5-1962

The Cost of Owning and Operating Farm Power and Machinery Used in Tillage Operations on Diversified Farms in Selected Areas of Utah, 1960

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THE COST OF OWNING AND OPERATING FARM POWER AND MACHINERY USED IN TILLAGE OPERATIONS ON DIVERSIFIED FARMS IN SELECTED AREAS OF UTAH, 1960

by

Clynn Phillips

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Agricultural Economics

UTAH STATE UNIVERSITY
Logan, Utah

1962

ACKNOWLEDGMENTS

The author wishes to express his sincere gratitude to the entire staff of the Department of Agricultural Economics for their advice and friendly assistance provided in the completion of this study. Special thanks are due Professor E. M. Morrison who was Acting Head of the Department when the study was initiated.

Deepest thanks are expressed to Dr. Lynn H. Davis under whose guidance and direction this study was made. His assistance, patience and helpful suggestions throughout this study are appreciated.

Sincere appreciation is extended to Dr. Reed R. Durtschi, Dr. Ellis W. Lamborn, and Dr. N. Keith Roberts who so willingly gave of their time in counseling and reading this manuscript.

Special thanks are offered to the farmers who gave of their time in providing the data used in this study.

I want to express my appreciation to my entire family who have encouraged me throughout my college work. I particularly wish to thank my wife, Karen, who provided immeasurable help and encouragement throughout the task of preparing this manuscript.

Clynn Phillips

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INTRODUCTION

A current problem facing farmers is, how much shouls they mechanize their farm perations? As the relative price and productivity of factors change farmers usually have to adjust their operations to assure maximum profits.[1] Technological advances often change the relative productiveness and the price of machinery. These changes have caused the progressive farmer to continually review his farm organization and make adjustments in levels of factor use. If he is to produce at maximum profits it is necessary that his machinery investment be in proper adjustment with other resources.

The portion of the total farm investment in machinery has been increasing. In 1940, machinery investment per farm amounted to 4.9 percent of the total investment in the United States. It had increased to 9.6 percent by 1958.[22] In 1940 the average value of farm machinery in terms of 1947-49 dollars in the United States was worth $646 per farm. It had increased to $2,126 by 1958. Total farm investment during this eighteen year period increased from $13,118 per farm to $22,042, table 1. This trend has also taken place in Utah.

The relative importance of farm power and machinery will probably continue to grow. During the last two decades, wage rates have

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1 Two cases when farmers might not adjust their operations is when there are compensating changes or the inputs are lumpy and the adjustment is not enough to move to the next combination.

2 Agriculture Outlook Charts 1959. United States Department of Agriculture, Washington, D. C. 1958.

Table 1. Value of assets per farm used in production in the United States, 1940-1958

Year	Valued in 1947-49 dollars			
	Machinery	Real Estate	Other	Total
	(dollars)	(dollars)	(dollars)	(dollars)
1940	646	9,165	3,307	13,118
1941	683	9,344	3,417	13,444
1942	790	9,579	3,708	14,076
1943	772	9,837	4,139	14,748
1944	716	10,062	4,264	15,042
1945	737	10,189	4,174	15,100
1946	776	10,258	4,117	15,151
1947	852	10,492	4,020	15,364
1948	1,034	10,701	3,774	15,509
1949	1,293	10,993	4,194	16,480
1950	1,523	11,225	4,231	16,979
1951	1,734	11,653	4,355	17,742
1952	1,900	12,009	4,519	18,428
1953	1,978	12,359	4,672	19,009
1954	2,077	12,824	4,730	19,631
1955	2,123	13,210	4,945	20,287
1956	2,153	13,745	5,193	21,091
1957	2,142	14,209	5,148	21,499
1958	2,126	14,505	5,411	22,042

Source: Agriculture Outlook Charts 1959. Agriculture Marketing Service & Agriculture Research Service, USDA, 1959.

increased at a faster rate than machine prices, figure 1, thus making it profitable to substitute machinery for labor. As farms become more mechanized, the demand for labor of a higher quality increases, adding to the wage rate.

Farmers, attempting to adjust to lower product prices, have invested in modern power and machinery units to raise the return to his own labor. Modern machines that can perform operations more efficiently than labor has allowed the farmer to substitute capital for labor profitably and raise his productivity.

Farmers are buying more and bigger tractors than ever before. The average maximum belt horsepower per tractor has increased from

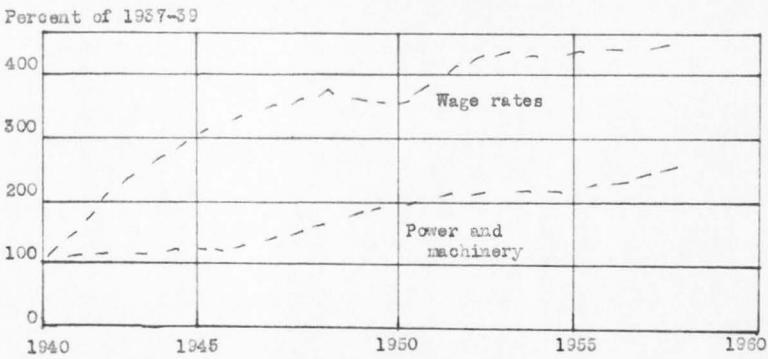

Figure 1. Changes in farm cost rates for labor and power and machinery in the United States, 1940-1958

Source: Farm Cost Situation. Agriculture Research Service, November 1958.

26 horsepower in 1940 to 45 horsepower in 1959, table 2. Purchases of tractors designed to use low cost fuel have increased significantly. Ninety four percent of the tractors manufactured in 1953 had gasoline engines, six percent had diesel, and one percent had engines that used L. P. gas. In 1959 these percentages were 66 percent, 29 percent and five percent respectively.

Interest in diesel and L. P. gas engines is attributable to the attempt by farmers to reduce operating costs. However, much of the reduction in operating costs has been at the sacrifice of higher fixed costs. Diesel engines in farm tractors cost four to six hundred dollars more than a comparable gasoline model. Tractors that use L. P. gas will cost two to four hundred dollars more than the same model with a gasoline engine in 1960.

Table 2. Production of wheel tractors, average maximum belt horsepower, and distribution by fuel type in the United States, 1940-59

Year	Production	Avg. maximum belt horsepower	Gasoline	Diesel	L.P. gas
	(thousand)	(horsepower)	(percent)	(percent)	(percent)
1940	249	26	---	---	---
1945	244	27	---	---	---
1950	497	29	---	---	---
1951	564	29	---	---	---
1952	415	31	94	6	---
1953	390	35	93	6	1
1954	246	39	87	11	2
1955	330	40	84	13	3
1956	215	40	82	13	5
1957	229	45	78	16	6
1958	241	45	71	24	5
1959	267	45	66	29	5

Source: Farm Cost Situation. Agriculture Research Service, November 1959.

Larger and more advanced farm tractors and machinery have made it possible for the individual farmer to perform his farming operations with less labor and in less time. They have encouraged the farm operator to purchase more land. Larger farms spread the high fixed costs associated with modern farm machinery over more units of production.

A significant trend in farming since 1940 has been the increase of purchased inputs by farmers, figure 2. Greater amounts of purchased inputs increases the farmers need for available operating capital.

Alternative methods of machine ownership are available to farm operators. Costs per unit can be reduced by owning machinery in partnership provided that greater use of the machines results. The purchase of used machinery may lower fixed costs. Increasing the acreage farmed will spread costs over more units of production. The

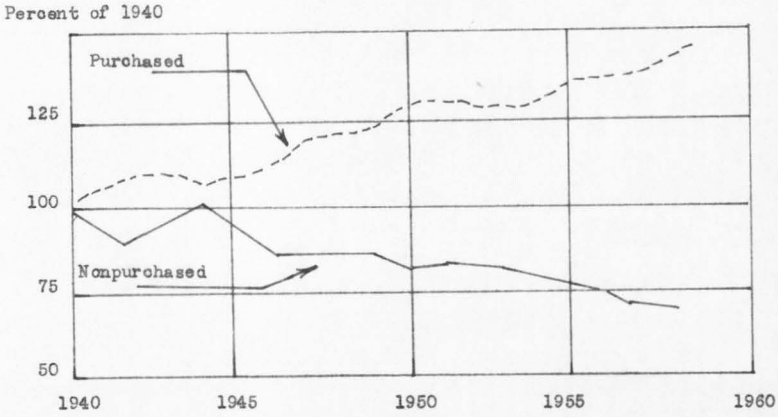

Figure 2. Purchased and nonpurchased inputs in agriculture in the United States, 1940-58

Source: Farm Cost Situation. Agriculture Research Service, May 1960.

hiring of custom machines is also a method that can be used to lower fixed costs of machine ownership.

Objectives

The general objective of this research was to develop input-output data for farm power and machinery used in seedbed preparation in two areas of Utah. More specific objectives are:

1. To ascertain physical input requirements and performance rates of farm power and machinery used in tillage operations in Utah.
2. To determine the monetary costs of these inputs.

