ESTIMATING COSTS OF PRODUCTION ON ARIZONA CROP FARMS

by

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ABSTRACT

Total farm budgets which estimate production costs, yields and prices before the crop is planted assist farmers in decisions concerning input procurement, crop mixes, marketing strategies and financing. This study focuses on the estimation of production costs and problems associated with their estimation on Arizona crop farms. Production costs are estimated with the Arizona Crop Budget Generator.

It was found that predicting past cash costs and comparing them to actual farm records proved beneficial to verify the model in order to make needed adjustments to predict future cash costs.

This study also presents an economic evaluation of the methodological alternatives for estimating farm machinery costs. The Traditional Method, Arithmetic Average Method, and Present Value Method are discussed, compared and contrasted. Results indicate that the Present Value Method should be used in estimating average annual costs, although similar results, with very little error were derived for the Arithmetic Average Method and may be used successfully when inadequate date exists for the present value method or when a quick answer is desired.

CHAPTER I

INTRODUCTION

Current budgets for Arizona crop production indicate that depressed farm prices and high input costs are making it difficult to realize profits with some crops. The accurate estimation of production costs, yields and prices before the crop is planted can assist farmers in decisions concerning input procurement, crop mixes, marketing strategies and financing. Also frequent use is made of estimated costs and returns in policy analysis. Dr. Scott Hathorn of the University of Arizona, Department of Agricultural Economics, has developed a crop budget generator which is used to estimate production costs and returns for irrigated crops grown in Arizona. The system can be adapted to estimate a specific farmer's total farm costs and returns. The budget generator developed by Dr.Hathorn is hereafter referred to as the Budget Generator.

The objectives of this study are to: 1) review the features of the Budget Generator, 2) evaluate the methodological alternatives for estimating farm machinery costs and 3) attempt to generate actual costs for case farms.

The approach used in estimating total farm costs and returns for the case farms consists of: 1) personal interviews of farmers to gather total farm crop data; 2) estimating costs and returns using the

Budget Generator; 3) personal interviews comparing accounting records with those estimated and identifying and researching differences between the records and estimated results; and 4) revision of estimates.

Four farmers from Pinal and Maricopa Counties were interviewed. The farms chosen ranged in size from 500 to over 3,000 cropped acres. Crops grown by the farmers interviewed include wheat, alfalfa, sugar beets, safflower, corn silage, sorghum silage and cotton. Water available to the farms in Maricopa County came mostly from the Salt River Project while farmers in Pinal County used on-farm pumped water.

A questionnaire was used during the first personal interview to gather data for each crop grown. The data collected included a calendar of operations, tooling, labor used, custom services and materials for each crop grown as well as machinery and well inventories. The data gathered from each farmer was used as input in the Budget Generator. Costs associated with repairs, materials, custom services and field operation rates are part of a common data base for the Budget Generator. All of these items were changed, however, where appropriate. Budget information for each crop is reported by the Budget Generator in a series of four tables entitled:

1) Calendar of Operations and Cost per Acre,
2) Tooling and Materials Used per Acre by Operator,
3) Receipts, Costs and Profit per Acre and
4) Cost Summary per Acre.

The Budget Generator aggregates machinery usage for all crops, but it was necessary to make a separate summary of the operating costs by total labor cost, total repair cost, total seed cost, total water cost, total fuel cost and total chemical cost since the Budget Generator does not summarize this information and it was required to make comparisons with the accounting records of the case farmers.

Chapter 2 will discuss estimating labor requirements, Chapter 3 will evaluate the methodological alternatives for estimating farm machinery costs, Chapter 4 will compare budgeted estimates derived from the Budget Generator with actual farm records from case farms and Chapter 5 will summarize research results and implications for further research.

CHAPTER 2

ESTIMATING LABOR REQUIREMENTS

Employees used on Arizona farms may consist of day laborers, monthly laborers, foremen, office managers, clerical staff and farm managers. The farms interviewed also involved owner-operators. Individuals in each of these positions may perform one or more functions. Four major labor functions are identified.

Scheduled Labor

Labor that is based upon hours per acre required to perform individual crop operations is referred to here as scheduled labor. Scheduled labor jobs include field operations and lubrication, fueling and minor adjustments made in the field and when servicing. Scheduled labor is usually performed by day and monthly wage labor. The Budget Generator was used to estimate scheduled labor requirements and costs based upon time requirements for the completion of individual crop operations. The list of operations and equipment used was based upon those reported by each farmer since differences in field operations and equipment sizes affects the number of acres a farmer can cover in an hour. Time requirements were specified in acres per hour based upon the farmer's estimates and converted by the Budget Generator into hours per acre for each operation.

