

USER GUIDE

FARM MACHINERY SELECTION AND MANAGEMENT PROGRAM

Version: S10

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# FARM MACHINERY SELECTION AND MANAGEMENT PROGRAM<sup>1</sup>

Version: S10

## INTRODUCTION

The Farm Machinery Selection and Management Program, Version S10, is specifically designed to assist in selecting and managing farm machinery for farms in Illinois. However, depending on the crops, location and other factors the program may be useful for farms in other states. Also, the program may be a very useful for learning many of the principles of machinery selection and management.

To write the program it was necessary to use numerous variables and assumptions. These variables and assumptions and methodology used, may not be applicable to a farm for which the program is used. Therefore, before making any decisions based on the results of the program, the variables, assumptions, and methodology should be understood and the results checked thoroughly.

## METHODOLOGY

### MACHINERY-RELATED COSTS

Machinery-related costs for Midwest farms range from \$50/ac/yr to \$70/ac/yr and overshadow all other cost categories, except land. Oversized equipment or more equipment than necessary means extra expense. Likewise, undersized or less equipment than necessary means critical operations are not completed in a timely manner, which results in decreased yields or lower crop quality and increased labor cost. The "optimum" or "least cost" machinery inventory is a compromise between costs for machinery and costs for labor and timeliness.

The program determines the optimum machinery inventory by estimating the costs of several sets of machinery that can perform the desired field operations. Various sizes of machinery are tried. As the size of a machinery set increases, both machinery productivity (ac/hr) and initial price increase. The annual machinery costs, fixed and variable, increase

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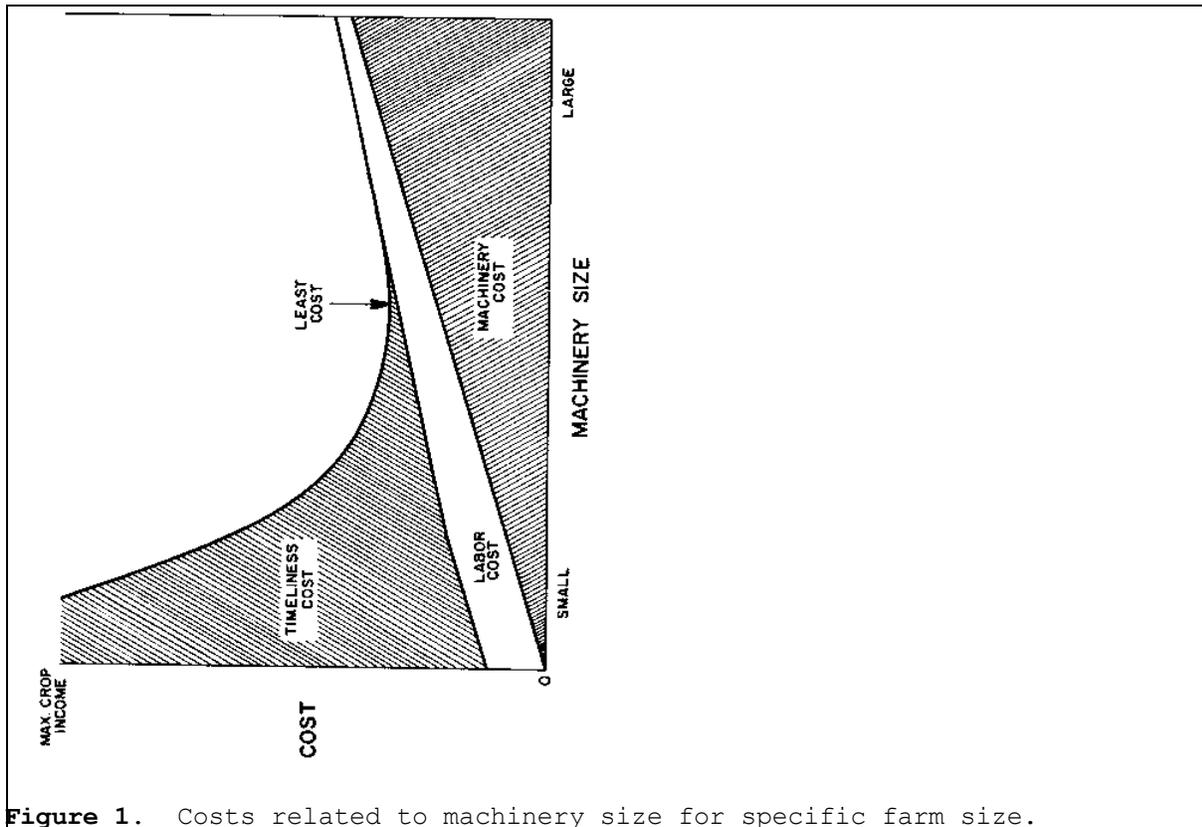


Figure 1. Costs related to machinery size for specific farm size.

with increasing machinery size as shown by the lower line in Figure 1. For labor costs, Figure 1 assumes machinery operators are paid on an hourly basis. Total labor cost is constant until machinery is large enough to reduce field time. Then labor cost decreases because total field time decreases. Timeliness is defined as the ability of available labor, using a given set of machinery, to complete each field operation within an optimum time period. Research data show that corn yields decrease if planting is not done before the middle of May in the Corn Belt. The value of the lost yield is the timeliness cost. A timeliness cost is associated with late planting of most crops. Also, a timeliness cost is associated with harvesting most crops. Timeliness cost is high with small machinery and decreases as machinery

size increases. The total machinery-related cost is the sum of the machinery costs plus labor and timeliness costs. Optimum, or least-cost machinery set is the one that results in the lowest total machinery-related cost as indicated in Figure 1.

Because of the many variables, finding the optimum machinery set is tedious and time consuming. A computer and appropriate software can efficiently compare a myriad of combinations and determine the optimum set for various farm sizes, crops, crop rotations and production systems. The program S10 is an attempt to provide such software.



## THE PROGRAM, S10

The program, S10, is written in the C programming language and runs on an IBM compatible computer. To explain the program and how the optimum machinery set is determined, a 1,000-acre corn-soy-bean farm will be used as an Example.

### LOADING THE PROGRAM

To load the program for the Example farm proceed as follows:

Insert the Farm Machinery Selection program diskette, S10, in drive A.

Get the "A>" prompt from MS - DOS on your computer screen.

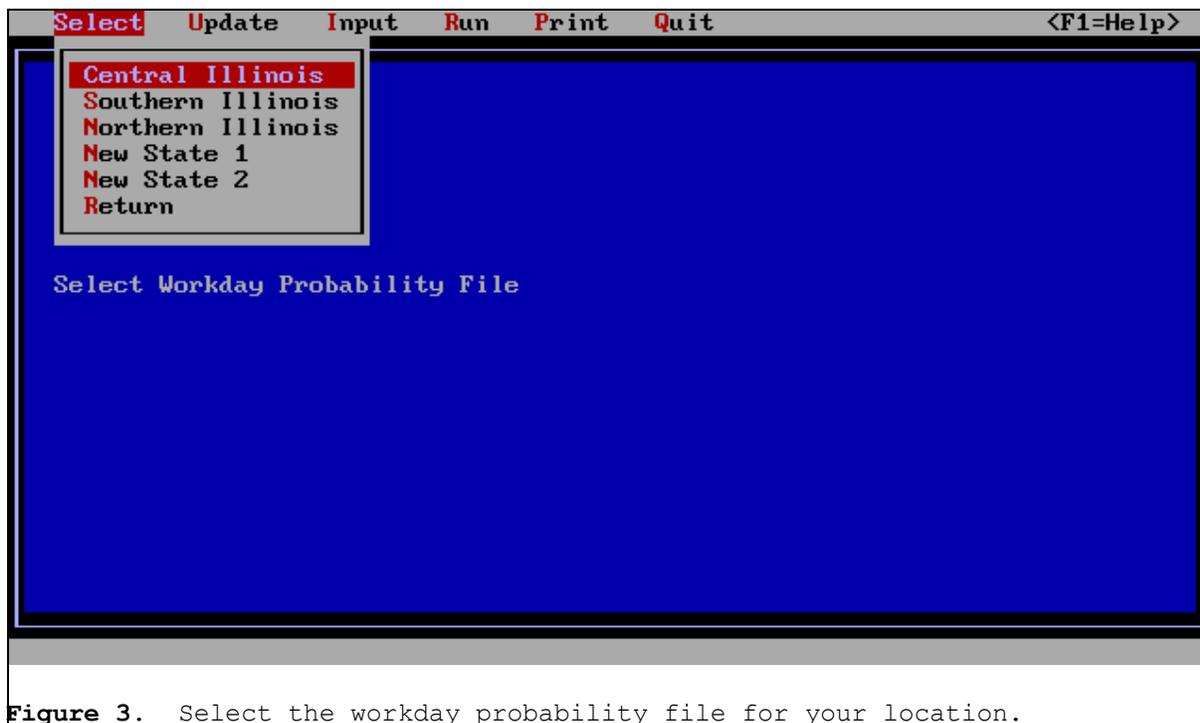
To load the program enter "S10" and press the enter key.

### TITLE SCREEN

The title screen (Figure 2) will appear shortly. Read the title screen. Press any key to continue.

Next you will see the "MAIN MENU" screen. Across the top will be the titles:

Select Update Input Run Print Quit



**Figure 3.** Select the workday probability file for your location.

## SELECT

From the Main Menu press the "Enter" key with the title "Select" highlighted, to select the workday probability data that will be used when running the program (Figure 3). You may choose to use workday probability data from Central, Southern, or Northern, Illinois or for the other locations listed if data has been entered and stored for the other locations. For other locations workday probability data can be entered and stored using "Update" from the Main Menu. The name chosen to store the data will replace the names "New State 1" or "New State 2".