3. To examine differences in tillage costs between the north and south-central areas of Utah.

Method of Study

The population for this study consisted of farms in irrigated diversified areas in four counties of Utah. Cache and Box Elder counties were chosen to represent northern Utah. Sanpete and Sevier were chosen to represent the south-central part of the state. It was thought these counties were typical of the areas they represent. Land under irrigation in these two areas was outlined with the help of Soil Conservation Service Personnel. Each section as established by rectangular survey was assigned a number and a sample was drawn from the population with the use of a random numbers table. A certain quarter of each section was chosen so that the sample would be taken from a wider distribution within each area. A list of names of the property owners on these quarter sections and the amount of irrigated land they owned was compiled from the records in the county assessor's office. The names on the list which owned 40 acres or more of irrigated land constituted the sample of farmers that were contacted.

Each farm operator was interviewed by a trained enumerator, and asked to supply information on all costs pertaining to owning and operating tillage equipment. Data were recorded on a survey schedule prepared and pretested for this purpose.

A total of 119 useful records were completed. They were obtained from 56 farmers in the northern counties and 63 farmers in the south-central counties.

The schedules were edited and tabulated to obtain totals and averages. Average costs per acre and per operating hour were obtained on a farm basis, on an operation basis and on a crop basis.

REVIEW OF LITERATURE

There have been several studies on economic aspects of machine operation and ownership in areas of the United States. These studies have been concerned with either specific machines or crops. There has not been any current work that dealt in the area of tillage operations in Utah or neighboring areas.

In Utah, Dean S. Arnold conducted a study in 1957 on machinery and equipment investment by type of farm, methods of financing farm machinery purchases, machinery operating costs for four types of harvesting machines, and standards for profitable machinery investment (2). Questionnaires were mailed to 2,239 farmers asking them to supply information on all costs of owning and operating specified machinery. These data were used to ascertain total machinery investment and operating cost on an hourly basis. He established costs of $4.61 per hour for forage harvesters, $5.36 per hour for hay balers, $4.88 per hour for self-propelled combines and $4.40 per hour for pull type combines. The Department of Agricultural Economics at Utah State University has made other studies on some aspects of machine and equipment use in operations other than tillage.

A bulletin was published in 1947 on the cost of operating machinery on Nebraska farms (10). Detailed cost information was gathered and cost figures arrived at for all machines under Nebraska conditions. The bulletin was revised in 1952 (4). At this time the cost figures reported in the 1947 bulletin were raised proportionally to the increased

costs of these items reported by the United States Department of Agriculture. It did not include any information on operations performed by farmers.

Other states have made studies in related areas but none have been extensive enough to furnish all the needed information.

FACTORS FOR PROFITABLE MACHINERY INVESTMENT

Decisions on the size of machinery investment, type of machinery that will be purchased, and age of machinery to buy are important in farm management. These decisions should be made after considering several factors. The cropping pattern, capital level, availability of custom service, effect of timeliness of operation, and size of farm are all factors to be considered. This study made no attempt to investigate the problems connected with each of these factors and made only partial attempts on some. However, a review of major decisions concerning the level of the machinery investment would seem in order.

Economic theory provides tools that can be used to guide farm operators when making a decision on machinery purchase and use.

To fully appreciate the significance of these analytical tools a knowledge of the costs associated with machine ownership and operation is required. These costs have been grouped into two classes; variable and fixed. Variable costs are those associated with operation of the machine. These costs include (a) fuel, oil, and lubrication, (b) labor, (c) repairs, and (d) supplies. The quantities of these factors that will be consumed depends directly on the operation of the machine.

Fixed costs are those associated with the ownership of machinery. They include (a) depreciation, (b) interest on investment, (c) taxes, (d) housing or shelter, and (e) insurance. These charges will accrue against the machine regardless of the amount of operation. Fixed costs vary per-unit of output but remain fixed in total; whereas variable cost tend to be relatively constant per unit of output but vary in total.

The first decision a farmer with limited capital must make regarding machinery investment is whether his return will be higher from his investment in an additional piece of machinery or in some other farm enterprise (10). If a farmer can earn a 15 percent return on his capital invested in another unit of fertilizer and only a five percent return on capital invested in more machinery he is economically better off to invest in fertilizer. Farmers may be able to invest their capital externally at a higher rate of return than any internal alternative. Profit maximization and the principle of equi-marginal returns dictates that capital be invested in enterprises with the highest marginal value product and that the marginal value product over the marginal factor cost for all enterprises will be equal or nearly equal with limited capital. With unlimited capital the marginal value product over the marginal factor cost will be equated for all enterprises and will equal one.

The choice of buying a new machine or a used machine can be clarified by compounding costs (9). For instance, a farmer has decided that he needs to invest in another power unit for his farm. Assume he has the choice of buying a new tractor for $4,000 that will last 16 years or a used tractor for $2,500 that will last eight years. Both tractors will furnish the farmer with the same services except that he will have to purchase another used tractor in eight years to receive services equal to the new machine. The farmer is faced with two alternatives. He can invest $4,000 in a new machine and receive 16 years of machine services with an annual depreciation of $237.50 or he can invest $2,500 now and another $2,500 in eight years and receive 16 years of machine services with annual depreciation of

$296.88. The decision the farmer must make is; should he buy a new tractor with a lower annual depreciation or should he buy a used tractor with a higher annual depreciation but lower initial cost and invest the difference in some other enterprise. The course of action he should follow will depend on the rate of return in the enterprise he would invest in if he bought a used tractor. If the return on his capital is sufficient to more than offset the differences in annual depreciation he should purchase a used tractor.

The real cost of both tractors can be figured by compounding costs.[1] The cost of the new tractor will be $4,000 $(1.06)^{16}$ or $4,000 (2.5404) or $10,161. Compounding the cost of the used tractors will give a total of $2\left[2,500\ (1.06)^{8}\right]$ or $2\left[2,500\ (1.5938)\right]$ or $7,969. The choice, on the basis of cost, now becomes clearer. The farmer can purchase the services of the new tractor for 16 years for a compounded cost of $10,161 or he can purchase an equivalent length of service by purchasing the used tractors with a compounded cost of $7,969, a compounded saving of $2,192.

Using the same formula a farmer can determine the upper limit he should pay for a used machine. From the example above the price of the new tractor is known to be $4,000 or a compounded cost over 16 years of $10,161. Inserting this value for large (C) in the formula used to compound the cost of the used tractors we can solve for small (c)

$$\$10,161 = 2\left[c(1.5938)\right]$$
$$\text{or}$$
$$c = 3,188$$

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[1] Compound formula $C=c(1+r)^n$
C-Compounded cost r-Market rate of interest
c-Current outlay n-Time

In other words, the farmer would be indifferent as to which tractor he bought, (on the basis of cost) if the used tractor was priced at $3,188. Any price less than $3,188 would offer a saving to the farmer if he purchased the used tractors.

In actual practice the farmer may be willing to forfeit substantial savings in the purchase price if he feels the new tractor is a better buy considering the possibility of higher maintenance costs and losses due to timeliness of operation. The probability of breakdowns that are costly and untimely will generally increase with age.

When buying farm tractors and auxiliary machinery, farmers are confronted with decisions of which size they should buy. There are implements on the market that double or even triple in width from the smallest to the largest size. The effective capacity of a machine does not double with an equal increase in size, figure 3.

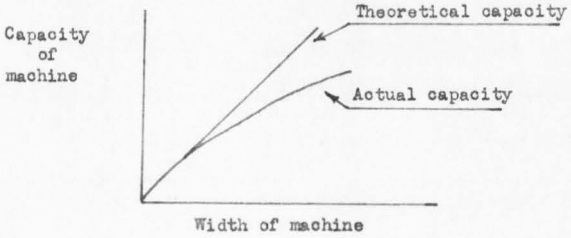

Figure 3. Relationship of width of machine to its capacity.

In a test in Iowa, a 4-row corn planter had a field efficiency of 75 percent, a 6-row corn planter had a field efficiency of only 67 percent. The 6-row planter, however, spent fewer minutes per-acre of corn planted. The percentage of time actually spent planting was lower for the 6-row machine, although it did the work faster (11).

The farm operator, when deciding which machine to purchase may choose the larger machine with a lower field efficiency. The reason for this is two fold--labor and timeliness. He may choose the larger machine because the cost of labor is high or unavailable, especially during the peak season.

Purchase of the larger machine can be justified in terms of timeliness of operation. The effect of timeliness of operation has been explained by Kenneth K. Barnes and David A. Link when they were both with the Department of Agricultural Engineering at Iowa State University.

> For every crop there is one day when you should plant to get maximum yield. Of course, the problem is to figure that day out ahead of time. Take Oats for example, Agronomists have found that the yield falls off if you plant after April 16, at Ames, Iowa. If you delay one week you lose six bushels an acre; if you delay two weeks you lose about 13 bushels per acre, more than twice as much. Timeliness is what makes the income low when the machine is too small. (11)

Actually, timeliness of operation consists of two phases. One phase is concerned with the relative time of year the operation is performed. This is the phase of timeliness Barnes and Link discuss directly above. Timeliness in this sense is only indirectly connected with size of machine. A small machine would require a farmer to allow more time for an operation which may cause him to start earlier than he would with a larger machine. The other phase of timeliness is concerned with the relative amount of time required to complete an

operation once it is begun. Timeliness in this sense is directly related to the size of machine. The greater the effect of timeliness the larger the machine should be.

With a small machine labor costs are high relative to acres planted, as width of the machine increases costs will fall. With larger machines fixed costs will be high relative to acres planted and as soon as fixed cost predominate over labor costs the cost per acre will begin to rise the width of the machine increases.