The calendar of operations table produced by the Budget Generator reports individual crop operations and total labor hours. Table 2.1 shows the calendar of operations for cotton for one case farmer. The cost associated with scheduled labor is computed by multiplying scheduled labor hours per operation by the wage rate. The wage rates vary for different operations and include social security, workman's compensation and fringe benefits.

Unscheduled Labor

Labor required to complete general farm maintenance and on-farm repairs is defined here as unscheduled labor. Unscheduled labor is included in the Budget Generator as a per acre general farm maintenance cost. This cost, however, also includes materials and the breakdown between each is not specified. Also, some Unscheduled Labor is included in repair costs, which are based upon Total Accumulated Repairs (TAR) equations in the Budget Generator. The proportion of on-farm labor, parts and "dealer" labor is not specified.

Supervision and Management

Supervision includes direction of jobs performed by day and monthly labor. Labor whose function is to assume the responsibility of making factor and product mix decisions, purchase and sale decisions, finance decisions and keep records, pay bills etc. is called Management. The Management function is performed by the owner-operator

Table 2.1 An Example Calendar of Operations and Costs Per Acre for Cotton.

Outgoing Crop: 1977 Cotton Water: Well No. 1 378 Foot Lift

					HOURS/ACRE		MACH	VARIABLE COSTS				TOTAL
ROW	M1	M2	TMS	OPERATION	MACH	LABOR	FIXED COST	MACH	LABOR	SERV	MATLS	COSTS
01	12	12	1.0	Residue Disposal	.180	.200	1.02	.127	.69	0.00	0.00	2.98
02	12	12	1.0	Disk	.109	.121	1.31	1.34	.42	0.00	0.00	3.07
03	01	01	1.0	Chisel or Rip	.180	.200	1.39	1.72	.69	0.00	0.00	3.80
04	01	01	1.0	Landplane	.257	.286	2.40	2.58	.99	0.00	0.00	5.97
05	02	02	1.0	List or Bed	.129	.143	1.16	1.33	.50	0.00	0.00	2.99
06	03	03	1.0	Planting	.300	.333	1.98	2.62	1.16	0.00	4.68	10.44
07	04	04	1.0	Buck Rows	.045	.050	.13	.18	.17	0.00	0.00	.48
08	04	04	1.0	Irrigate	0.000	.500	3.50	6.58	1.75	0.00	0.00	11.83
09	04	04	1.0	Disk Ends	.022	.025	.22	.20	.09	0.00	0.00	.51
10	04	04	1.0	Cultivate	.300	.333	1.42	2.24	1.16	0.00	0.00	4.82
11	05	05	1.0	Fert Ap—Broadcast	.090	.100	.64	.67	.35	0.00	13.06	14.72
12	05	05	1.0	Buck Rows	.045	.050	.13	.18	.17	0.00	0.00	.48
13	05	09	7.0	Irrigate	0.000	3.500	24.50	46.06	12.27	0.00	0.00	82.83
14	06	06	1.0	Fert Ap—Side Dress	.180	.200	1.20	1.75	.69	0.00	12.48	16.12
15	05	07	5.0	Cultivate	1.500	1.667	7.11	11.19	5.78	0.00	0.00	24.08
16	06	08	6.0	Insecticide Applic.	0.000	0.000	0.00	0.00	0.00	13.80	27.21	41.01

Table 2.1--Continued.

Outgoing Crop: 1977 Cotton Water: Well No. 1 378 Foot Lift

ROW	M1	M2	TMS	OPERATION	HOURS/ACRE MACH	HOURS/ACRE LABOR	MACH FIXED COST	VARIABLE COSTS MACH	VARIABLE COSTS LABOR	VARIABLE COSTS SERV	VARIABLE COSTS MATLS	TOTAL COSTS
17	07	08	1.0	Weeding	0.000	0.000	0.00	0.00	0.00	25.00	0.00	25.00
18	05	07	5.0	Disk Ends	.112	.125	1.12	1.01	.43	0.00	0.00	2.56
19	05	07	5.0	Buck Rows	.225	.250	.65	.89	.87	0.00	0.00	2.41
20	10	10	1.0	Prepare Ends-Harvest	.022	.025	.22	.20	.09	0.00	0.00	.51
21	10	10	1.0	Defoliant Applic	0.000	0.000	0.00	0.00	0.00	2.30	2.79	5.09
22	10	11	1.0	First Pick Cotton	.900	1.000	27.13	13.03	3.78	0.00	0.00	43.94
23	10	11	1.0	Tramp Trailers	0.000	2.000	0.00	0.00	6.69	0.00	0.00	6.69
24	11	11	1.0	Second Pick Cotton	.600	.667	18.09	8.68	2.52	0.00	0.00	29.29
25	12	12	1.0	Rood Cotton	.300	.333	3.18	3.24	1.16	0.00	0.00	7.58
26	10	12	1.0	Hauling 10 Miles	.222	.333	8.89	3.13	1.11	0.00	0.00	13.13
				Cotton TLR Hours	4.500							
27	10	12	1.0	Ginning 30.30 CWT	0.000	0.000	0.00	0.00	0.00	60.61	0.00	60.61
28				Pickup Use 60 MI	2.000		6.02	8.35				14.37
29				Production Credit at	9.25	Percent	Interest			8.75		8.75
				Column Totals	7.718	12.441	113.41	118.44	43.53	110.46	60.22	446.06
				Total Variable Cost				118.44	43.53	110.46	60.22	332.65