## UPDATE

From "Update" information and data pertaining to the "Operation List", "Timeliness Costs", and "Workday Probabilities" can be assessed, changed and stored.

## Operation List

The "Operation List" contains the field operations that can be performed by the program and the machinery available to perform those operations. Included for each machine are the cost factors, RV1 and RV2 for calculating depreciation, RC1 and RC2 for calculating repair costs, and the estimated LIFE. For power units, combines (Figure 4) and tractors (Figure 6) data also include the horsepower, name, and list price. For combine attachments, corn heads and grain platforms, and implements for tractors, the data include power unit used, size, estimated productivity, and list price (Figures 5 and 7). Any of the machines and data may be

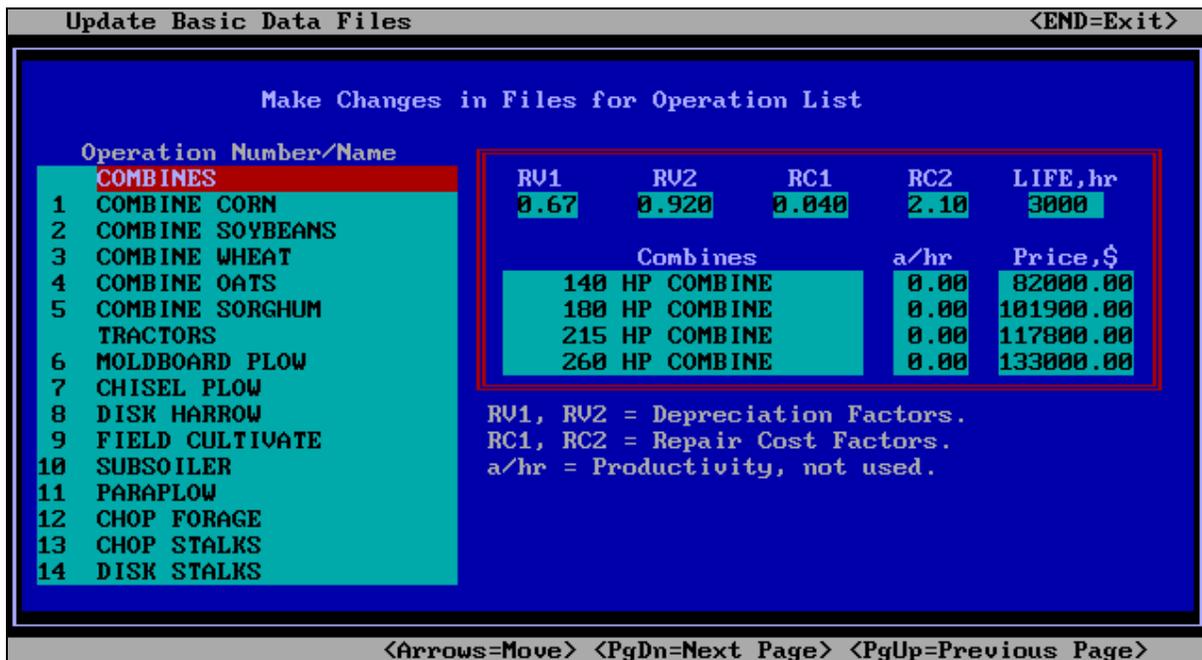


Figure 4. List of combines (without headers)

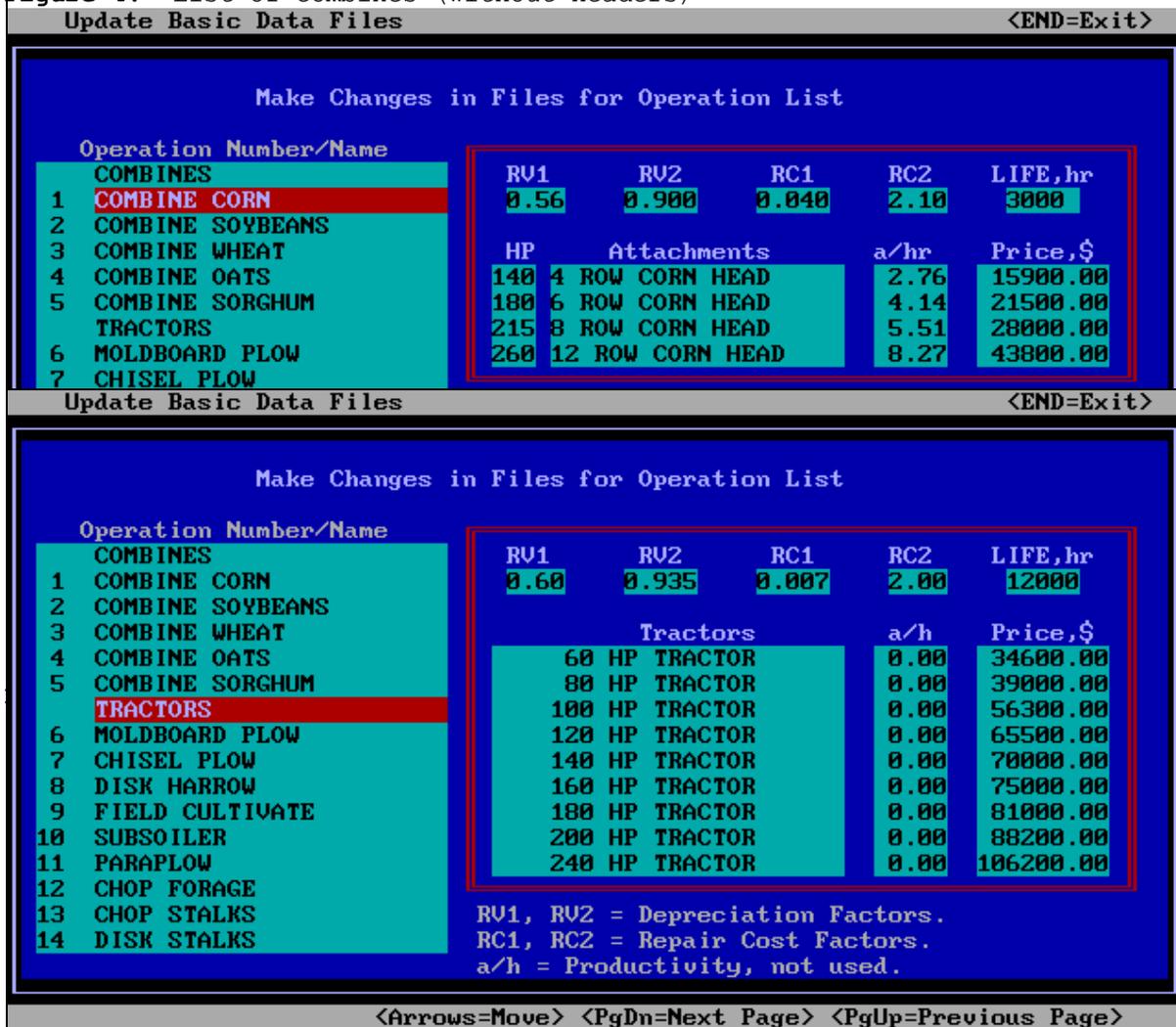


Figure 6. List of tractors

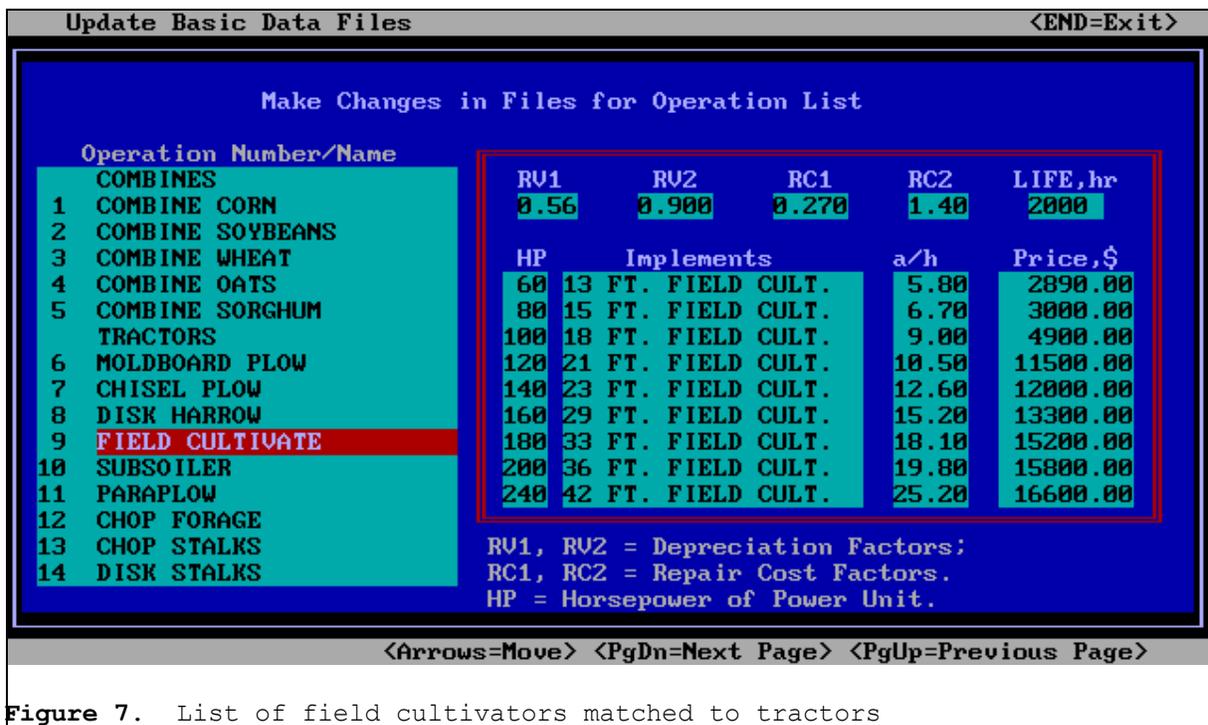


Figure 7. List of field cultivators matched to tractors

Table 1. Array used to match tractors, combine corn heads and planters.