The weight that timeliness should have in making a machinery decision is summarized by Barnes:

> It's quite simple, in any operation where timeliness matters, the most profitable size of machine will be larger than the minimum cost size of machine, and the more timeliness matters the larger the machine should be. Furthermore, it seems to be a characteristic of the profit curve that it drops off far more sharply for an undersized machine. So if you are in doubt between two sizes, always choose the larger machine, but especially so if timeliness is important. (11)

The adoption of a new crop into the rotation that requires specialized machinery or a technological change in machinery presently in use presents the farmer with the task of deciding whether he should own the implement or hire its services (10). The solution can be made easier with the use of a formula that will arrive at a point where it becomes cheaper to own than to hire custom services.[2]

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[2] The logic behind this formula is to arrive at a point where annual fixed costs on a per unit basis are equal to that portion of the custom rate that is allocated to fixed costs plus profits. That portion of the custom rate allocated to fixed costs and profit is arrived at when the operating cost per unit is subtracted from it. Since the per unit costs from ownership (fixed plus variable) are equal to the next best price alternative (fixed plus variable plus profit), ownership is justified even though fixed costs per unit are higher. This is possible because charges are entered against an enterprise at cost; not cost plus profit.

$$\frac{\text{Annual fixed costs}}{\text{custom rate minus operating cost}} = \text{no. of acres to break even}$$

Suppose a farmer has decided to raise a certain crop and is debating whether he should buy a particular implement needed in its production or hire the machine's services. Estimating annual fixed costs and operating costs and by using the custom rate for performing this service a break even point can be figured. If the farmer's long run plan calls for more acres than the break even point he should purchase the machine. If his plans are for less acres than that indicated by the formula at the break even point he should hire the machine's services.

By using the formula in reverse with a given level of crop production the farmer can figure a maximum custom rate he can pay before it becomes more profitable to own the machine. If he anticipates lower custom rates he should delay buying the machine. In actual practice both the number of acres required to break even and maximum custom rate may be reduced lower than the formula would indicate if timeliness of operation has any effect. If the farmer feels that there is a change that he could not hire custom services at the optimum time he may be justified in buying for a smaller number of acres or at a lower maximum custom rate than indicated by the formula.

The goal of farmers should not be minimum machinery investment per acre. However, this resource should not be purchased excessively. Careful and conscientious investment and use of farm power and machinery can go a long way toward making the farm unit a financial success. Ownership of low use machinery in partnership with a neighbor, increased

annual use, proper care and lubrication are methods that can be used to reduce both fixed and operating costs and make for profitable machinery investment.

DEFINITION OF COSTS

This section was prepared to show how the various costs in the sections which follow were calculated. The first part of this section is devoted to fixed costs. Some fixed costs are not met with cash outlays. Nevertheless, they do accrue against a machine and should be covered over its life. The value of these items may be somewhat arbitrary for any given year. Costs of this nature were depreciation, interest on investment, and the charge against land used for machine storage. Other fixed costs such as insurance, taxes, and contracted interest, which is part of the interest on investment charge, are met with cash outlays.

The second half of this section is devoted to variable costs. These are costs incurred from operation of the machine. Operating costs have to be met with cash expenditures.

Overhead or Fixed Costs

Depreciation

No effort was made to separate depreciation due to use from that due to obsolescence. Use depreciation is that value lost from use or wear and tear on the machine. Obsolescence depreciation, on the other hand, is the loss in value from the passing of time. A machine may lose value just setting around or it may become obsolete, even though it is being used, from an advance in technology.

Depreciation charges were calculated by the straight line method. This method is relatively simple and easily understood. The straight

line method depreciates the purchase price less the salvage value or the value of an asset lost by its owner evenly over a given period of time, which results in an annual depreciation charge equal throughout the life of the machine. Farmers indicated they were currently using this method which can be calculated by the following formula:

$$\frac{\text{Purchase price minus salvage value}}{\text{given period of time}} = \text{annual depreciation}$$

Depreciation was based on the average useful length of life for a particular implement. The useful length of life for different types of machines and implements was based on a study by M. S. Parsons, "Depreciation as a Cost of Farm Machinery" (5). In Parson's study the average useful length of life for the basic types of machines was calculated from a nationwide survey. The salvage value used in this study was figured at five percent of the new price. No salvage value was allowed for buildings.

Interest on investment

Interest on investment was charged against the enterprise for capital in its present use. This item is usually not met with an out-of-pocket expenditure unless the owner of the capital is not the same as the owner of the machine. The rate charged should be equal to the rate of return it would receive in its next best alternative use or its opportunity cost. An interest rate of six percent per annum was used to calculate this cost item. Total interest on investment charged to tillage was calculated by multiplying the average annual investment in equipment and buildings used in tillage operations by six percent.

Taxes

Taxes were based on tax valuation schedules provided by the state and the mill rate levy for the respective counties. Knowing the age and new purchase price of a tractor or implement and applying it to the correct tax formula produced a value that was equal to 40 percent of a fair market value. This value was then multiplied by the mill levy for the respective county. This figure represented the assessed value for a particular tractor or implement. The assessed value was then multiplied by the percentage of the particular machine charged to tillage to arrive at the total tax charge.

Insurance

Insurance is financial protection against a calculated risk. The most prevalent types of insurance on farm machinery are public liability and fire insurance. Some farmers had no insurance, some had insurance on individual machines, and some had their machinery covered under broad policies that insured almost everything on the farm.

Insurance charges in this project were based entirely on those amounts paid out by farmers for this protection.

Land charge

A charge was made for land used for machinery storage. Doane Agriculture Digest suggests the square feet of space required to store different machines (6). Combining the square foot requirements for an average line of machinery about 1/8 of an acre was required for machinery storage. This amount of land was held constant for all farms. Multiplying it by the average value per acre for the different farms the total land investment for this use was figured. A six percent

return on investment was allowed and the resulting figure was the land charge.

Variable or Operating Costs

Labor

Total labor hours used in performing tillage operations were calculated for each farm. Labor hours were broken into two groups--operating hours and preparation hours. Farmers were asked to supply information on the amount of time it would take to perform a particular operation on an acreage basis. This procedure was followed for every tillage operation. Total hours were multiplied by a constant wage rate of $1.25 per hour. The resulting figure represented the total labor cost for performing tillage operations on a particular farm.

Fuel

Fuel costs were arrived at by the same method as labor costs. Farmers supplied information on fuel consumption rates for each of their tractors for the different operations. Total gallons of fuel was multiplied by the price that the farmer paid to arrive at a total fuel cost.

Oil and lubrication

All farmers were not using the same method in determining oil and lubrication needs. Some farmers serviced their tractors and implements according to manufacturers specifications. Others serviced regularly at given intervals regardless of need. Others serviced only when needed. There were farmers that seemed only to service their equipment when it was handy.

Much of the oil and lubrication materials were purchased in bulk supplies and some farmers were reluctant to estimate the quantities used on only tillage. A figure of five cents an operating hour, based on those records reporting oil and lubrication charges, was used as a standard rate in figuring oil and lubrication charges. This figure was compared against results of other studies and it was concluded there were no significant differences.

Repairs

Repair costs were given by the farmer on each machine covering the previous 12 months. The portion of repairs charged against tillage was according to the percentage the machine was used in tillage operations. Repair costs represented the cost of parts, cost of hired or custom labor, and cost of the farmer's labor spent in repairing the implement.

Custom work

Some farmers were using custom service to perform some of their tillage operations. The use of this service was most prevalent in those operations that required expensive low-use machines, such as drilling. The total cost of this service was furnished directly by the farm operators.

Miscellaneous machines

A charge was made for the use of machines not directly connected with tillage operations. These charges were the family automobile used in making trips into town for repairs or the truck used for hauling seed, fuel, etc. Farmers were asked to estimate the total hours of use or miles of travel and a fair rate to be charged per hour or mile for each of his machines connected with tillage operations. Each

total was multiplied by its respective rate and the resulting figure was the miscellaneous machine charge.

ANALYSIS AND PRESENTATION OF DATA

Tillage Costs per Farm

Description of the population

The population for this study was limited to diversified irrigated farms of 40 or more acres of irrigated crop land in four counties, as previously mentioned. It was felt that these four counties were representative of their areas. The population was further defined to include only those farms that had a minimum of one legume, one small grain, and one row crop in its rotation.

There was no distinction made between the types or classifications of farms. Some of the farmers that were interviewed for this project were on farms that had only crops; some were crop-livestock operations; and some were on farms made up of irrigated and dry-land combinations. There were no special adjustments made for the different types of farms other than the proportionment of the total machinery investment between tillage and other types of farming a particular farmer may follow.

Investment in land, machinery, and machine housing

Included in this section is the average farm land investment and the average investment in machinery and machine housing allocated to tillage. The land investment was that land usually referred to as the farm. This included land in roadways, ditches, along fencelines, small areas of waste and dry land, land used for the farmstead if it was located on the farm, and the tillable land.

Farms on the average were 123 acres, table 3. They ranged from a high of 450 acres to a low of 41 acres. The average number of cropland acres was 112.7 acres. The northern area had an average of 113 acres while the southern area averaged 112 acres. The average value of land for both areas was $399 per acre. However, the average value varied considerably between the areas. Land was valued on the average at $456 an acre in the northern area and $348 in the south-central area. Some of this difference can be explained in that the south-central area has suffered from drought conditions the last few years. Box Elder County in the northern area had the highest average value of $514 per acre. This would seem reasonable since the land in this area is relatively productive and there is some pressure on land prices from urbanization.

