even expensive machinery may be purchased with cash money. However, most of the time farmers need to obtain a loan in order to have sufficient funds to purchase even moderately expensive equipment. The loan is obtained from a bank, a specialized finance company, or the manufacturer itself in developed countries. Some manufacturers sometimes make more profit from financing than manufacturing. Governmental and non-governmental organizations (NGOs) often provide the financing, and even subsidies, in less-developed countries in the hope of boosting food production and the local rural economy through increased mechanization.

Agricultural machinery is often subject to joint ownership when individual farmers do not have sufficient use or sufficient capital to have individual machines. In many cases, the ownership is shared between family members or neighbors. Assuming an appropriate fair sharing relationship can be established, this allows the farmers to have access to larger or more technologically advanced machines at a lower cost. Sometimes machinery is owned by a formal organization such as a farmer co-operative or company.

Farmers also often obtain the use of equipment by renting or leasing from either a manufacturer, dealer, or specialized leasing company. This allows the farmer to obtain the latest equipment without having to make a large capital investment or loan. Rental tends to be more advantageous than purchase when there is low annual use, a need to defer capital expenditure, uncertainty of future needs, or a need for additional capacity to eliminate a particular timeliness problem.

Sometimes farmers get the use of a machine by hiring a firm to provide the machines and the operators to perform a specific operation. This is especially frequently done with expensive harvesting machines. Historically, such contracting was especially popular with large harvesting machines. But contracting now appears to be becoming more popular for other machines also.

3. Equipment Costs

The use of equipment obviously involves substantial financial costs. The accurate assessment of these costs is of great concern when making acquisition and operation decisions. These costs vary with the above different methods of obtaining access, and with the local political, social, and economic conditions. Interest, inflation and fuel prices are particularly affected by local conditions. They also vary with the agronomic or horticultural conditions. For example, abrasive soils may accelerate wear and increase the need for repair.

The costs of equipment ownership and use are usually divided into fixed and variable categories. The fixed costs are those which remain the same on a yearly basis regardless of the amount of use of the equipment. Variable costs are those costs which are treated as being approximately linearly proportional to the amount of use.

The greatest fixed cost is depreciation, the decrease in value of the machine as it ages. However, the value of a piece of agricultural equipment is somewhat affected by the amount and type of use it is subjected to. Most agricultural equipment will become technologically obsolete before it wears out because the annual usage is relatively low, often due to short seasons for particular field operations. So it is now common to treat depreciation as fixed, rather than variable. The calculation of depreciation is done by various methods. Straight-line, the simplest and most common method, divides the decrease in value (purchase cost minus sale price at end of life) by the number of years of life to obtain an average loss of value per year. Unfortunately, straight-line depreciation does not accurately reflect the instantaneous value of the equipment on the commercial market. As soon as a machine is not new, it has a dramatic drop in value. As it ages, the rate at which the value drops tends to decrease. There are a variety of methods, such as sum-of-the-digits and declining balance, to mathematically model these decreases in value. In times of high inflation, the value of a piece of equipment may increase in the nominal currency. However, such equipment should not be viewed as a profit-making investment since its value will usually decline relative to other commodities and its replacement. Care must be taken to properly mathematically account for the inevitable depreciation during analyses in such times.

Since much equipment is purchased with loans, interest is another significant fixed cost. Even if a piece of equipment is purchased with the farmer's available funds, a charge should be made against the equipment for the lost opportunity cost. That is, the capital used to buy the equipment could have generated funds if it was alternatively invested.

Shelter and insurance are usually necessary to protect the equipment and the capital it represents. Since these are constant regardless of use, they are again fixed costs.

Fuel is an obvious variable cost. The more a machine is used, the more fuel it consumes. Fuel efficiencies of tractors and engines can be obtained from test results or measurements during operation. The fuel cost depends upon the fuel consumed and the unit cost of the fuel. The most efficient tractors can now achieve about four kilowatt-hours per liter of diesel fuel under certain conditions. Unit costs of fuels vary widely depending upon fuel availability and government policies. Lubricant costs are also

treated as variable, although in very low usage conditions it would more properly be modeled as being a fixed cost. One model treats lubricants as being 15% of the fuel cost. Although oil changes are scheduled and hence their cost can be predicted, that model gives sufficient accuracy because lubricants represent a minor cost.

Repairs and maintenance are also treated as variable costs. The more the equipment is used, the more repairs and maintenance that are required. Usually the repair and maintenance cost is expressed as a percentage of the purchase price of the machine, depending upon the type of the machine. Unfortunately, this does not account for the inevitable huge differences in local operating conditions. In addition, the cost of repairs and maintenance is not constant over the life of a machine. When the machine is new, the repair costs will be very low. The repair cost rate will gradually increase until it is more economical to replace the machine rather than to constantly repair it. The total maintenance and repair cost over the life of a piece of agricultural equipment is typically about the same magnitude as the initial purchase price, although as little as ten percent may be expended in the first quarter of the equipment's life.

Since the other costs remain relatively constant, the depreciation and repair costs determine the most economical point at which to replace machinery. A machine should be kept until the average yearly cost starts to increase because the increases in repair cost exceed the decreases in average depreciation. Of course, this assumes that other reasons to replace a machine (such as lack of reliability, technological obsolescence, or need for a different size or type) have not already caused a replacement to be made. These other reasons are relevant and need to be considered. It should also again be stressed that the goal is to maximize overall farm profitability rather than minimizing equipment costs. As a consequence, successful farms often have what erroneously appears to be excess machinery to improve reliability and reduce timeliness costs.

Labor is also usually considered a variable cost. Agricultural equipment usually requires at least one operator. So the labor, along with the value of the labor’s fringe benefits (retirement, healthcare insurance, etc.), should be properly accounted for. The inclusion of labor and fuel costs in analyzing an operation using equipment allows it to be financially compared to an operation without equipment. The above discussions indicate the importance of yearly usage. Fixed costs are significant and most agricultural equipment is used for only a short period of time each year. Many tractors receive only three hundred to four hundred hours of use per year. Other equipment and implements often receive much less during short tillage, planting, pest control, and harvesting seasons. The hourly fixed cost can be significantly reduced if the equipment can be given more usage. This is one of the factors which favors equipment sharing and contracting.

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Biographical Sketch

John K. Schueller is Professor of Mechanical Engineering and an Affiliate Professor of Agricultural and Biological Engineering at the University of Florida. He has received his BSME degree from Marquette University and his MSE and Ph.D. degrees from Purdue University. He taught engineering and agriculture courses at Purdue University, Texas A&M University, and the University of Florida. His private sector involvements include employment at a dairy-grain-vegetable farm, a lawn and garden equipment manufacturer, and with Caterpillar. Dr. Schueller is an active member of the American Society of Agricultural Engineers, the American Society of Mechanical Engineers, the American Society for Engineering Education, the Society of Automotive Engineers, the Society of Manufacturing Engineers, the European Society of Agricultural Engineers, the International Commission of Agricultural Engineering, and the Club of Bologna. He has had technical travels to Australia, Brazil, Canada, France, Germany, India, Italy, Mexico, Netherlands, Sweden, and the U.K. John Schueller is known for his expertise in the engineering of mobile agricultural equipment. He was one of the early developers of spatially-variable crop production.