Tractor (HP)	Corn Head Size (No. of Rows)							
	4	6	8	12	4	6	8	12
	Planter Sizes (No. of Rows)							
	----- Same <sup>1</sup> -----				----- Twice <sup>1</sup> -----			
60	4	-	-	-	-	-	-	-
80	4	6	8	-	8	-	-	-
100	4	6	8	12	8	12	16	-
120	4	6	8	12	8	12	16	24
140	4	6	8	12	8	12	16	24
160	4	6	8	12	8	12	16	24
180	4	6	8	12	8	12	16	24
200	4	6	8	12	8	12	16	24
220	4	6	8	12	8	12	16	24

<sup>1</sup> Planters may have the same or twice the number of rows as combine corn head.

changed by the program user. How the factors, RV1, RV2, RC1, RC2, and LIFE are used to estimate costs is discussed later.

A list price of \$0.00 is used for a machine assumed not to be owned but made available at no charge. This may occur with fertilizer applicators, for example. For such operations costs are estimated by the program only for use of a tractor. If desired the program user may enter a list price for these implements and then their cost will be estimated.

If a tractor does not have sufficient power to pull an implement the productivity is set to 0.0. For example, for the 60 horsepower tractor the productivity for chisel plow is set to 0.0, which means the program will not allow the 60 horsepower tractor to be used for chisel plowing.

The user is cautioned about changing the size of the planters and row cultivators.

These implements are not matched to the tractors as indicated. The program uses an array used to match planters and row cultivators to tractors and combine corn heads (Table 1). The array provides a choice of 1) same number of rows on the planter as on the corn head or 2) twice the number of rows on the planter as on the corn head. An additional constraint imposed is that the tractor, planter and row cultivator sizes must be compatible in regard to available tractor power and power required by the planter and row cultivator. The array may be changed by using an appropriate editor from outside the program. The array is stored in the file "PLANTERS.JTK".



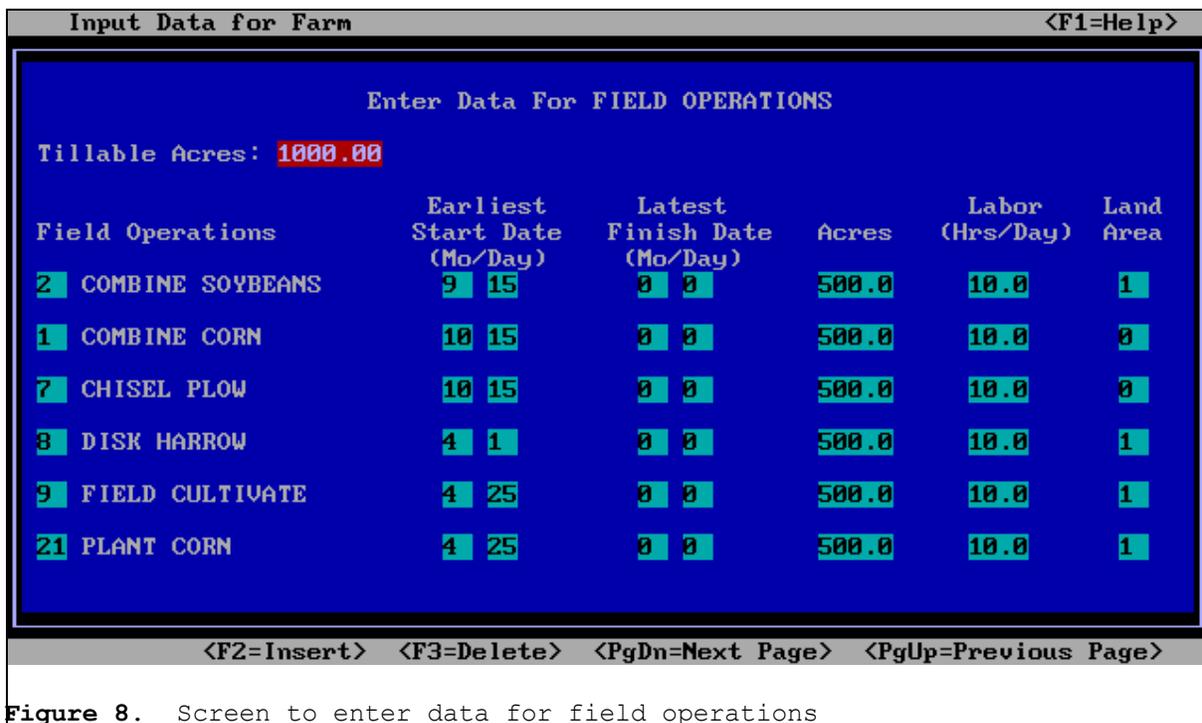


Figure 8. Screen to enter data for field operations

### Workday Probabilities

From "Update" the "Workday Probabilities" can be accessed and if desired changed and saved. The workday probability data accessed from "Update" are the data loaded under "Select" from the Main Menu or if not loaded under "Select" the data are default data. The probabilities provided with the program are for Illinois (Schwart, 1981). The probabilities represent the fraction of each day of the year which field work is feasible at least 5 of 6 years (83.3% of time). For the discussion which follows related to running the "EXAMPLE" farm, it is assumed that the probability data for Central Illinois is loaded in computer memory.

### Timeliness Costs

When a planting or harvesting operation occurs after the penalty date, a crop yield decrease is assumed and a timeliness penalty is calculated. The timeliness penalty is calculated by multiplying the expected crop yield, appropriate timeliness factor, number of acres delayed, and days of delay. From "UPDATE" only the timeliness factor can be changed. The expected crop yields can be set under "Input". The number of acres and the days of delay are determined when the operations are scheduled.

## INPUT

The "Input" menu has seven screens which are discussed below.

### Input Stored Data File

"Input Stored Data File" allows a stored data file to be read and contains all the necessary information to run the program for a farm. For your first time through the program read in the file "EXAMPLE".

### Field Operations

For the EXAMPLE farm, the first entry on the "Field Operations" screen is the total tillable acres which is used in the program to calculate total costs per acre (Figure 8).

The rest of the screen is used to enter the desired field operations and other information needed for each operation. For a list of the field operations acceptable to the program, press the "F1" key. Acceptable operations and the number to enter for each operation will appear.

For each field operation, the code number corresponding to that operation must be entered. We have found it convenient and to cause the fewest problems by beginning the entries with the first fall operation or the first spring operation. It is important to start the list of operations at a time that two or more operations are not likely to conflict when scheduled and then in the order in which they occur. The order in which the operations are entered is important and is discussed more below.

For each operation the "Earliest Start Date" must be entered. For the "EXAMPLE" farm the Earliest Start Date for combine soybeans has been entered as 9/15. This means that September 15 is the

earliest date soybeans are typically ready for harvest. An entry in the "Latest Finish Date" column is optional. It is suggested that the "Latest Finish Date" column be left blank, "0/0", for all operations. In fact, entering a date restricts the machinery selection procedure. The program will determine a finish date for each operation. The "Latest Finish Date" is intended to be used only if an operation must be completed by a specific date for a machinery set to be acceptable. For combine soybeans a latest finish date of 12/15 might be entered to prevent the program from spending time with machinery sets that harvest soybeans after that date.

The next entry is the acres for the operation and then the hours per day. For hours per day use the number of hours labor is available per day or the maximum number of hours each day the operation can be preformed, which ever is least. The number of hours per day is hours in the field operating machinery.

The last entry for each desired field operation is the "land area" number. Allowable numbers for land area are 0 through 4. The "land area" numbers are used to help insure that the operations are scheduled correctly. To determine the "land area" number for each operation, divide the farm into areas on which the same set of operations are to be preformed and then give each area a different "land area" number. For the EXAMPLE farm there are two land areas - one for corn and one for soybeans. A "land area" of "0" has been entered for operations preformed on land from which soybeans are harvested. Likewise, a "land area" of "1" has been entered for operations preformed on the land from which corn is harvested. Other farms with more crops or different tillage and planting operations for the same crop will require

additional land area numbers.

The second operation listed for the EXAMPLE farm is combine corn. The third operation listed is chisel plow. The chisel plow operation is performed on the same land area from which the corn is harvested. Thus, the land area numbers are the same for both combine corn and chisel plow operations. The land area number for chisel plow being the same as the number for combine corn insures that the chisel plow operation will not occur before or get ahead of the combine corn operation when the operations are scheduled.

For the EXAMPLE farm, the spring operations for corn are disk harrow, field cultivate and plant corn. These operations are to be performed on the ground that was in soybeans the previous year and, therefore, have the same land area number, "1". For soybeans, the spring operations are disk harrow, field cultivate, and plant. These operations are to be performed on the previous years corn ground and, therefore, have the same land area number, "0".

Note that the "Earliest Start Date" for both disk harrow operations is 4/1. For the spring operations, the program will first schedule the operations for corn; disk harrow, field cultivate, and plant. Because these operations for corn are listed first they have priority in scheduling over the disk harrow operation listed before soybean planting. The disk harrow operation will be scheduled on any dates an operator, tractor, and disk harrow are available on or after April 1. Then as soon as possible after the indicated earliest start date, the field cultivate and plant soybeans operations will be scheduled. And last, the row cultivate operations will be scheduled.

## Tractors and Combines

To explain the information required on the "Tractors and Combines" screen (Figure 9), it is necessary to understand the "Run" options available in the program.