Table 3. Investment in land, machinery and machine housing allocated to tillage, northern and south-central counties in Utah, 1960

Item	Unit	Northern		South-central		Total	
		Av. per farm	Av. per acre	Av. per farm	Av. per acre	Av. per farm	Av. per acre
No. of acres	Acres	124		122		123	
Land	Dollars	56,716	456	42,469	348	49,175	349
Housing	Dollars	438	3	242	2	333	3
Machinery	Dollars	4,626	37	4,239	35	4,421	36
Total	Dollars	61,780	496	46,950	348	53,929	438
Percent machinery to total	Percent		7.5		9.1		8.2

Farmers had an average of $3 per acre invested in housing for their tillage equipment. An interesting difference in building construction appeared between the two areas. In the northern area nearly all the buildings were built on a foundation, while in the south-central area nearly all the buildings were of pole type construction. Average building investment allocated to tillage was $3 per acre in northern area and $2 per acre in the south-central area.

Average machinery investment in tillage equipment was $36 an acre. The northern counties had an average investment in machinery of $37 an acre. The south-central counties had an average investment of $35 an acre. The variation in this item was considerable between farms. The upper 25 percent of the farms had an average machinery investment of about $65, while the lower 25 percent had an average machinery investment of $17 per acre.

Total investment in land, machinery, and machine housing allocated to tillage operations was $438 an acre for the average farm. This total varied from an average of $496 an acre for the northern area to an average of $385 an acre for the south-central area. Most of this difference was due to differences in land values between the two areas. Machinery investment as a percent of the total investment amounted to 7.5 percent in the northern area and 9.0 percent in the south-central area. Total machinery investment was relatively close between the two areas, while the land investment varied considerably.

Operating hours, labor hours, and quantities of fuel required to perform tillage operations

Average number of operating hours, labor hours, preparation hours, and gallons of fuel required to perform tillage operations are given in

this section. The figures are an indication of the number of operating hours, labor hours, and gallons of fuel required to operate an average farm. They are based on the cultivated land in a farm and are not averaged over the whole farm. This excludes land in roadways, ditches, along fences and minor waste areas that are not actually tilled.

Farmers spent an average of 2.3 operating hours per acre in performing tillage operations, table 4. The variation between areas was slight. Farmers spent 2.3 operating hours an acre in the northern area and 2.2 operating hours an acre in the south-central area.

Table 4. Operating hours, labor hours, preparation hours and gallons of fuel used in performing tillage operations, northern and south-central counties in Utah, 1960

		North		South-central		Total	
Item	Unit	Av. per acre	Av. per operating hour	Av. per acre	Av. per operating hour	Av. per acre	Av. per operating hour
Operating hours	hrs.	2.3		2.2		2.3	
Labor hours	hrs.	2.5	1.1	2.5	1.1	2.5	1.1
Preparation hours	hrs.	3.2	.1	.3	.1	.2	.1
Fuel	gals.	3.7	1.6	3.7	1.7	3.7	1.6

Hours of labor required to perform tillage operations were the same in both areas on an acreage basis. Farmers on the average spent 2.5 hours of labor per acre. The difference between operating hours and labor hours is the time spent in preparing the different machines for operation. The south-central area had a slightly higher labor

requirement than the northern area. Some of this difference was due to location of the farmstead in relation to the farming land. In the south-central area most of the farmers had their home and farm buildings in town and traveled to the outlying districts to their farm land. In the northern area the farmstead was usually located on the farm, thus eliminating the daily travel to and from town. Preparation hours had a close relationship to operating hours. In almost every operation in both areas farmers spent 0.1 hours of labor in preparation for every operating hour.

There was no difference in the gallons of fuel consumed per acre between the two areas. Farmers used, on the average, 3.7 gallons of fuel per acre in performing their tillage operations. Fifty-one percent of the observations were between 2.5 and 4.5 gallons of fuel used per acre.

Variation in fuel consumption per acre is probably more a result of variation in other factors than to differences in the rate of consumption. If one farmer does twice as much tillage work per acre than another it is reasonable to believe that his fuel consumption per acre will be approximately twice as much.

Variation in average fuel used per operating hour between areas was slight. Farmers used 1.6 gallons per operating hour in the northern area and 1.7 gallons in the south-central area.

Fixed costs

Fixed costs are associated with ownership. They are fixed in total and do not vary with output. It would seem reasonable to believe that farmers by prudently investing in their farm machinery could keep fixed costs at a minimum level. Increasing the use of machines and planning

their machinery purchases so that their machinery stock was relatively stable over time would cause depreciation and interest on investment allowances to be stable. Large purchases for two or three years and none the next few will cause depreciation, interest on investment allowances, and taxes to vary considerably.

The latitude of control that a farmer has over fixed costs would seem to be rather wide. He can influence his fixed costs in many ways. More extensive use of his machinery will spread fixed costs over more units. Buying used equipment or buying in partnership will reduce a farmer's fixed costs. Proper care which extends the useful life of a machine will reduce fixed costs. These methods are within reach of almost every farmer as a means of reducing fixed costs.

Total fixed costs were $4.45 an acre for the average farm, table 5. The northern area had higher fixed costs per acre than the south-central area. They were $4.60 an acre in the northern area and $4.31 an acre in the south-central area. Fixed costs averaged slightly more than $8 an acre for the upper 25 percent of the farms, and slightly more than $2 an acre for the lower 25 percent of the farms. Fixed costs per operating hour were $1.98 in the northern area and $1.94 in the south-central area.

The largest single fixed cost item was depreciation. Depreciation accounted for 58.5 percent of the fixed costs in the south-central area and 55.9 percent in the northern area. The average farm had a charge of $2.10 an acre for depreciation. This total consisted of $2.05 for machinery depreciation and $.05 an acre for building depreciation.

Interest on investment was the second largest single item. It accounted for 34.5 percent of the total fixed cost in the south-central area and 37.0 percent in the northern area. Interest on investment

Table 5. Fixed costs allocated to tillage operations, northern and south-central counties in Utah, 1960

Item	Unit	Northern		South-central		Total	
		Av. per acre	Av. per operating hour	Av. per acre	Av. per operating hour	Av. per acre	Av. per operating hour
Taxes:							
Building	Dollars	.04	.02	.02	.01	.03	.02
Machinery	Dollars	.29	.13	.24	.11	.26	.12
Insurance charge	Dollars			.03	.01	.01	.01
Interest on investment:							
Building	Dollars	.11	.05	.07	.03	.09	.04
Machinery	Dollars	1.56	.67	1.42	.64	1.49	.66
Land	Dollars	.02	.01	.01	.01	.01	.01
Depreciation:							
Building	Dollars	.05	.02	.04	.02	.05	.02
Machinery	Dollars	2.52	1.09	2.47	1.11	2.05	1.10
Total fixed costs	Dollars	4.60	1.98	4.31	1.94	4.45	1.96

amounted to $1.69 an acre on the average in the north and $1.50 an acre in the south-central counties. Average cost of this item for the combined areas was $1.59 an acre. A charge for land used for machinery storage was included in interest on investment. The figure charged for land in this use was a six percent return on its value.

The third largest item was that of taxes. Taxes accounted for 6.3 percent of the total fixed costs in the two south-central counties and 7.1 percent in the two northern counties. Taxes averaged 29 cents an acre. The average for Cache and Box Elder Counties was 33 cents an acre. Sanpete and Sevier Counties had an average of 26 cents an acre.

The lowest average fixed cost item per acre was that of insurance. There were no insurance charges reported in the northern counties. This, however, is probably due to chance and is not necessarily representative of the area. Insurance costs for the south-central area amounted to three cents per acre for the average farm.

Operating costs

Operating costs are the costs incurred in performing tillage operations. Variation in operating costs between farms could be due to several factors. Each farmer has in mind certain operations that must be done in order to properly prepare the seedbed. Soil types and soil conditions will cause farmers to alter tillage patterns. Tillage operations will vary with crops. A crop such as sugar beets usually requires extensive tillage operations in preparing its seedbed, whereas, a crop like barley may require little preparation. Also, operating costs will differ as a result of the type of tillage equipment used.

It would seem logical that once a farmer has defined what he thinks is an optimum seedbed condition that he has narrowed his control over operating costs. Weather, soil condition for the particular year, and other external conditions may allow the farmer to reach this optimum condition with less operating costs one year than the next, but the latitude that the farmer operates in for given conditions would seem to be somewhat narrow.

Operating costs amounted to $6.20 an acre on an average, table 6. The south-central area had slightly higher costs at $6.27 per acre than the northern area with a cost of $6.11 per acre. On an operating hour basis the average operating cost was $2.82 for the south-central

Table 6. Operating costs for performing tillage operations, northern and south-central counties in Utah, 1960

Item	Unit	Northern		South-central		Total	
		Av. per acre	Av. per operating hour	Av. per acre	Av. per operating hour	Av. per acre	Av. per operating hour
Custom work	Dollars	.25	.11	.17	.08	.21	.09
Labor charge	Dollars	3.16	1.36	3.08	1.39	3.12	1.37
Repair charge	Dollars	1.06	.46	.86	.39	.95	.42
Misc. machine charge	Dollars	.52	.22	1.03	.46	.79	.35
Fuel	Dollars	1.02	.44	1.02	.46	1.02	.45
Oil and lubrication	Dollars	.12	.05	.11	.05	.11	.05
Total	Dollars	6.11	2.63	6.27	2.82	6.20	2.73

area and $2.63 for the northern. Average costs for the combined areas were $2.73 per operating hour.

