APPENDIX 1: MACHINERY OPERATING COST ESTIMATES

Introduction: The types of machinery costs that need to be estimated depend on the decision facing a farm manager. If a farm manager has an existing, serviceable machinery complement, the operating costs are important in decisions concerning enterprise profitability. For cash flow considerations, operating costs and fixed costs (such as personal property taxes and insurance) are important. For longer term decisions such as a substantial shift in rotation that would require a major change in the machinery complement, both operating and ownership costs enter the decision framework to select the most profitable alternative.

For the estimates of per acre production costs used in this special report, operating costs are of explicit concern. Machinery operating costs are the summations of separate estimates for fuel, oil and lubrication, and repairs for self-propelled machines. For machinery that is not self-propelled, operating costs are equal to repair costs.

Operating costs would likely be more accurate if they were based on the records of an individual farm operation. However, for the majority of farms, records of fuel, oil and lubricants, and machine repair costs are likely recorded at the whole-farm level and not separated by machine or by enterprise. In the absence of farm records from which to derive machinery operating costs, such costs are estimated using economic engineering equations.

Per acre machinery fuel cost estimates require information on the type of fuel, fuel use per hour, price of fuel, and acres per hour of machine use. Per acre oil and lubricant costs are estimated as a proportion of per acre fuel costs. Per acre machinery repair costs are estimated using list prices for machines, repair cost factors, the useful life of machines in hours, and the acres covered per hour of machine use. The sum of these individual cost components constitute machinery operating costs per hour for an individual machine.

Equations for Components of Machinery Operating Costs: Equations are presented to estimate each component of machinery operating cost.

Per Acre Fuel Costs--Fuel costs will enter most management decisions related to self-propelled machinery and power units such as tractors. Fuel costs for self-propelled farm machinery and power units are estimated using two equations. These are:

1. Per acre fuel cost = (fuel price per gallon) x (gallons of fuel used per acre)

2a. Gallons of diesel per acre = (0.044) x (maximum horsepower) x (hours used per acre)

2b. Gallons of gasoline per acre = (0.06) x (maximum horsepower) x (hours used per acre)

Oil and Lubrication Costs--Oil and lubrication costs enter into most managerial decisions that involve self-propelled machinery and equipment. A single equation is required for this estimate. It is:

1. Per acre fuel and lubrication cost = (0.15) or (0.10) x (per acre fuel cost)

The factor 0.15 is applicable to diesel-powered equipment. A factor 0.10 is applicable to gas-powered machinery.

Machinery Repair Costs--Repair costs enter into most machinery and equipment management decisions. Repair costs refer to more than just major overhauls. Belts, bearings, batteries, tires and other replacements are part of repair costs. Repair costs for an individual machine used in the production of a particular crop generally need to be estimated through the use of a single equation. It is:

1. Per acre repair cost =

$$\frac{\text{(list price of the machine) x (repair cost factor) x (hours used per acre)}}{\text{(hours of useful life of the machine)}}$$

The list price of the machine is its price as a new machine without any discounts or trade-in considerations. In this study the list values of machines were obtained by conferring with machinery dealers in the production area.

Repair cost factors are estimated through engineering trials for tractors and machinery. As examples, the repair cost factors for a 4-wheel drive tractor and a self-propelled combine are 1.00 and 0.60, respectively. These engineering estimates anticipate that over the useful life of a 4-wheel drive tractor a farm manager will spend an amount for repairs equal to the list price of the tractor and over the life of the combine will spend 60 percent of its list price in repairs. These repair costs assume that repairs are done in off-farm repair shops with the prevailing local shop rates charged for the labor.

The useful life of machinery is also estimated through engineering trials for tractors and machinery. For example, the estimated useful life of a 4-wheel tractor is 12,000 hours and the estimated useful life of a self-propelled combine is 2,000 hours. These estimates of useful life assume a consistent pattern of repairs.

For production cost budgets, machinery operating costs are reported by intervals within the cropping season rather than by individual machine. Machinery operating costs are summarized as: preplant till and seeding; fertilizer application; pesticide application; and harvesting, including trucking.