Run option "Without Optimization" is used to determine the work schedule, machinery use, and costs with the number and sizes of the tractors and combines specified. For this option the user must fill all the entries in Figure 9. Entries include; the number of tractors, how many are large and small and the size of the tractors; and the number and size of the combines and the number of combine attachments. Note that a maximum of six tractors of two sizes is allowed, and a maximum of three combines is allowed.

Run option "With Optimization" is used to optimize the sizes of the tractors and combines with the number of each being fixed. For this option the number of tractors, large and small, and the number of combines must be specified in Figure 9. To optimize the number of tractors and combines using this option, it is necessary to run the program with different numbers of tractors and combines and then compare the results.

Run option "Complete Optimization" is used to optimize both the sizes and number of tractors. For this option no entries need to be made in Figure 9. With this

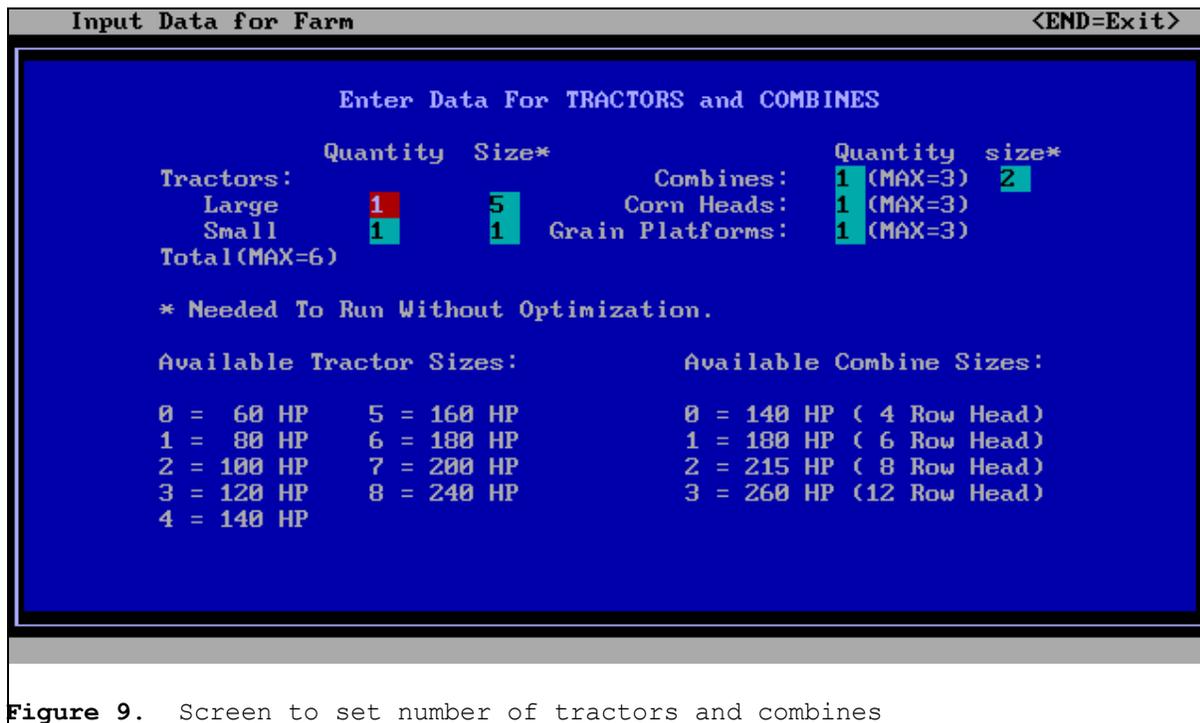


Figure 9. Screen to set number of tractors and combines

option the number of tractors is limited to two, the number of combines to one, and the number of machine operators to four.

### Match Implements to Tractors

On the "Match Implements to Tractors" screen (Figure 10) the number of large and small tractors previously set on the "Tractor Data" screen is shown in the upper right corner. This serves only as a reminder of the number of large and small tractors set on the "Tractors and Combines" screen (Figure 9).

The upper left corner on the screen is used to set the planter size (Figure 10). If a "T" is entered, the planter size (number of rows) used in the program will be twice the combine size (number of rows on corn head). If an "S" is entered, the planter size (number of rows) will be equal to the combine size (number of rows).

In the lower portion of the screen, you must specify the number of implements and assign each implement to either the large or small tractors. At least one implement for each different field operation to be performed (as listed in Figure 8) must be assigned. If you assign one or more specific implements to both large and small tractors, the program will include the total number of implements in the inventory and cost calculations. It may be necessary to try different implement assignments and by trial and error find the particular assignments which result in a realistic low cost solution.

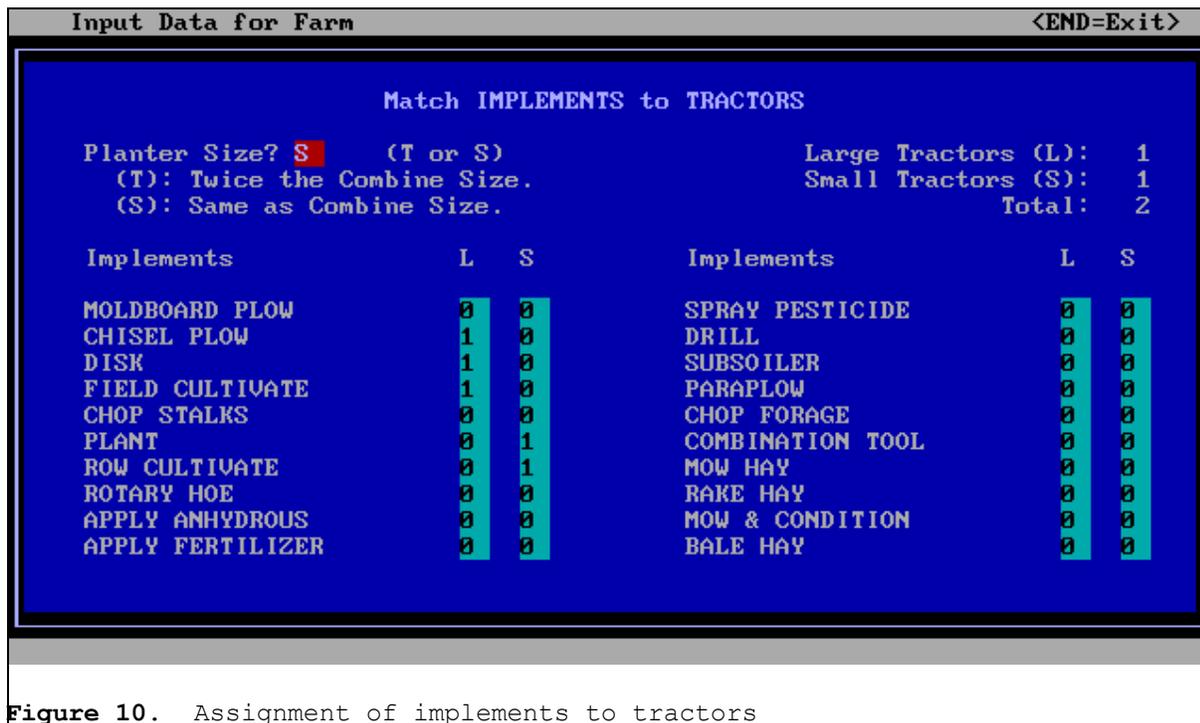


Figure 10. Assignment of implements to tractors

Press the "End" key to exit the "Match Implements to Tractors" screen and return to the main Input screen.

### Economic Factors and Timeliness

Operators, Number and Cost, may be changed (Figure 11). The minimum number of operators is 1 and the maximum is 6. Cost for operators may be entered in terms of dollars per hour. A cost of \$0.00/hr means operators are available but the time spent operating machinery is not considered a factor in determining the optimum machinery size or cost.

The program does not optimize the number of machine operators. To optimize the number of operators, it is necessary to run the program with various numbers of operators and compare the results.

Combine harvesting operations are assumed to utilize two operators; one to operate the combine and one to haul grain from the combine. If only one person is available for combine harvesting, it is assumed 50% of that persons time is spent hauling and processing the grain. Thus, the combine operating time per day is reduced 50%.

Economic Factors includes machinery purchase price, as a percent of list; housing, interest and insurance percentage; percent inflation; and fuel price are used to estimate the machinery fixed and variable costs (Figure 11). Details of how these costs are calculated are given in the Appendix.