Labor was the largest single operating cost item. Labor accounted for 51.7 percent of total operating costs in the northern area and 49.2 percent in the south-central area. On an acreage basis labor averaged $3.12. Labor costs were slightly higher in the northern area than in the south-central-- $3.16 compared to $3.08.

Labor costs were $1.36 and $1.39 per operating hour for the north and south-central areas respectively. Using a constant wage rate of $1.25 an hour it leaves $.11 and $.14 spent on labor for preparation time for every hour of operating time.

The second largest expenditure was for fuel. In the northern 16.6 percent and in the south-central counties 16.3 percent of the total operating cost was for fuel consumption. Fuel cost for the average farm were $1.02 an acre for the combined areas. However, there was a small variation in fuel cost per operating hour-- 44 cents in the north compared to 46 cents in the south-central area.

Cost of repairs averaged 95 cents an acre. This item was the second largest expenditure in the north and the fourth largest in the south-central area. It accounted for 17.3 percent of the total operating cost in the northern area and 13.7 percent of the total operating cost in the south-central area. In Sanpete and Sevier Counties repair costs per acre ranked behind expenditures for labor, fuel, and miscellaneous machines. Cost of repairs averaged $1.06 an acre in the northern area and $.86 an acre in the south-central area.

The fourth largest cost item in this category for the combined areas was expenditures on miscellaneous machines. The average expenditure was 79 cents an acre. However, average costs in the south-central area were almost double that of the northern area, $1.03 an acre compared to $.52 an acre. Most of this variation was probably due to the fact that the majority of south-central farmers live in town and have to drive to the outlying areas to reach their farms. This item accounted for 16.4 percent of the total operating costs in the south-central area and 8.4 percent of the total operating costs in the northern area.

Custom work cost farmers $.21 an acre on the average. In the northern area, farmers paid an average of $.25 an acre for custom work while in the south-central area farmers paid an average of $.17 an acre. Custom work accounted for 4.1 percent and 2.7 percent of the total

operating costs for the northern and south-central areas respectively. It should be pointed out that in this section costs were averaged over total acres tilled in each area. This accounts for some costs appearing unduly low. In the following section costs are reported per acre and per operating hour for each operation on only those acres receiving the particular operation.

The lowest cost item in total operating costs was the expenditure for oil and lubrication. This item accounted for 1.9 percent and 1.7 percent of total operating costs in the north and south-central areas. Since oil and lubrication costs were figured at a constant rate of five cents per operating hour both areas would have the same costs per operating hour. The difference in oil and lubrication costs per acre between the areas would be in the same ratio as the difference in operating hours per acre between the two areas. The north had an average expenditure of $.12 an acre, while the south-central area had an average expenditure of $.11 per acre.

Total costs

Total costs were $10.65 per acre for the average farm. In the northern area, total costs amounted to $10.71 per acre. In the south-central area, total costs were $10.58 per acre for the average farm. The highest 25 percent had total costs above $13.00 per acre. The lowest 25 percent had total costs below $9.00 per acre. In other words, the middle 50 percent of the farmers had average total costs between $9.00 and $13.00 per acre.

Total costs per operating hour averaged $4.69 for the total area. The northern area had slightly lower costs per operating hour than the south-central area. Total costs for the northern counties was $4.61

per operating hours. In the south-central area total costs amounted to $4.76 per operating hour.

Higher total cost per acre and lower total cost per operating hour, which was representative of the northern area, indicate that this area was spending more operating hours per acre than the other area.

Labor, depreciation, and interest on investment accounted for almost 70 percent of total cost, figure 3. Operating costs were 58.2 percent of total cost. Fixed cost represented the remaining 41.8 percent of the total cost.

The average age, average new price, average purchase price, average capital improvement expenditure, and the average value for 1960 for the different machines is given in table 7. The number of observations for each machine is given because it was felt that part of the variation between areas for some of the machines may be due to the low number of observations in these groups.

Tillage Costs Per Operation

Information on the cost of performing different tillage operations is given in this section. Table 8 is a summary of the major cost items, with a more detailed breakdown of the costs per operation in the appendix tables 13 through 23.

Costs for each tillage operation are the average total costs for only those farmers performing the operation, and is not an average cost for the sample. Also, cost figures given are average total costs for each operation. Some operations are performed several times on the same ground in working up a seedbed, and the cost figure shown is an average cost for the total operation.

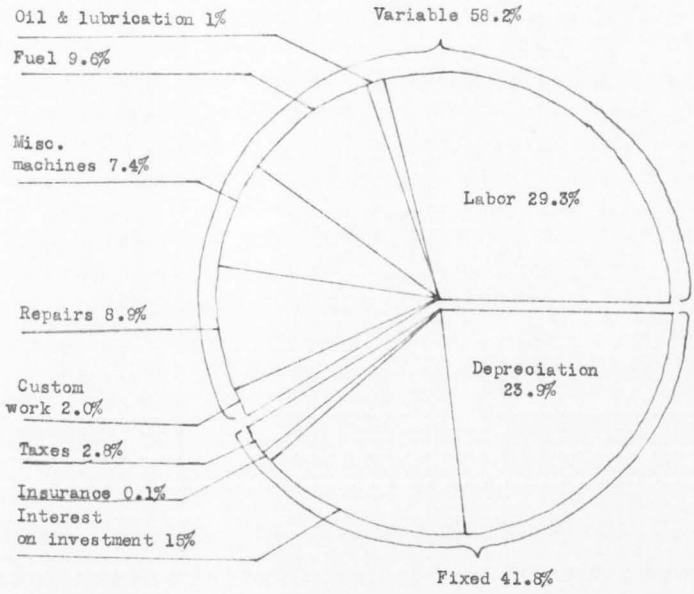

Figure 4. Relative importance of fixed and variable costs to total seedbed preparation costs in selected areas of Utah, 1960

Table 7. Average age, new price, purchase price, capital improvements, and average investment in tillage machinery, 1960

Machine	No. of observations	Av. age	Av. new price	Av. purchase price	Av. capital improvements	Av. investment 1960
		years	dollars	dollars	dollars	dollars
Tractor						
North	131	6.7	2,402	2,190	74	1,336
South	147	6.3	2,321	1,940	61	1,233
Manure loader						
North	46	6.8	525	507	1	292
South	44	8.3	436	421	-	203
Manure spreader						
North	59	7.6	461	405	4	252
South	72	6.8	565	481	-	315
Fertilizer spreaders						
North	37	5.8	183	172	-	121
South	40	7.0	164	156	-	106
Plows						
North	74	6.4	379	342	-	206
South	74	6.7	361	356	-	204
Harrows						
North	62	6.8	139	121	-	75
South	64	7.9	96	93	-	38
Levels						
North	62	7.4	190	162	-	56
South	54	11.4	436	360	-	157
Disks						
North	32	7.7	356	278	-	112
South	24	8.2	339	303	-	116
Diggers						
North	29	8.4	316	310	-	139
South	24	9.6	165	162	-	44
Grain drill						
North	47	9.0	431	401	-	261
South	47	11.3	352	341	-	212
Corn drill						
North	21	5.4	150	146	-	128
South	20	6.6	198	183	-	95
Beet drill						
North	11	3.7	332	330	-	253
South	14	6.6	241	134	-	69
Misc. machine						
North	0	-	-	-	-	-
South	8	8.8	239	218	-	32

Table 8. Cost of performing tillage operations in selected counties of Utah, 1960

	Operating hours per acre	Labor cost per acre	Fuel cost per acre	Other variable costs per acre	Depreciation charges per acre	Interest on investment per acre	Other fixed costs per acre	Total costs per acre
	hrs.	dols.	dols.	dols.	dols.	dols.	dols.	dols.
Manuring	2.4	3.20	.92	.88	1.85	1.11	2.26	10.22
Commercial fertilizing	.3	.44	.10	.11	.11	.09	.25	1.07
Plowing	1.1	1.47	.60	.61	.44	.27	1.28	4.69
Harrowing	.3	.36	.13	.03	.05	.04	.32	.92
Leveling	.4	.58	.21	.04	.16	.06	.53	1.57
Disking	.6	.62	.23	.19	.32	.14	.71	2.19
Digging	.4	.54	.18	.24	.43	.18	.81	2.37
Drilling grain	.4	.58	.15	.12	.29	.29	.51	1.94
Drilling corn	.5	.72	.06	.54	.24	.21	.50	2.36
Drilling sugar beets	.4	.60	.13	.62	.16	.15	.50	2.16

Annual fixed costs on the power units were allocated to each operation on a percentage basis. The amount of time spent on each operation was calculated separate for each tractor and the fixed costs accruing against it were allocated to the different operations accordingly.

One other explanation should be made at this point concerning the calculation of custom work charges. The cost of custom work for a particular operation was averaged over all farmers performing this operation. This was done primarily for two reasons. The first was

because some of the farmers using custom services could not be logically separated from those who did not. For instance, those farmers who rented an implement but furnished their own power and labor, could not be clearly divided into a separate group. It would seem reasonable that if any adjustment should be made they would be included with those farmers that owned their own equipment. The rental rate they pay would be handled as a fixed charge, since this is what the rate covers. The second reason is that the farmers who used a complete custom service to perform an operation were so few that their effect was usually less than one cent per acre. Also some of the farmers used custom services only in an emergency along with their own operations which made them difficult to separate.