and personnel hired to perform the management function. The cost of Management and Supervision is included in the Budget Generator as Management Service Cost and is expressed as a per cent of gross income. Return to risk is not included in the Cost of Management.

Accounts Data On Labor

Accounting records provided by case farms included the total cost of wages and salaries for management, supervisory, unscheduled and scheduled labor functions. Each case farm also kept individual employee labor cost records. The actual fringe benefit cost was estimated by the owner-operator/manager since they were not included in either set of records. Using the individual employee labor cost records, each employee was categorized as to what labor functions he performed. It was found some of the laborers performed only Scheduled and Unscheduled labor functions. It was also possible to determine the amount of time spent by owner-operator, farm and office managers and foremen on Scheduled or Unscheduled work (combined) and the amount of time spent in supervision or management (combined).

Unscheduled labor is very difficult to measure since time spent on this function varies from day to day. In some cases, however, it was possible to identify specific activities as unscheduled labor, e.g. one farmer hired a crew specifically to keep ditches clean and in repair. In other cases an estimate of the proportion of time spent was made. No attempt was made to distinguish between time spent in major repair of machinery and other farm maintenance.

CHAPTER 3

EVALUATION OF THE METHODOLOGICAL ALTERNATIVES FOR ESTIMATING FARM MACHINERY COSTS

The purpose of this chapter is to consider the estimation of certain costs of owning and operating farm machinery. The costs associated with owning machinery include depreciation, interest on investment, property taxes, insurance and housing. Housing will be omitted here since few farmers house farm machinery in Arizona. Costs associated with operating farm machinery include operator labor, repairs and fuel and oil. Operator labor and fuel and oil are assumed to be directly related to hours of use. As a result, repair costs are the only operating costs that will be considered in the chapter.

Depreciation and Interest

Depreciation is the cost associated with the decline in value of an asset due to obsolescence, use and aging. Total depreciation over the life of an asset is the purchase cost less the salvage value. Average annual depreciation is therefore computed by dividing total depreciation by the years of useful life:

$$\text{Average Annual Depreciation} = \frac{PC - SV}{N}$$

where

PC = purchase cost,

SV = sales value at end of use and

N = years of use.

The American Society of Agricultural Engineers report estimates of the sales value of farm machinery and equipment as a proportion of purchase cost (Agricultural Engineers Handbook, 1978). The remaining farm values (RFV) equations reported there are of the form:

$$RFV_N = \alpha \beta^N PC$$

where

RFV_N = the value of the machine at N years of age,

α, β = constants estimated for each class of machine and

PC = purchase cost.

It appears the RFV equations were estimated by deflating "Blue Book" prices of machinery and equipment and fitting equations for each class of machine.

Average annual depreciation is identical to the annual depreciation calculated by the straight-line method. Figure 3.1 shows the depreciation of an asset according to the straight-line method and as would be represented by an RFV equation. As shwon in Figure 3.1, actual annual depreciation as estimated by an RFV equation is greater than average in the early years and less than average in the later years.