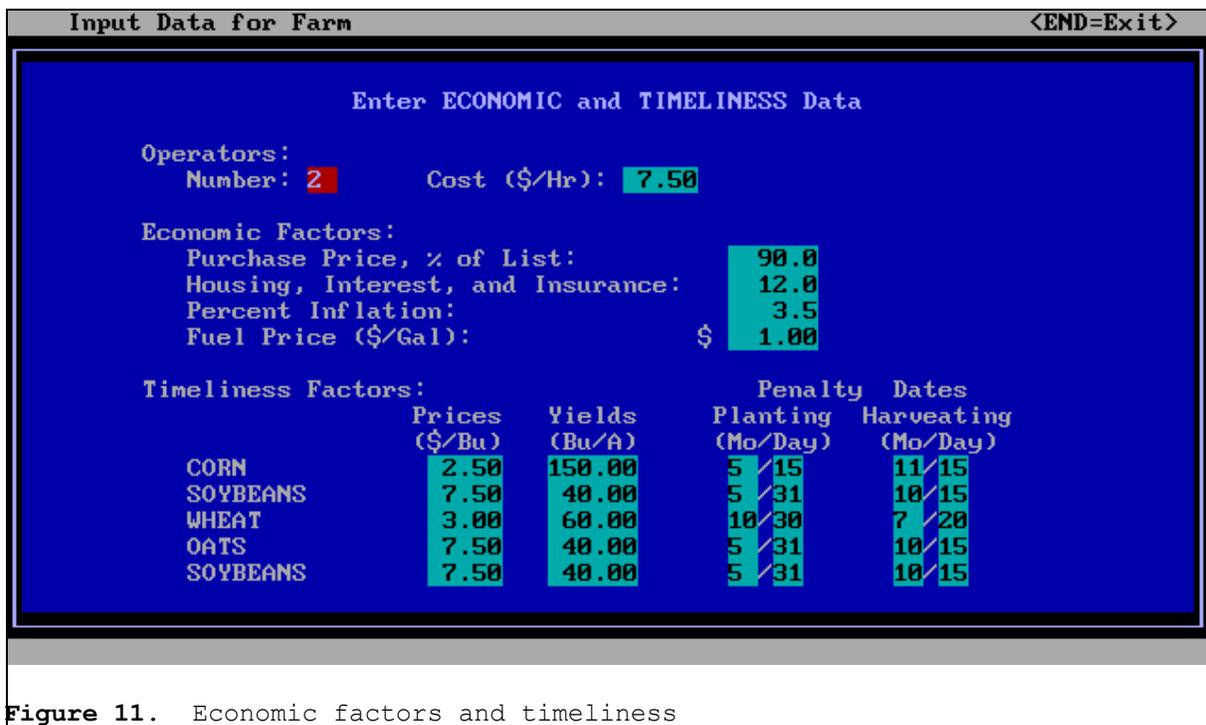


Figure 11. Economic factors and timeliness

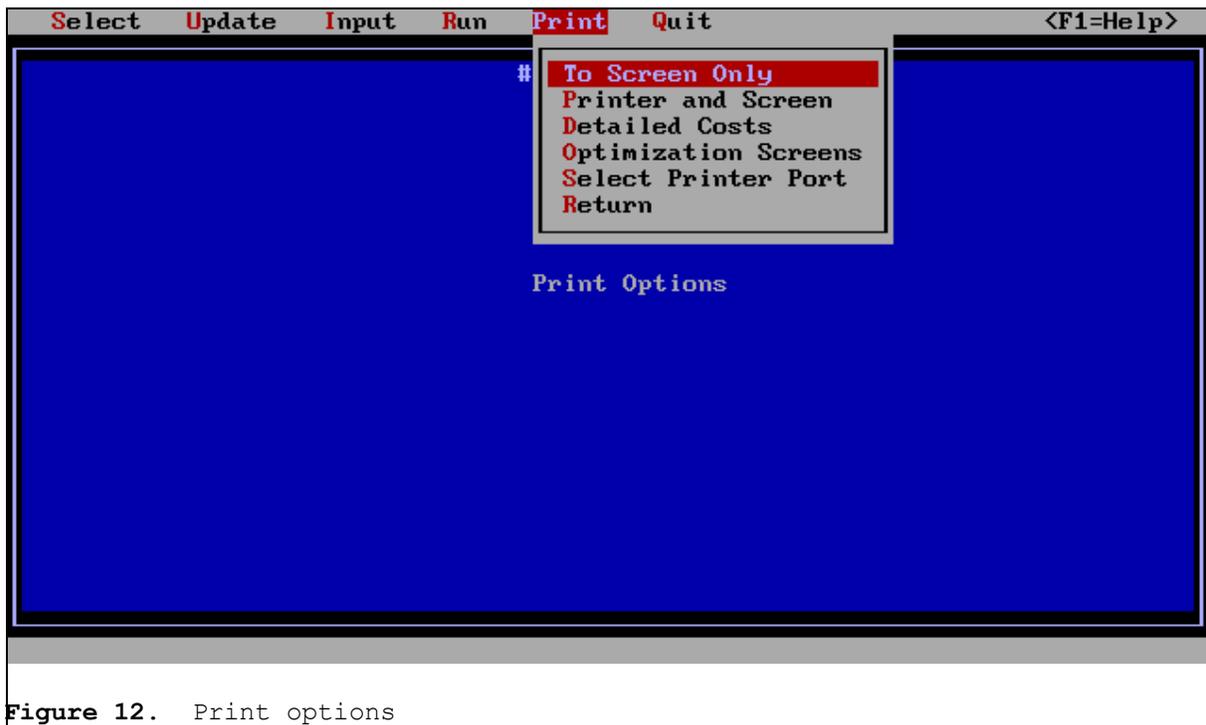
Timeliness Factors include Crop Prices, Yields and Penalty Dates (Figure 11) are used to compute applicable timeliness penalties when the field operations are scheduled. Crop yields are assumed to equal the values entered for each specific crop, if the planting and harvesting operations are completed on or before the respective penalty date entered. When either a planting or harvesting operation occurs after the penalty date, a yield decrease is assumed and a timeliness penalty is calculated. The yield decrease assumed is equal to the yield entered for the crop times the appropriate timeliness factor times the number of days late. Timeliness factors for the different crops can be set on the "Timeliness Costs" screen, an option of "Update" on the Main Menu.

Using a timeliness factor of 1% and a price of \$2.50/bu a timeliness cost for corn would be figured as follows. When the

program schedules the operations, if corn is planted after the penalty date, the yield decrease would be equal to 1.0% (penalty factor previously set for corn) times the yield times the number of days delay. The yield decrease would be 1.50 (1.0% of 150) bushels per acre for each day of delay. If 50 acres are planted one day late, the yield decrease or penalty would be 75 (50 x 1.50) bushels. The timeliness cost would be \$150 (75 \* 2.50), the timeliness penalty times the price of the crop.

#### Store Data File

"Store Data File" allows you to store the data entered on the Input screens. When asked for a file name do not use the file



name "EXAMPLE" as this would erase the data stored under that name.

### Print Options

From the Main Menu the "Print" options can be set (Figure 12). "To Screen Only" means results will appear on the computer screen. "Printer and Screen" means results will be printed by the printer and appear on the screen. Selecting "Detailed Costs" causes the cost of each machine will appear on the screen and, also, printed if "Printer and Screen" option is selected. The optimization screens will always appear on the screen and may be printed by selecting "Optimization Screens".

For the discussion that follows select "To Screen only" and "Detailed Costs".

### RUN

As discussed in the section above on "Tractors and Combines", three "Run" options are available; "Optimization", "Complete Optimization", and "Without Optimization".

### Optimization

Selecting "Optimization" causes the program to search for the optimal (least cost) machinery set with the number of operators, tractors, and combines as set on the "Tractors and Combines" and the "Economic Factors and Timeliness" screens. That is, only the size of the tractors and combines are optimized.

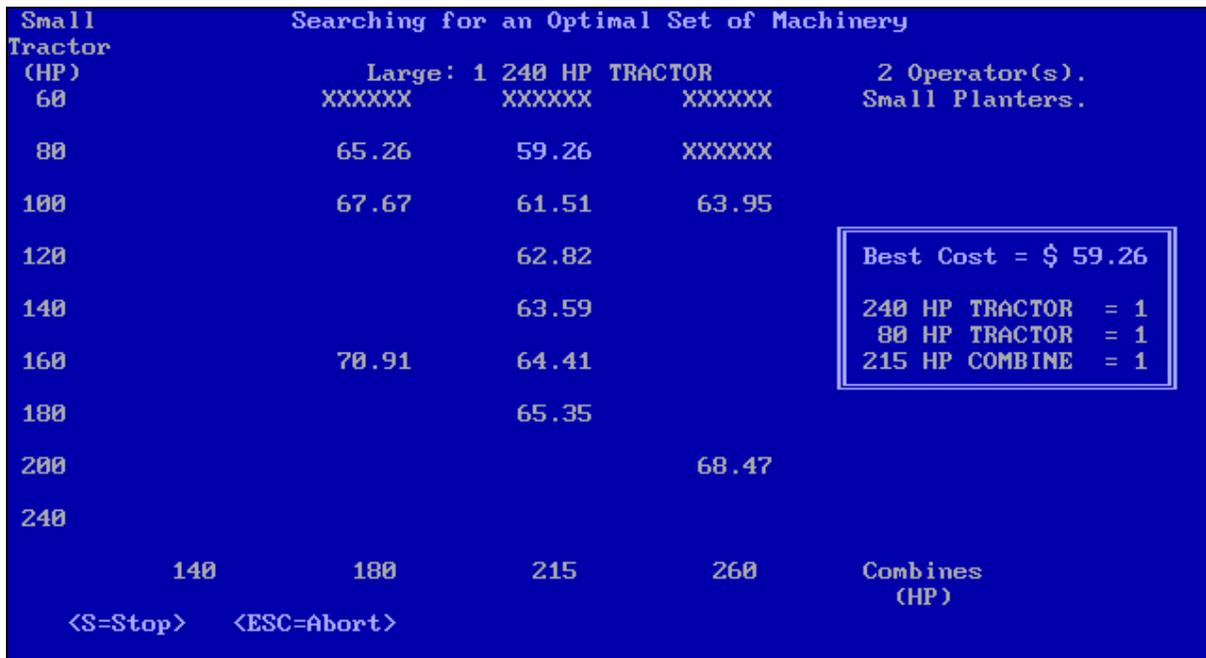


Figure 13. First optimization screen

### Complete Optimization

Selecting "Complete Optimization" causes the program to find the least cost set of machinery including the number and size of tractors and combines, number of operators, and size of planters relative to combine head size. However, this portion of the program has not been fully completed, as the number of tractors is limited to two, the number of combines to one, and the number of machine operators to four.

### Without Optimization

Run "Without Optimization" causes the program to use constraints selected earlier including the number of machine operators, number and sizes of the tractors and combines, and size of planters relative to combine header size for row crops.