Several farmers performed miscellaneous tillage operations other than those discussed below. Average costs were not figured for them because there were not enough farmers performing each operation for reliability.

The manuring operation was the most expensive operation on an acreage or operating hour basis. The average total cost of manuring was $10.22 an acre, table 8. The northern area had an average cost of $10.41 an acre while the south-central area had an average cost of $9.92 per acre. Labor, depreciation and interest on investment accounted for 60 percent of the total cost. The labor cost was $3.20 an acre or 31 percent of the total cost and was the largest single cost item. To arrive at a figure that would give a general measure of the amount of land that the average farmer would manure, total acres manured was divided by total acres plowed. It was found that farmers on the average spread manure on approximately 45 percent of the ground they plowed.

Commercial fertilizing cost $1.07 an acre. The south-central area had slightly higher costs at $1.09 an acre than the northern area with $1.05 an acre. Labor was the largest single cost item amounting to 44 percent of total cost per acre. Farmers that spread commercial fertilizer covered 54 acres on the average.

Plowing was next to the manuring operation in terms of cost per acre. The average farmer had a cost of $4.69 per acre for plowing. The average cost per acre was $4.73 for the south-central counties and $4.62 for the northern counties. Labor and fixed costs on the power unit were the largest cost items. Labor accounted for 31 percent of total costs while fixed costs on the power unit was 27 percent. There were only two farmers who did not do any plowing. Those who did plow averaged 57 acres per farm.

Harrowing cost an average of $.92 per acre. Harrowing costs per acre were $1.29 for farms in the south-central area and $.73 an acre for farms in the northern area. This difference is difficult to explain since farmers in the northern area on the average harrowed each acre plowed 3.5 times while south-central farmers harrowed each acre only 2.0 times. The only reason that could be found for this difference was that south-central farmers were using smaller harrows and were not harrowing as fast as northern farmers.

The average leveling cost per acre was $1.57 for the combined areas. The difference between the two areas was 39 cents an acre in favor of the northern area. Although farmers in both areas leveled each acre plowed an average of 1.5 times, the difference was due to the type of leveling done in each area. In the south-central area, farmers tended to use commercially manufactured metal levelers, while in the northern area the majority of farmers were using homemade wooden

levelers. The metal leveler acts much like a land plane, while the wooden leveler is used more as a method of packing and smoothing the seedbed than as a method of leveling it. Being bulky, heavy, and harder to pull, the metal leveler had higher operating costs associated with its use. Also, the initial outlay for the metal leveler is greater and has higher fixed costs than the wooden leveler. As a result of these two factors the south-central area had higher leveling costs per acre.

Of the 119 farmers interviewed 68 of them performed a disking operation. There was a slightly higher percentage of farmers disking in the south-central area than in the north. The average acreage disked by farmers performing this operation was 46 acres. The average cost of disking was $2.19 per acre. The difference between areas was relatively small-- $2.22 an acre in the north and $2.18 an acre in the south-central area.

Farmers who performed a digging operation, dug an average of 38 acres. Relatively few farmers indicated they were doing this operation, and of the total 22 out of the 36 farmers were in the northern area. A reason for this may be that digging the soil tends to leave it open and loose. In the south-central area where moisture conservation is a problem digging would not have wide application because of this condition.

Digging costs averaged $2.37 an acre. The south-central area had an average digging cost of $3.47 per acre, while the northern area had an average cost of $1.86 per acre. Farmers in the north averaged a half acre per hour more than farmers in the south-central area, resulting in lower costs per acre for the northern area. Also, it is

felt that the fixed costs on the power unit are unduly high and may be a result of the low number of observations in the south-central area.

The cost of drilling grain, peas, alfalfa, and grasses was separated from drilling beets or corn because of the different type of drills used. The average cost of drilling grain, peas, alfalfa, and grasses was $1.94 an acre. Farmers in the northern area were drilling more than three acres an hour while south-central farmers drilled about two acres in an hour. Also, drilling costs were higher in the south-central area--$2.07 compared to $1.81 in the northern area. Most of the difference was due to higher labor expenditures, which would result from a higher operating hour per acre requirement in the south-central area.

The average cost of planting corn was $2.36 an acre. The difference between the two areas was 59 cents an acre less in the northern area. Operating hours per acre requirements for corn drilling in the south-central area was higher than the northern area and would tend to explain operating cost differences. Higher fixed cost could be due to differences in relative age of the machines, number of acres fixed costs were spread over, or differences in the original cost of corn drills between the areas.

The average cost of drilling sugar beets was $2.08 for the combined areas. This cost averaged $2.14 an acre in the north and $2.01 an acre in the south-central area. There were enough farmers having their beets drilled by custom service to warrant a separation of the records. The average cost of custom drilling was $2.08 an acre in the northern area and $1.87 in the south-central area. In the northern area more than 37 percent of the farmers hired their beets drilled, while in the south-central area it was less than 10 percent. After subtracting the acres

drilled by custom service and the cost of custom drilling out of total cost, average costs per acre was ascertained for farmers drilling their own beets. Average costs on this basis were $2.16 an acre for the northern farmers and $2.02 for the southern farmers.

Tillage Costs Per Crop

The average cost of tillage operations for the major crops grown in the two areas are given in this section. Data from the records were tabulated to give the average number of times each farmer performed a particular operation, the total acres each operation was performed on, operating cost per hour and the total operating hours required to perform the operation for each crop. By multiplying total operating hours for each operation by the average cost per operating hour, it was possible to ascertain a total cost for each operation performed on the different crops. The average cost per crop acre was obtained by dividing total operating costs by the total acres of the particular crop.

The tables in this section show the average number of times each operation was performed and the average cost of this operation per crop acre.

Alfalfa

Tillage operations performed on alfalfa are a method of weed control on established alfalfa stands and not preparation of a seedbed. Since these operations are performed with standard tillage equipment and are closely related to other tillage operations they were included as part of the tillage operations.

Every farmer but one indicated they were growing alfalfa. (The one exception was a farmer in the northern area growing red clover for seed.) The tillage operation performed on alfalfa varied considerably from farm to farm, with probably not more than 30 to 40 percent of the alfalfa acreage receiving any tillage.

The average cost of tillage operations performed on alfalfa was $.71 an acre, table 9. In the northern area, the average cost per acre of alfalfa was $.94, while in the south-central area it averaged $.67 an

Table 9. Average cost of tillage operations performed on alfalfa in northern and south-central counties in Utah, 1960

	Northern		South-central		Total	
	Avg. no. of times over	Avg. cost per acre	Avg. no. of times over	Avg. cost per acre	Avg. no of times over	Avg. cost per acre
Manuring	.02	.23	.04	.20	.03	.21
Commercial fertilizing	.33	.39	.27	.32	.30	.35
Plowing	XX	XX	**	**	XX	XX
Harrowing	.33	.28	.07	.06	.17	.15
Leveling	XX	XX	**	**	XX	XX
Disking	XX	XX	XX	XX	XX	XX
Digging	XX	XX	.02	.09	XX	XX
Drilling	.02	.04	**	**	XX	XX
Total	XX	.94	XX	.67	XX	.71

** Less than 1 cent.
XX No operation performed.

acre. Most of the difference was due to the harrowing operation. In the northern area approximately 33 percent of the acreage was harrowed, while in the south-central area about four percent of the acreage was harrowed.

Grain

The average cost of tillage operations performed on grain was $14.11 per acre, table 10. Average cost was $2.67 an acre higher in the southern area than in the northern area. The largest difference was in the manuring per acre of grain grown was $2.19 an acre higher in the southern

Table 10. Average cost of tillage operations in the preparation of land for grain, in northern and south-central counties in Utah, 1960

	Northern		South-central		Total	
	Avg. no. of times over	Avg. cost per acre	Avg. no. of times over	Avg. cost per acre	Avg. no. of times over	Avg. cost per acre
Manuring	.14	1.43	.34	3.62	.24	2.56
Commercial fertilizing	.39	.43	.24	.32	.32	.37
Plowing	.96	4.42	.83	3.87	.90	4.14
Harrowing	2.74	2.11	1.31	1.84	2.00	1.97
Leveling	1.41	1.80	1.28	2.43	1.34	2.12
Disking	.21	.48	.49	1.18	.36	.84
Digging	.13	.24	.03	.13	.09	.19
Drilling	1.0	1.82	1.0	2.01	1.0	1.92
Total	XX	12.73	XX	15.40	XX	14.11

XX No operation performed.

area were manuring 34 percent of the grain acreage, while farmers in the northern area were covering only 14 percent. The average cost of plowing and harrowing was higher in the northern area. This was primarily due to a higher percentage of the ground plowed and harrowed. Leveling costs were higher in the southern area because of a higher cost per operating hour. Differences in other operations were due mainly to variations in the number of times over.

Corn

Corn was grown on 88 of the 119 farms. The average acreage of corn was 14 acres. The average cost of tillage operations in preparing and planting corn was $20.23 per acre for the combined areas. The northern area had slightly higher costs at $20.86 an acre than the south-central area at $19.54 an acre, table 11.