APPENDIX 2: INTEREST ON OPERATING COSTS

Survey respondents were not asked to provide financial information, as it was anticipated that questions addressing their financial situations would be extremely sensitive and perhaps result in some of them not providing cropping practice information. As a consequence, interest on operating costs were calculated using an interest rate of nine percent over a period in which such costs are usually incurred.

For winter wheat, interest on operating costs was estimated as follows:

$$\text{Interest on operating costs} = 12 \text{ months} \times \frac{0.09}{12} \times 3\,\frac{\$\text{operating costs}}{2}$$

For spring wheat, durum wheat, and barley the interest on operating costs was estimated as follows:

$$\text{Interest on operating costs} = 6 \text{ months} \times \frac{0.09}{12} \times 3\,\frac{\$\text{operating costs}}{2}$$

For fallow, interest charge on operating costs was estimated as follows:

$$\text{Interest in the year fallowed} = 12 \text{ months} \times \frac{0.09}{12} \times 3\,\frac{\$\text{operating costs}}{2}$$

$$\text{Interest in the crop year} = 12 \text{ months} \times \frac{0.09}{12} \times 3\,\$ \text{ operating costs} + \text{fallow year interest}$$

The cost of production budgets for each crop includes a line itemized as *interest on operating capital.* Interest costs for each crop are entered on this line.

Interest on fallow is included in the entry for the line itemized as *fallow operating costs, including interest.* The entry in this line is the summation of the fallow operating costs and interest on fallow operating costs in the year fallowed plus interest on fallow operating costs for the year the acre is in a crop.

It is recognized that interest in the fallow year could be overstated if no fallow activities occurred in the fall after the harvesting of a crop, i.e., the operating capital would be used for fewer months if all fallow passes were conducted in the spring and summer seasons.

APPENDIX 3: OWNERSHIP COSTS

Ownership costs for machinery and buildings include the opportunity costs on investment, insurance and personal or real property taxes and deprecation. For the land resource the ownership costs are primarily opportunity costs on the land investment and real property taxes.

There are also costs associated with family-supplied inputs including family labor and management. The appropriate measures for such family-supplied resources are their respective opportunity costs. Opportunity costs are derived by determining the value of each resource would be in its next best use. For instance, if a family member can either operate a combine or net $11.50 per hour from an off-farm job, the opportunity cost of that family member's labor for operating the combine would be $11.50 per hour.

There are several ways to estimate ownership costs. For instance, to determine the opportunity cost on investments, it is possible to elicit the values of resources such as land and machinery and apply an interest rate to determine the opportunity cost on investment. But the valuation of these resources is problematic. Likewise, for each operator there would have to be an assessment of the opportunity costs associated with their labor and management utilized on the farm. Explicit identification of the opportunity costs for labor and management requires that farm operators have intimate knowledge of their employment opportunities in relevant markets. Such a direct approach to estimating ownership costs is fraught with procedural difficulties. As a consequence, many studies use residual returns above operating costs as the returns to capital and family labor and management.

A proxy of the opportunity costs for capital and family labor and management is provided by the market in the form of revenues which could have been received per acre for enrolling annually planted cropland in the Conservation Revenue Program. Montana CRP participants have generally followed a bidding strategy whereby they submit bids for participation that are break-even bids relative to the next best use for the bundle of resources that would be idled through CRP program participation. (The bidding procedure is described in an article written by James B. Johnson and Richard T. Clark entitled *How some potential CRP participants were taught to bid and ensuing land market distortions* that appeared in the Journal of Soil and Water Conservation, Volume 44, Number 5 in September-October 1989). By program requirement, the resources to be idled through CRP participation had to have a history of being in annually-planted crop production in the five years prior to program participation. Therefore, the next best use of those resources idled through CRP participation was defined by the program's implementation rules as annually-planted crop production.