The following discussion assumes from the Main Menu that the following steps have been taken from the Main Menu:

- 1) The "Select" option was used to load workday probability data for "Central Illinois".
- 2) Using "Input" from the Main Menu and the "Input Stored Data File" option, the file "EXAMPLE" has been read into memory.
- 3) From the "Run" option the "Enter" key is pressed with "Optimization" highlighted. After you press "Enter" with "Optimization" highlighted, the program should begin searching for the optimal machinery set.

### RUNNING THE PROGRAM

### Searching for an Optimal Set of Machinery

The first optimization screen is reproduced in Figure 13. The other optimization screens are not shown in this paper. For each optimization screen the program holds constant the number and size of the large tractors, shown near the top of the screen. Starting with the largest tractors available in the program, the size of the small tractors and the size of the combines are varied. Each value that appears on the chart (Figure 13) is the total annual machinery related costs, in dollars per acre for the machinery set indicated. The different trials are made to find the least cost machinery set with the size of the large tractors fixed. For each machinery set tried, the program computes the work schedule, keeps track of the hours on each machine, and the number of hours each operator works. Then the program computes the fixed and variable costs for each machine, labor cost, and timeliness cost. These costs are summed to obtain the total average annual machinery cost in dollars per acre which is shown on the screen. For each tractor and combine size, matched implements and attachments are utilized but are not shown on the screen. The search procedure continues by varying the machinery sets until the lowest cost set is found.

The "XXXXXX" on the screen means the combination of machinery indicated is not acceptable. A tractor may be too small to pull an implement for a desired field operation or the set of machinery may be

unable to get all field operations completed during one year or by the latest finish date listed in the desired "Field Operations" (Figure 8). If the program is run "Without Optimization" and the machinery set is not acceptable, the program will not run to completion and a message "Not able to complete schedule" will appear on the screen and you will be given an opportunity to change the input information.

When the least cost machinery set is found with the various sizes of small tractors and combines and with the largest tractors available fixed, the program decreases the size of the large tractors and repeats the process. The entire process is repeated until the total cost increases due to the large tractors being too small and causing timeliness costs to increase. Once the total cost increases, the program sets all tractors to the same size and finds the optimum machinery set with that constraint.

When the program has completed the search, the screen will show eight "Low Cost Machinery Combinations" (Figure 14). The "Low Cost Machinery Combinations" are the eight lowest cost machinery sets the program found in the process of finding the least cost or "optimum" set. It is very likely that there are other machinery sets that would have a lower cost than some of those listed. You may want to use the program to find a machinery set having a lower cost. The reason eight machinery sets are listed instead of just one is to show the variation in cost of different machinery sets and to provide a

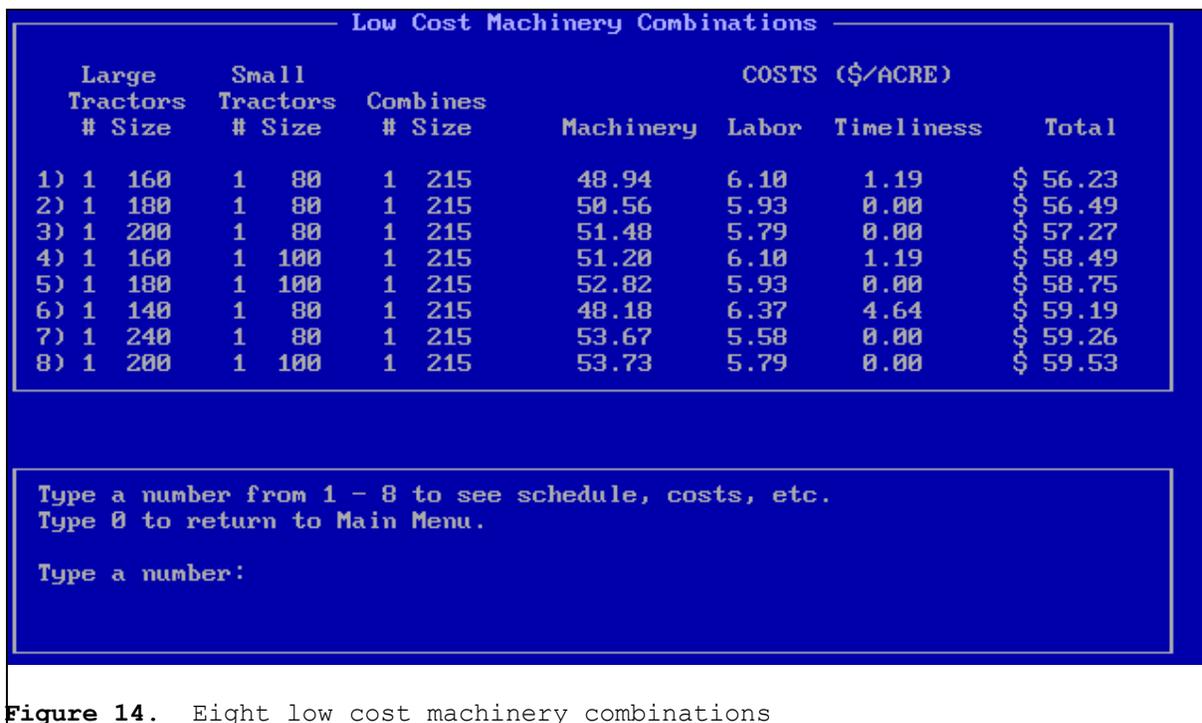


Figure 14. Eight low cost machinery combinations

choice of different machinery sets having essentially the same total cost.

Now enter a number (1 through 8) corresponding to one of the low cost machinery sets listed. The computer will schedule the field operations for that machinery set and calculate the associated costs. If you want, page through the results by pressing any key until you return to the screen showing the eight "Low Cost Machinery Combinations".

## RESULTS

The following discussion of program results, assumes you have done the following:

1) Loaded into computer memory the workday probability data for "Central Illinois" using "Select" from the Main Menu (Figure 3).

2) Loaded into computer memory information for the EXAMPLE farm using "Input Stored Data File" from "Input" of Main Menu.

3) Using the "Print" option, "Print to Screen" and "Detailed Costs" are turned "ON": "ON" is indicated by the # sign (Figure 12).

4) The program is "Run" with "Optimization" to obtain the eight "Low Cost Machinery Combinations". And the number "1" key is pressed. Then the screen entitled "The Following Field Operations Were Provided" should appear on the screen (Figure 15).

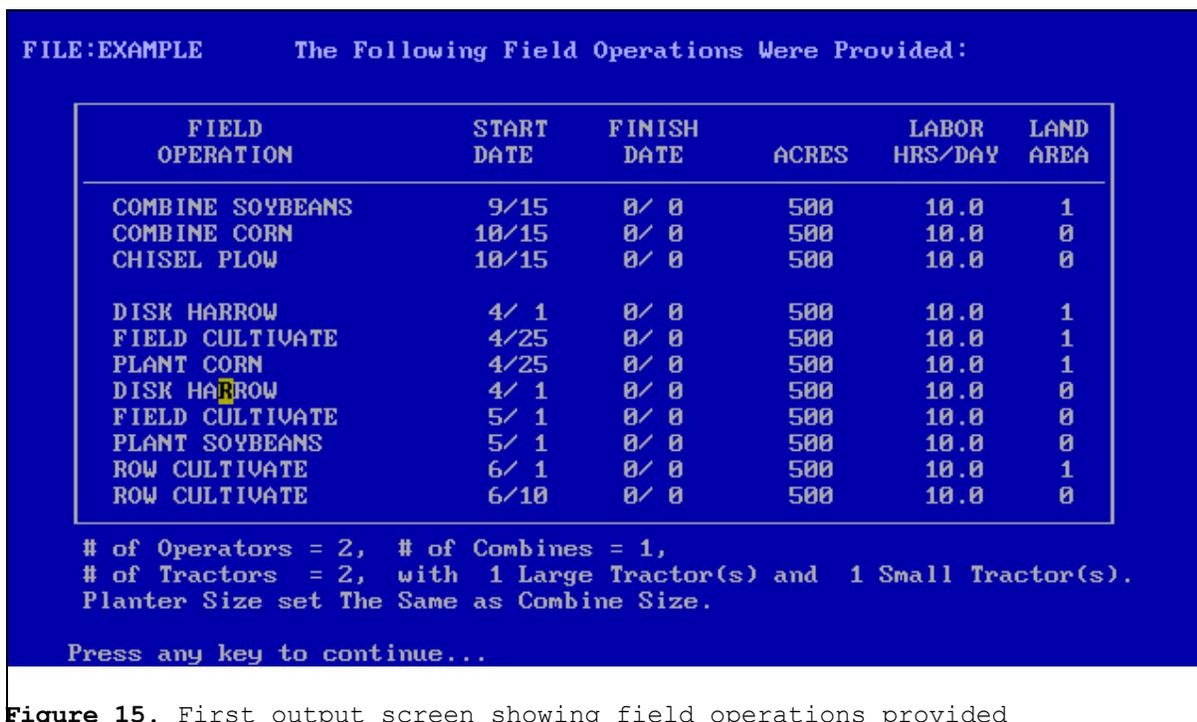


Figure 15. First output screen showing field operations provided

The Following Field Operations Were Provided

The first output screen shows the desired field operations entered in the input data (Figure 15). The screen can be used for checking and for printing a hard copy of the input data if desired.

With the Following Set of Machinery

This screen (Figure 16) is a list of the complete machinery inventory selected from the "Low Cost Machinery Combinations" (Figure 14). If the program is "Run" using "Without Optimization" the screen would list the machinery inventory previously identified on the "Tractors and Combines" and the "Match Implements to Tractors" screens. The assumed purchase price and computed annual use of

each machine are also shown. At the bottom of Figure 16, the number of machine operators and the annual number of hours each operator spends operating machinery is given.