Cost of the different operations varied considerably between areas. Farmers in the northern area had higher expenditures for manuring, plowing, and harrowing. All the corn land was plowed in the northern area, while 95 percent was plowed in the south-central area. Farmers in the northern area harrowed their ground 2.85 times compared to 1.57 times in the southern area. The disking operation was used on more acres in the south-central area than in the north, while just the reverse was true for digging.

The cost of drilling corn is given only for those farmers doing their own drilling. South-central farmers had an average cost of $2.77 an acre for drilling, while northern farmers had a cost of $2.06 an acre. The higher cost was due to a higher operating hour requirement per acre drilled in the south-central area.

Table 11. Average cost of tillage operations in the preparation of land for corn, in northern and south-central area in Utah, 1960

	Northern		South-central		Total	
	Avg. no. of times over	Avg. cost per acre	Avg. no. of times over	Avg. cost per acre	Avg. no. of times over	Avg. cost per acre
Manuring	.69	7.46	.54	5.59	.62	6.51
Commercial fertilizing	.54	.81	.45	.39	.50	.59
Plow	1.00	5.03	.95	4.79	.97	4.91
Harrowing	2.85	2.23	1.57	2.24	2.20	2.23
Leveling	1.37	2.22	1.24	2.25	1.31	2.24
Disking	.28	.78	.48	1.08	.38	.94
Digging	.12	.27	.12	.43	.12	.35
Drilling[a]	.81	2.06	.85	2.77	.83	2.43
Total	XX	20.86	XX	19.54	XX	20.23

[a] Costs incurred by farmers drilling their own corn.

Sugar beets

Sugar beets were grown on 69 of the 119 farms, with an average of 20.3 acres per farm. The average cost of tillage operations on this land was $19.24 an acre, table 12. The difference in cost between the two areas was $2.64 an acre in favor of the northern area. Costs were higher per acre of beet land tilled in the south-central for the following reasons; a higher percentage of the land was manured, harrowing cost was more because of a higher operating hour requirement per acre even though the average number of harrowings were less, and higher leveling cost which was a result of the type of level use. Disking cost per acre of beet land planted was higher in the south-central area because

of a higher percentage of the land disked. Farmers in the south-central area often had to irrigate their land before planting to assure sufficient moisture to germinate their seed. This tends to cause a duplication of some operations.

Table 12. Average cost of tillage operations in the preparation of land for sugar beets, in northern and south-central areas in Utah, 1960

	Northern		South-central		Total	
	Avg. no. of times over	Avg. cost per acre	Avg. no. of times over	Avg. cost per acre	Avg. no. of times over	Avg. cost per acre
Manuring	.48	5.24	.73	6.95	.59	6.03
Commercial fertilizing	.83	.98	.92	.87	.86	.93
Plowing	1.00	4.43	.96	4.27	.97	4.36
Harrowing	3.56	2.53	2.21	2.85	2.94	2.68
Leveling	1.82	2.09	1.60	2.59	1.72	2.32
Disking	.17	.43	.54	1.13	.34	.75
Digging	.11	.24	.11	.31	.11	.27
Drilling[a]	.68	2.12	.97	1.73	.82	1.90
Total	XX	18.06	XX	20.70	XX	19.24

[a] Costs incurred by farmers drilling their own beets.

Miscellaneous crops

Other crops grown in the two areas were potatoes, peas, tomatoes, cabbage, beans, and celery. There was not enough acreage in these crops to establish reliable cost figures. Approximate cost for these crops could be arrived at by estimating the average number of times

over for each operation and multiplying it by the operating costs established in the cost per operation section.

SUMMARY

A total of 119 records were taken from two areas in Utah. Cache and Box Elder counties were chosen to represent the northern part of the state while Sanpete and Sevier counties were chosen to represent the south-central area. With the help of Soil Conservation Service personnel, irrigated crop land in these two areas was outlined on sectioned maps. Quarter sections were randomly chosen and farmers with more than 40 acres growing at least one row-crop, one small grain and a legume were used in compiling the list of sample farmers.

Information was collected from these farmers on all costs of tillage operations performed in preparation of the seedbed. The data collected was tabulated to ascertain performance rates, input requirements, and the monetary costs of these inputs for farm power and machinery.

The average size farm was 123 acres. Investment in land, tillage machinery and machine housing charged to tillage averaged $438 per acre. The machinery investment was $36 an acre and machine housing amounted to $3 an acre. Machinery investment was 8.2 percent of the land, machine, and machine housing investment.

Farmers on the average were spending 2.3 operating hours per acre on tillage operations. The average labor hour requirement per acre was 2.5 hours. The difference between operating hours and labor hours was time spent on preparation of the machine for use. Farmers used, on the average, 3.7 gallons of fuel per acre in performing their tillage operations.

Costs were grouped into two categories-- fixed and variable. Fixed costs, those costs associated with ownership, incurred by farmers in this project were: depreciation, interest on investment, taxes, and insurance. Fixed costs averaged $4.45 an acre, with the largest proportion accounted for by depreciation and interest on investment. On an operating hour fixed costs amounted to $1.96 an hour.

Variable costs result from operating the machine. Variable costs consisted of expenditures for labor, fuel, repairs, oil and lubrication, custom work, and miscellaneous machine charges. Average variable costs were $6.20 per acre. Labor was the largest item followed by fuel and repairs. Variable costs averaged $2.73 per operating hour.

Total costs were $10.65 per acre for the average farm. Operating costs were 58.2 percent of the total costs. Fixed costs accounted for the other 41.8 percent of the total cost.

Tillage costs were ascertained for each operation on a per acre tilled basis. Manuring was the most expensive operation with an average cost of $10.22 per acre. Plowing costs averaged $4.69 an acre, harrowing $.92 an acre, leveling $1.57 an acre, disking $2.19 an acre, digging $2.37 an acre, and commercial fertilizing $1.07 an acre. Average costs were figured separate for drilling the different crops. Drilling alfalfa, grain, peas, or pasture costs $1.94 for the average farm. Drilling corn averaged $2.36 an acre, and drilling beets $2.16 an acre.

Tillage costs for major crops grown in these areas ranged from a low of $.71 an acre for those operations performed on alfalfa to a high average cost of $20.23 an acre for corn. Grain had an average tillage cost of $14.11 an acre, while farmers growing sugar beets had an average tillage cost of $19.24 an acre.

CONCLUSION

Farmers in the two areas were well supplied with tillage machinery. The average tillage machinery investment was 8.2 percent of the investment in land, tillage machinery and machine housing allocated to tillage investment. The national average for all machinery as a percent of the total farm investment was 9.6 percent.

The size and type of machinery investment for a particular farmer will depend on several factors. Farmers with a high percentage of their land in alfalfa can get by with a smaller investment in tillage equipment than farmers with a low percentage. Operations other than tillage may determine the power unit and, consequently, its auxiliary tillage implements. Available labor and effects of timeliness of operation will also determine the size of the machinery investment.

Farmers are in need of information on the physical relations between output and timeliness of operation and compaction of the soil from working their ground. Without physical relationships for these factors economic relationships cannot be used with precision in determining an economical machinery investment. Also, information is needed on the machinery requirement for other phases of farming before a final decision can be made. Operations such as harvesting and cultivating may be more important as a determinant of the machinery investment than tillage. This project is concerned with only one phase of the production cycle and any decision regarding the whole cycle should be made only after weighing all factors.

In general, tillage costs were relatively close between the two areas. Farmers in the south-central area were taking a longer time to perform an operation, but this was partly offset in that northern farmers were performing more operations on their land than south-central farmers. With the exception of leveling there were no noticeable differences in the types of machines used. There were some slight differences in operations between the areas. These differences were due mainly to variations in moisture conditions between the areas. Any attempt to designate an economical machinery investment or an optimum method of performing tillage operations will have to await information on the physical relationships of these factors to crop production.

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APPENDIX

Table 13. Average cost per acre and per operating hour for manuring operation, in northern and south-central counties, Utah, 1960

Item	Unit	North		South-central		Total	
		Avg per acre	Avg per operating hour	Avg per acre	Avg per operating hour	Avg per acre	Avg per operating hour
Operating hours[a]	hrs.	2.7		2.1		2.4	
Labor	dol.	3.38	1.28	3.05	1.43	3.20	1.35
Repairs	dol.	.57	.22	.67	.31	.63	.27
Fuel	dol.	.86	.33	.96	.45	.92	.39
Oil & lubrication	dol.	.13	.05	.10	.05	.12	.05
Custom work	dol.			.13	.06	.13	.06
Taxes	dol.	.14	.05	.16	.08	.15	.07
Depreciation	dol.	1.89	.72	1.81	.85	1.85	.78
Interest on investment	dol.	1.12	.43	1.10	.51	1.11	.47
Fixed costs on power unit	dol.	2.32	.88	1.94	.91	2.11	.89
Total costs	dol.	10.41	3.96	9.92	4.77	10.22	4.33

[a] Non-cost item.