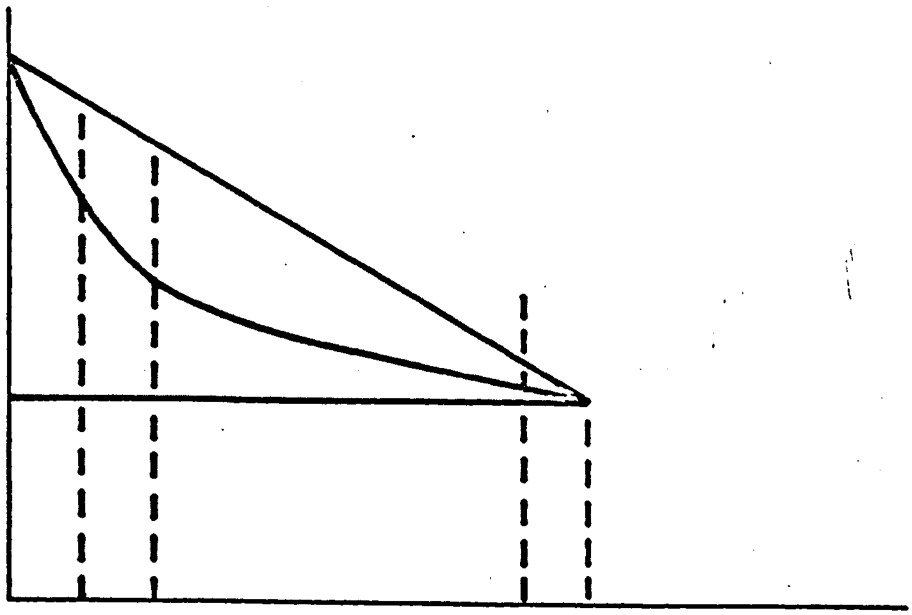

Figure 3.1. Depreciation of an Asset According to the Straight-Line Method and an RFV Equation.

If the total purchase cost is borrowed and the principal repaid at the same rate that the asset depreciates, Figure 3.1 would then represent the loan balance outstanding at each point in time. Assuming the straight-line method of depreciation and assuming principal repayments are made continuously throughout the life of the asset, the frequency function for the loan balance at each point in time is represented graphically in Figure 3.2 where f(X) = frequency of X and X = loan balance at each instant of time.

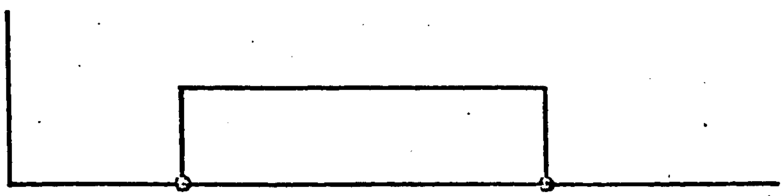

Figure 3.2 Frequency Function for a Loan with Continuous Principal Payments.

Since the frequency function must add up to unity

$$\int_{SV}^{PC} f(X) = 1.0$$

and, therefore,

$$f(X) = \frac{1}{PC-SV}$$

and the average loan balance is

$$\int_{SV}^{PC} X\ f(X)dX = \frac{X^2}{2}\left(\frac{1}{PC-SV}\right)\Bigg|_{SV}^{PC} = \frac{PC+SV}{2}\ .$$

For an annual interest rate of r, the average annual interest cost would be calculated by multiplying the average loan balance times the annual interest rate:

$$\text{Average Annual Interest Cost} = \frac{PC + SV}{2}\ r .$$

This method has been used extensively by the U.S. Agricultural Experiment Stations and State Extension Services. The Budget Generator used in this study also used this "traditional" method of calculating average interest costs and therefore average annual investment costs are

$$\text{Traditional Average Annual Investment Cost} = \frac{PC - SV}{N} + \frac{PC + SV}{2}\ r .$$

Another method that can be used to evaluate investment costs is the Present Value Method. The Present Value Method takes into account the time value of money. A dollar paid out today does not have the same value as a dollar paid out in the future and discounting of future annual cash flows to the present and assigning an annuity factor to the total of the annual discounted cash flow, provides a series of equal annual payments which take into account the time value of money.

Consider a current expenditure of A_0. After one interest bearing period an expenditure A_0 would have accumulated interest of rA_0 so that the equivalent expenditure one period from now (future value) would be $A_1 = A_0 + rA_0 = A_0(1+r)$, the equivalent expenditure at the end of two periods would be $A_2 = A_0(1+r)(1+r) = A_0(1+r)^2$ and for N periods, $A_N = A_0(1+r)^N$. Alternatively, solving for A_0, the current equivalent (present value of) an expenditure N periods from now of A_N would be $A_0 = A_N/(1+r)^N$. The present value of expenditures in each of N periods is $P = A_0 + A_1/(1+r)^1 + A_2/(1+r)^2 + A_N/(1+r)^N$ and for $A_0 = 0$

and $A_1 = A_2 = \ldots = A_N = A$, the present value of N equal expenditures at the end of each period is $P = A(1/1+r + 1/(1+r)^2 + \ldots + 1/(1+r)^N)$ and the finite series on the right hand side reduces to $P = A \dfrac{1-(1+r)^{-N}}{r}$.