The Work Schedule Would be as Follows

The computed work schedule is the most critical portion of the program (Figure 17). The schedule is used to compute any timeliness penalties. A penalty occurs for any planting or harvesting operation completed after the penalty date which were specified on the "Economic Factors and Timeliness" screen (Figure 11). An asterisk, "\*", appears next to any operation for which a timeliness penalty occurs.

With the Following Set of Machinery:

MACHINE NAME	PURCHASE PRICE	--ANNUAL USE-- HOURS	ACRES
215 HP COMBINE	106020.00	173	
160 HP TRACTOR	67500.00	231	
80 HP TRACTOR	35100.00	236	
8 ROW CORN HEAD	25200.00	91	500.0
22 FT GRAIN PLATFORM	13320.00	82	500.0
11 FT. CHISEL PLOW	8190.00	76	500.0
25 FT. DISK HARROW	15930.00	89	1000.0
29 FT. FIELD CULT.	11970.00	66	1000.0
8 ROW PLANTER	20430.00	107	1000.0
8 ROW CULTIVATOR	6390.00	129	1000.0

continue on next page.

Press any key to continue...

Figure 16. Machinery set selected for cost and scheduling details

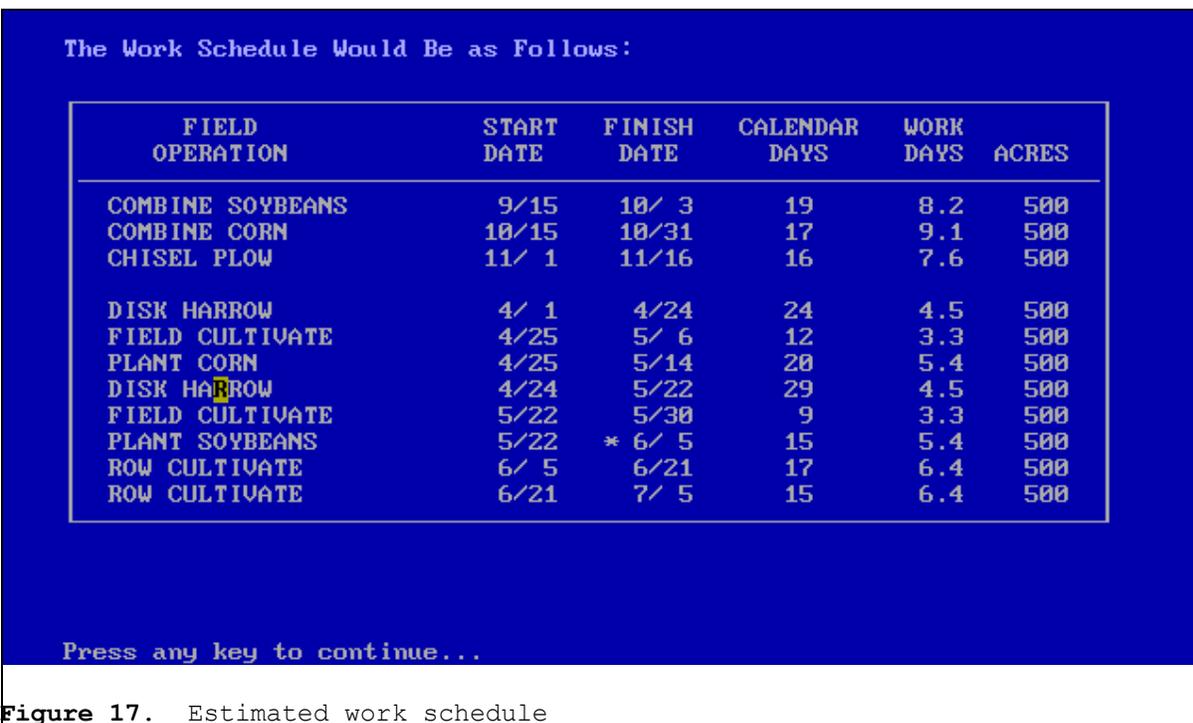


Figure 17. Estimated work schedule

The program schedules the operations according to the order in which they were entered on the "Field Operations" screen (Figure 8). For the EXAMPLE farm the first field operations scheduled are the harvesting operations. Harvesting operations are often interrupted by unloading, hauling, and processing the grain harvested. When only one operator is available for harvesting, it is assumed the operator spends 50 percent of the time hauling and processing the grain. Thus, the productivity of the combine is reduced 50 %. When two or more operators are available, the combine operates at the specified productivity (Figure 5). It is realized large variations exist in time spent unloading, hauling, and processing grain during harvest operations. The program does not account for these variations. The program user may adjust the productivity of any of the machinery (As in Figures 5 and 7).

Each field operation begins on the earliest start date listed in the input data (Figure 8)

unless an operator and machine are not available on that date. In the latter case the start for that operation is the first date that both an operator and a machine are available.

The acres completed on a given date equal the productivity (acres per hour) for the machinery being used (see Figures 5 and 7), times the hours available per day (see Figure 8), times the workday probability for that date being suitable for field work (see Figure 3).

For the EXAMPLE farm the operations are scheduled beginning with combine soybeans which begins on September 15 and is completed on October 3 which is 19 calendar days and requires 8.2 work days to cover the 500 acres. Combine Corn and Chisel Plow operations are completed in the fall as indicated (Figure 17).

In the spring the disk harrow, field cultivate, and plant corn operations are sched-

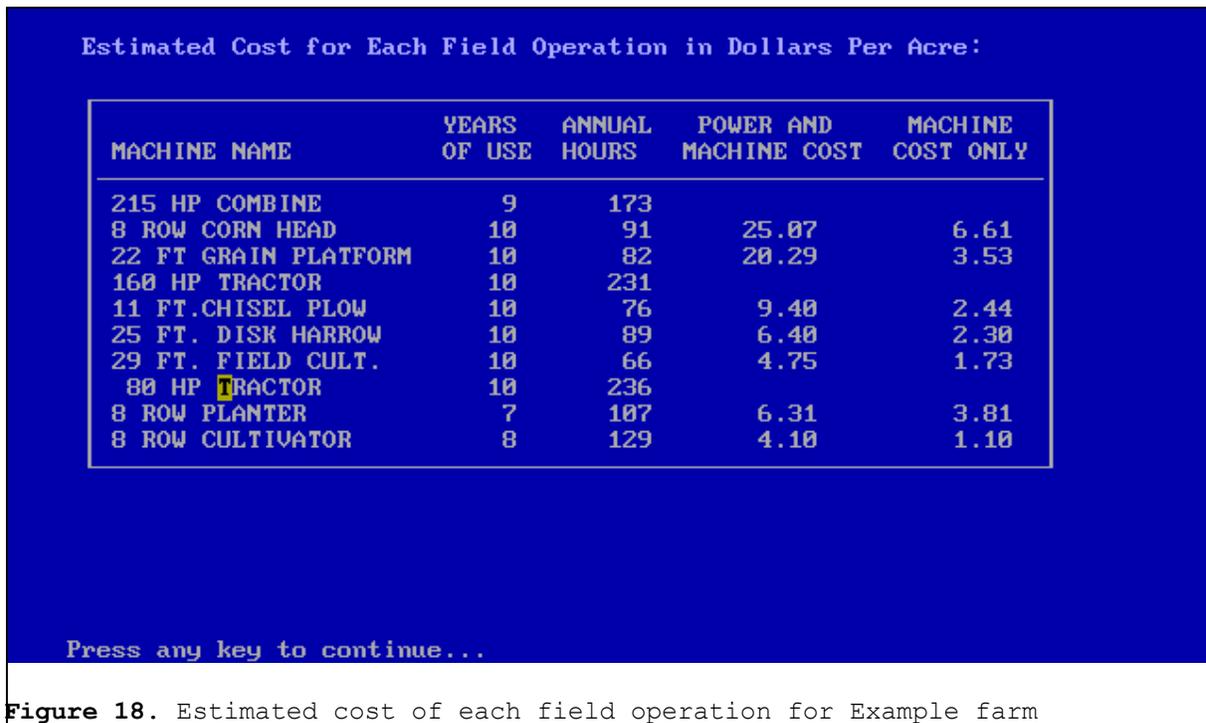
uled. Corn is planted as early as the schedule will allow, on or after the earliest start date entered in the input. For the EXAMPLE farm corn planting is completed on May 14. Then the spring field operations for soybeans and the two row-cultivate operations are scheduled.

Recalling the penalty dates entered for the EXAMPLE farm (Figure 11), no timeliness penalties occur in conjunction with combine soybeans, combine corn, or plant corn operations. Soybean planting is not completed until June 5 and the penalty date entered was May 31. Therefore, a timeliness cost is calculated for planting soybeans. The asterisk, "\*", beside 6/5 confirms this.

When using the program for a farm which justifies two or more tractors, it is especially important to study the work schedule in detail. You may be able to gain insight on the number of operators, tractors, combines, and certain implements that might provide an improved work schedule and lower cost.

#### Estimated Cost for Each Field Operation in Dollars Per Acre

For each machine the assumed years of use and annual use is given (Figure 18). In addition, the estimated cost of owning and operating each machine is given in dollars per acre.



**Figure 18.** Estimated cost of each field operation for Example farm

### Detailed Costs for Each Machine

If you chose to view "Detailed Costs" for each machine, which is an option on the "Print" menu (Figure 12) these will appear next. Otherwise, a screen showing the total annual machinery-related costs will appear. For the EXAMPLE farm only the detailed costs for the combine and corn head are shown here (Figures 19 and 20). The program shows detailed costs for each machine.