Nonetheless, several concerns exist about using these CRP payments as proxies for the opportunity costs associated with the bundle of fixed and quasi-fixed resources devoted to crop production. One concern is that cropland enrolled in CRP may have been less productive than cropland that continued to be used in crop production. Survey data previously collected from Montana farm operators indicates that, on average, the per acre wheat yields for cropland enrolled in CRP were 90 percent of those on cropland that was maintained in crop production. Another concern is that some of the early bids were made over a decade ago and may not reflect current opportunity costs for the resources in the bundle of resources idled. However, it should be recognized that the bidding process that most Montana producers explicitly and/or implicitly employed allowed for increases in net returns over the 10-year CRP contract periods and took into account the time value of money. A third concern is that a bundle of resources may not have been idled when cropland was enrolled in CRP. However, empirical evidence obtained from CRP contract holders indicates that few of them had re-employed idled resources in other endeavors subsequent to CRP enrollment nor had they leased or purchased additional cropland. Only 13 percent of those with whole-farm enrollments, who constituted less than 20 percent of total enrollment in cropland in CRP, reported any immediate liquidation of their farm machinery (for more information on the disposition of resource refer to *The Conservation Reserve Program in Montana: A Descriptive Analysis of Farms with CRP Contracts,* Extension Bulletin 57, Montana State University Extension Service).

The average of the CRP rental rates for sign-up periods 1 through 12 were used as the proxies for this study. For example, a farm observation in Sheridan County would have assigned as the proxy for ownership costs for a crop produced under recrop conditions the county-average CRP rental rate. On the same farm, for crops produced after fallow, the proxy for ownership costs would be twice the county-average CRP rental rate to reflect that the bundle of resource idled were associated with two acres of cropland.

The ownership costs included in the MLRA-level average budgets for each crop reflect the simple average of the ownership costs assigned to the individual observations for that crop within the MLRA. For example, the ownership cost per acre for spring wheat produced after fallow for the MLRA is the simple average of the ownership costs for all farms reporting spring wheat after fallow in the MLRA.

APPENDIX 4: FALLOW COSTS

For the determination of fallow operating costs, the continuum of fallow practices was delineated into three categories. The delineations were: (1) mechanical fallow; (2) minimum till fallow; and (3) chemical fallow. Operating costs were estimated for each of these categories of fallow (Appendix Tables 4-1, 4-2, and 4-3).

A weighted average per acre fallow operating cost was calculated for the MLRA using estimates of the proportions of fallowed cropland in each of the three discrete fallow categories. These proportions were adjusted when there was a lack of sufficient useable cost information associated with a certain fallow category.

For northeastern Montana MLRA 53A the weights given to the fallow categories were the following:

Mechanical fallow	0.83
Minimum til	0.15
Chemical fallow	0.02

Appendix 4, Table 1: Operating Costs for Mechanical Fallow, Northeastern Montana MLRA 53A

Cost Item	Cost ($/acre)
Pesticides	0.00
Machinery operating costs	
Tillage	6.10
Pesticide application	0.00
Fallow operating costs	6.10
Interest on fallow operating costs in the fallow year	0.28
Interest on fallow operating costs for the year in crop	0.57
Fallow operating costs, including fallow	6.95

Appendix 4, Table 2: Operating Costs for Minimum Till Fallow, Northeastern Montana MLRA 53A

Cost Item	Cost ($/acre)
Pesticides	4.81
Machinery operating costs	
Tillage	3.45
Pesticide application	1.18
Fallow operating costs	9.44
Interest on fallow operating costs in the fallow year	0.43
Interest on fallow operating costs for the year in crop	0.89
Fallow operating costs, including fallow	10.76

Appendix 4, Table 3: Operating Costs for Chemical Fallow, Northeastern Montana MLRA 53A

Cost Item	Cost ($/acre)
Pesticides	9.38
Machinery operating costs	
Tillage	0.00
Pesticide application	3.22
Fallow operating costs	12.60
Interest on fallow operating costs in the fallow year	0.57
Interest on fallow operating costs for the year in crop	1.18
Fallow operating costs, including fallow	14.35