Table 14. Average cost per acre and per operating hour for commercial fertilizing, in northern and south-central counties, Utah, 1960

Item	Unit	North		South-central		Total	
		Avg per acre	Avg per operating hour	Avg per acre	Avg per operating hour	Avg per acre	Avg per operating hour
Operating hours[a]	hrs.	.2		.4		.3	
Labor	dol.	.39	1.63	.50	1.39	.44	1.49
Repairs	dol.	.02	.08	.01	.04	.02	.05
Fuel	dol.	.08	.34	.13	.36	.10	.35
Oil & lubrication	dol.	.01	.05	.02	.05	.02	.05
Custom work	dol.	.07	.31	XX	XX	.07	.31
Taxes	dol.	.01	.05	.01	.02	.01	.03
Depreciation	dol.	.11	.45	.12	.34	.11	.39
Interest on investment	dol.	.10	.40	.09	.25	.09	.31
Fixed cost on power unit	dol.	.26	.92	.22	.60	.24	.75
Total costs	dol.	1.05	4.23	1.09	3.05	1.07	3.57

[a] Non-cost item.
XX No operation performed.

Table 15. Average cost per acre and per operating hour for plowing in northern and south-central counties, Utah, 1960

Item	Unit	North		South-central		Total	
		Avg per acre	Avg per operating hour	Avg per acre	Avg per operating hour	Avg per acre	Avg per operating hour
Operating hours[a]	hrs.	1.1		1.1		1.1	
Labor	dol.	1.42	1.34	1.52	1.36	1.47	1.35
Repairs	dol.	.58	.55	.43	.39	.51	.47
Fuel	dol.	.61	.58	.59	.53	.60	.56
Oil & lubrication	dol.	.05	.05	.06	.05	.05	.05
Custom work	dol.	.06	.06	.04	.04	.05	.05
Taxes	dol.	.03	.03	.04	.03	.03	.03
Depreciation	dol.	.42	.40	.45	.40	.44	.40
Interest on investment	dol.	.25	.24	.28	.25	.27	.25
Fixed cost on power unit	dol.	1.20	1.15	1.31	1.17	1.25	1.16
Total costs	dol.	4.62	4.41	4.73	4.22	4.69	4.32

[a] Non-cost item.

Table 16. Average cost per acre and per operating hour for harrowing, in northern and south-central counties, Utah, 1960

Item	Unit	North		South-central		Total	
		Avg per acre	Avg per operating hour	Avg per acre	Avg per operating hour	Avg per acre	Avg per operating hour
Operating hours[a]	hrs.	.2		.4		.3	
Labor	dol.	.29	1.38	.50	1.35	.36	1.37
Repairs	dol.	.02	.10	.02	.06	.02	.08
Fuel	dol.	.10	.46	.18	.49	.13	.48
Oil & lubrication	dol.	.01	.05	.02	.05	.01	.05
Custom work	dol.	XX	XX	XX	XX	XX	XX
Taxes	dol.	**	.02	**	.01	**	.01
Depreciation	dol.	.05	.22	.06	.17	.05	.20
Interest on investment	dol.	.02	.11	.03	.07	.04	.09
Fixed cost on power unit	dol.	.24	1.06	.48	1.18	.32	1.12
Total cost	dol.	.73	3.41	1.29	3.39	.92	3.40

[a] Non-cost item.
** Less than one cent.
XX No operation performed.

Table 17. Average cost per acre and per operating hour for leveling, in northern and south-central counties, Utah, 1960

Item	Unit	North		South-central		Total	
		Avg per acre	Avg per operating hour	Avg per acre	Avg per operating hour	Avg per acre	Avg per operating hour
Operating hours[a]	hrs.	.4		.5		.4	
Labor	dol.	.51	1.33	.86	1.36	.58	1.35
Repairs	dol.	.01	.02	.03	.05	.02	.04
Fuel	dol.	.19	.48	.23	.48	.21	.48
Oil & lubrication	dol.	.02	.05	.02	.05	.02	.05
Custom work	dol.	XX	XX	XX	XX	XX	XX
Taxes	dol.	**	.01	.01	.02	.01	.01
Depreciation	dol.	.11	.28	.21	.44	.16	.36
Interest on investment	dol.	.04	.09	.10	.20	.06	.15
Fixed cost on power unit	dol.	.52	1.49	.53	1.08	.52	1.24
Total cost	dol.	1.40	3.76	1.79	3.68	1.57	3.68

[a] Non-cost item.
** Less than one cent.
XX No operation performed.

Table 18. Average cost per acre and per operating hour for disking, in northern and south-central counties, Utah, 1960

Item	Unit	North		South-central		Total	
		Avg per acre	Avg per operating hour	Avg per acre	Avg per operating hour	Avg per acre	Avg per operating hour
Operating hours[a]	hrs.	.4		.5		.5	
Labor	dol.	.52	1.27	.67	1.36	.62	1.33
Repairs	dol.	.13	.31	.10	.20	.11	.24
Fuel	dol.	.19	.46	.25	.50	.23	.49
Oil & lubrication	dol.	.02	.05	.03	.05	.05	.05
Custom work	dol.	XX	XX	.03	.06	.03	.06
Taxes	dol.	.02	.06	.02	.03	.02	.04
Depreciation	dol.	.40	.99	.29	.56	.32	.70
Interest on investment	dol.	.16	.40	.12	.25	.14	.30
Fixed cost on power unit	dol.	.74	1.61	.67	1.21	.69	1.32
Total cost	dol.	2.22	5.23	2.18	4.25	2.19	4.54

[a] Non-cost item.
XX No operation performed.

Table 19. Average cost per acre and per operating hour for digging, in northern and south-central counties, Utah, 1960

Item	Unit	North		South-central		Total	
		Avg per acre	Avg per operating hour	Avg per acre	Avg per operating hour	Avg per acre	Avg per operating hour
Operating hours[a]	hrs.	.4		.5		.4	
Labor	dol.	.48	1.38	.70	1.36	.54	1.37
Repairs	dol.	.12	.34	.55	1.07	.22	.57
Fuel	dol.	.17	.48	.21	.41	.18	.46
Oil & lubrication	dol.	.02	.05	.03	.05	.02	.05
Custom work	dol.	XX	XX	XX	XX	XX	XX
Taxes	dol.	.03	.08	.01	.03	.02	.06
Depreciation	dol.	.43	1.23	.42	.81	.43	1.10
Interest on investment	dol.	.19	.55	.13	.25	.18	.45
Fixed cost on power unit	dol.	.42	1.11	1.42	2.72	.79	1.85
Total cost	dol.	1.86	5.22	3.47	6.69	2.37	5.92

[a] Non-cost item.
XX No operation performed.

Table 20. Average cost per acre and per operating hour for drilling grain, peas, alfalfa and pasture in northern and south-central counties, Utah, 1960

Item	Unit	North		South-central		Total	
		Avg per acre	Avg per operating hour	Avg per acre	Avg per operating hour	Avg per acre	Avg per operating hour
Operating hours[a]	hrs.	.3		.5		.4	
Labor	dol.	.47	1.36	.69	1.37	.58	1.36
Repairs	dol.	.10	.28	.07	.15	.08	.20
Fuel	dol.	.13	.38	.18	.35	.15	.36
Oil & lubrication	dol.	.02	.05	.03	.05	.02	.05
Custom work	dol.	.02	.06	.02	.04	.02	.05
Taxes	dol.	.03	.09	.02	.04	.03	.06
Depreciation	dol.	.30	.88	.27	.54	.29	.68
Interest on investment	dol.	.31	.90	.28	.56	.29	.70
Fixed cost on power unit	dol.	.44	1.08	.52	.93	.48	.99
Total cost	dol.	1.81	5.07	2.07	4.02	1.94	4.45

[a] Non-cost item.

Table 21. Average cost per acre and per operating hour for drilling corn in northern and south-central counties, Utah, 1960

Item	Unit	North		South-central		Total	
		Avg per acre	Avg per operating hour	Avg per acre	Avg per operating hour	Avg per acre	Avg per operating hour
Operating hours[a]	hrs.	.4		.6		.5	
Labor	dol.	.57	1.40	.85	1.41	.72	1.41
Repairs	dol.	.05	.12	.10	.17	.08	.15
Fuel	dol.	.15	.36	.18	.30	.16	.32
Oil & lubrication	dol.	.02	.05	.03	.05	.03	.05
Custom work	dol.	.46	1.13	.40	.67	.43	.85
Taxes	dol.	.02	.04	.03	.05	.02	.05
Depreciation	dol.	.18	.44	.29	.48	.24	.47
Interest on investment	dol.	.17	.41	.24	.40	.21	.41
Fixed cost on power unit	dol.	.44	1.08	.52	.93	.48	.99
Total cost	dol.	2.06	5.04	2.65	4.47	2.36	4.70

[a] Non-cost item.

Table 22. Average cost per acre and per operating hour for drilling sugar beets in northern and south-central counties, Utah, 1960

Item	Unit	North		South-central		Total	
		Avg per acre	Avg per operating hour	Avg per acre	Avg per operating hour	Avg per acre	Avg per operating hour
Operating hours[a]	hrs.	.3		.5		.4	
Labor	dol.	.49	1.46	.73	1.35	.60	1.40
Repairs	dol.	.07	.21	.08	.15	.08	.18
Fuel	dol.	.11	.31	.15	.28	.13	.30
Oil & lubrication	dol.	.02	.05	.03	.05	.02	.05
Custom work	dol.	.70	2.08	.32	.58	.52	1.21
Taxes	dol.	.03	.08	.01	.01	.02	.04
Depreciation	dol.	.20	.60	.11	.20	.16	.37
Interest on investment	dol.	.21	.61	.09	.16	.15	.35
Fixed cost on power unit	dol.	.32	.79	.49	.87	.40	.82
Total cost	dol.	2.14	6.28	2.01	3.67	2.08	4.71

[a] Non-cost item.