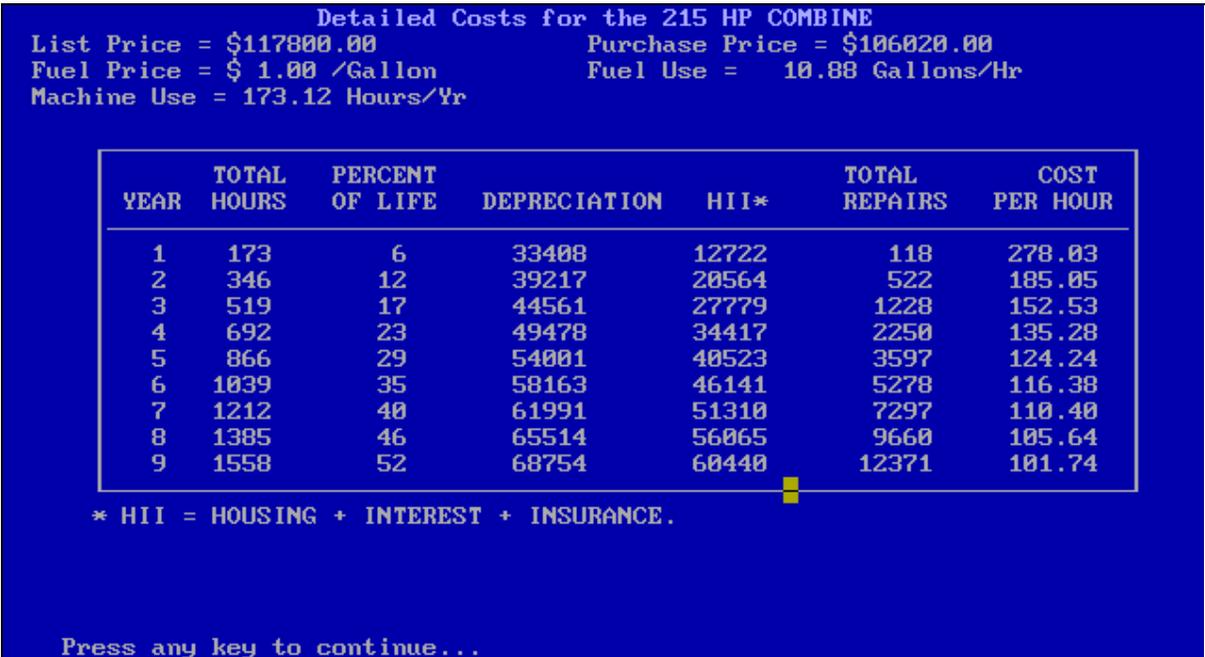
The detailed cost screen for a machine includes the list price, fuel price and consumption (if a power unit), and annual use. Also, for each year up to 10 years the following is estimated:

- a. Total accumulated hours on machine.
- b. Percent of the machine life used.
- c. Accumulated depreciation.

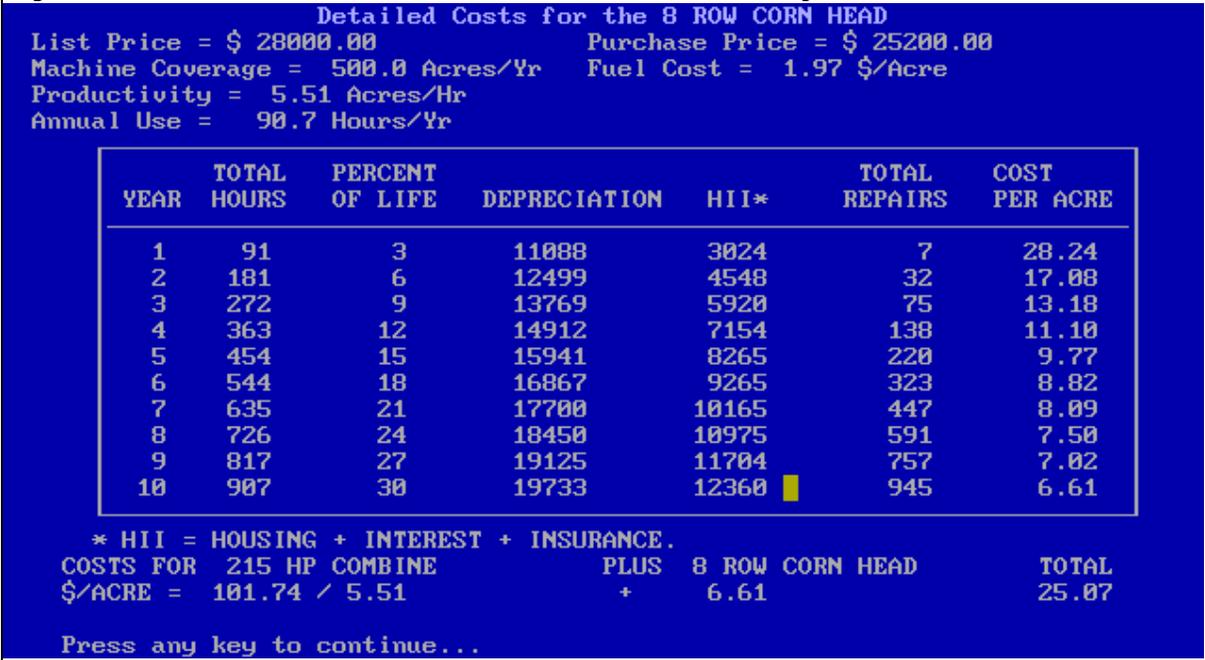
- d. Accumulated housing, interest, and insurance (HII) cost.
- e. Accumulated repair cost.

f. Average annual total cost per hour or per acre. For power units (tractors and combines) the average annual total cost includes fuel cost. The years of ownership, and the machinery fixed and variable costs are calculated for each machine after the operations are scheduled as follows:

The assumed machinery purchase price is equal to the list price (from Figures 4 to 7) multiplied by the "purchase price, % of list" entered on the Economic Factors and Timeliness screen (Figure 11). The percent of life is used to determine the num-



**Figure 19.** Detailed costs for combine not including header



**Figure 20.** Detailed costs of corn head and total cost for combine

ber of years of assumed ownership and      the number of years the costs are calculat-

ed for a machine as follows:

1. If the machine use reaches 70 percent of its life and the machine is less than 5 years old, it is assumed the machine is sold and a new machine purchased.

2. If the machine use reaches 50% of its life and the machine is 5 years old or more with a maximum of 10 years old, it is assumed the machine is sold and a new machine is purchased.

The assumed life of each machine is set in "Operation List" (Figures 4 to 7).

The formula used for estimating remaining farm value is:

$$RFV = LP * RV1 * RV2^y$$

Where:

RFV = remaining value at end of year y

LP = list price

RV1 and RV2 = Constants (Figures 4 to 7)

y = machine age, years

Depreciation is obtained by subtracting the remaining farm value from the purchase price.

Housing, Interest, and Insurance costs, (HII) are estimated by multiplying the percent entered for these costs (see Figure 11) times the remaining farm value (RFV) at the beginning of the year.

Repair cost formula used is:

$$TAR = LP * RC1 * (100 * Hrs / LIFE)^{RC2}$$

Where:

TAR = Total accumulated repair cost, dollars

LP = List price of machine, dollars  
(Figures 4 to 7)

Hrs = Total machine use, hours

RC1 and RC2 = Constants  
(Figures 4 to 7)

LIFE = Life of machine, hours  
(Figures 4 to 7)

Fuel and Lubrication Costs for tractors and combines are estimated as follows:

$$\text{Diesel fuel, gal/hp hr} = 0.52 * X + 0.77 - 0.04 * (738 * X + 173)^{0.5}$$

Where:

X = the ratio of the equivalent PTO power required to the maximum available from the PTO. X is set in the program at 0.85.

Oil and lubrication is assumed to cost 10% of the fuel cost.

The cost of the operation in dollars per acre is given at the bottom of each detailed cost screen. For combine attachments and implements for tractors this cost figure includes the cost for the power unit and implement or combine attachment but not labor cost.

TOTAL MACHINERY-RELATED COSTS

## FOR EXAMPLE FARM

The total machinery-related costs for the machinery set is given for the Example farm (Figure 21). The machinery fixed cost includes estimated depreciation, housing, interest, and insurance. To the fixed cost is added the estimated fuel and repair costs to get the total machinery cost.

Labor cost is figured using the labor rates entered earlier.

Timeliness cost is calculated for any crop planted or harvested late. For the EXAMPLE, farm the work schedule showed the plant soybeans operation would not be completed until June 5 while the penalty date entered for plant soybeans was May 31. Thus, a timeliness cost is calculated for those soybeans planted between June 1 and June 5.

The dollars per year figures are divided by the total tillable acres to get the dollars per acre values.

## RESULTS WITH ANOTHER MACHINERY SET OR RETURN TO MAIN MENU

The program will return to the Low Cost Machinery set screen (Figure 18) if you chose to run with optimizing and you may now view the results with any of the low cost machinery sets listed or you may return to the Main Menu. If you chose earlier to run without optimizing you will return to the Main Menu.

## REFERENCES

1. Agricultural Machinery Management Data. ASAE Standards 1992.
2. Bowers, Wendell. 1987. Machinery Management. John Deere Service Training, John Deere Road, Moline, Illinois.
3. Schwart, R. B. 1981. Farm Machinery Worksheet No. 1, What Size Machinery for Your Farm? Illinois Cooperative Extension Service, University of Illinois at Urbana-Champaign

Average Annual Machinery Related Costs:

COSTS	\$/YEAR	\$/ACRE
Machinery Fixed Cost	40867.10	40.87
Fuel Cost	4707.68	4.71
Repair Cost	3367.59	3.37
Total Machinery Cost	48942.37	48.94
Labor Cost	6098.35	6.10
Timeliness Cost	1189.96	1.19
Total Cost	56230.68	56.23

Press any key to continue...

Figure 21. Average annual machinery related cost for EXAMPLE farm