Solving for A, the end of period series of equal payments equivalent to a present expenditure of P is

$$A = \frac{P}{\dfrac{1-(1+r)^{-N}}{r}}.$$

For a depreciable asset the present value of the cash flow associated with its purchase and sale is $P = PC - SV/(1+r)^N$ and the equivalent end of period series of equal payments is

$$A = \frac{PC-SV/(1+r)^N}{\dfrac{1-(1+r)^{-N}}{r}} = \frac{PC-SV+SV-SV/(1+r)^N}{\dfrac{1-(1+r)^{-N}}{r}}$$

$$= \frac{PC-SV}{\dfrac{1-(1+r)^{-N}}{r}} + r\ SV.$$

This equation can be divided into two parts, an amortized loan (interest and principal) for the amount of depreciation (PC-SV), and annual interest on the salvage value. The amoritized loan portion of the equation is the difference between the purchase cost and salvage value divided by the appropriate annuity factor. The annuity factor converts the present value amount into a series of equal payments and is based upon the interest rate and the expected years of useful life. The last part of the equation can be thought of as a fixed loan for the value of the asset at the end of its useful life with fixed annual interest charge.

The present value method is proposed as the "exact" method for investment analysis. Walrath comments in reference to the Traditional Method, "The average investment method should never be used in the analysis of any investment". He further indicates that "the average investment method is incompatible with sound analysis." The reasoning behind these statements is that the Traditional (average investment) Method does not recognize the time value of money, whereas the Present Value Method does as demonstrated above. Walrath further states that "Results obtained by using the average investment method are always inconsistent with the data as given. If an investor uses this method as the basis for determining the soundness of an investment, he will never recover all his investment or he must accept a lower rate than he used in his calculation." An example will clarify this. Table 3.1 shows when the salvage value is 45% of purchase cost and useful life equals 2 years, the Traditional Method underestimates the average annual investment cost using the Present Value Method from 2.3% when interest is 5% ($.311 vs $.3183 per $1 purchase cost) to 7.1% when interest is 20% ($.42 vs $.45 per $1 purchase cost). When salvage value is 10% and N is 10 the underestimation of the Traditional Method ranges from 3.4% when interest is 5% to 17.3% when interest is 20%. Thus, one can conclude that the Traditional Method is outdated since the errors are sizeable for high interest rates.

The difference between the Present Value Method and the Traditional Method is only in part due to the fact that the Present Value Method takes into account the time value of money. The difference

Table 3.1 Average Annual Investment Cost Per $1 Purchase Cost.

	Traditional Method			Arithmetic Avg. Method			Present Value Method	T.M. as % of PV Meth.	Arith. Avg. Method as % of PV Method
	Depr.	Int.	TOTAL	Depr.	Int.	TOTAL			
SV=.45, N=2 Interest									
5%	.275	.0362	.311	.275	.0431	.3181	.3183	2.3	0.06
10%	.275	.0725	.347	.275	.0862	.3612	.3619	4.3	.2
15%	.275	.1037	.334	.275	.1293	.4043	.4058	5.7	.4
20%	.275	.145	.42	.275	.1725	.4475	.45	7.1	.6
SV=.3, N=5 Interest									
5%	.14	.0325	.1725	.14	.036	.176	.1766	2.4	.3
10%	.14	.065	.205	.14	.072	.212	.2146	4.7	1.2
15%	.14	.0975	.2375	.14	.108	.248	.2538	6.9	2.3
20%	.14	.13	.27	.14	.144	.284	.2940	8.9	3.5
SV=.10, N=10 Interest									
5%	.09	.0275	.1175	.09	.0297	.1197	.1215	3.4	1.5
10%	.09	.055	.145	.09	.0595	.1495	.1564	7.9	4.7
15%	.09	.0825	.1725	.09	.0892	.1792	.1943	12.6	8.4
20%	.09	.11	.20	.09	.119	.209	.2346	17.3	12.3

is also partly due to the difference in assumptions about the rate of repayment of the principal. If annual principal payments are made at the end of each year equal to the average annual depreciation, the loan balance at the beginning of the first year would be the purchase cost, PC, and the loan balance at the beginning of the last year would be SV + (PC - SV)/N and an arithmetic average annual interest cost (not accounting for the time value of money) would be the average loan balance times the annual interest rate:

$$\text{Average Annual Interest Cost} = \left(\frac{PC + SV + (PC - SV)/N}{2}\right) r$$

where

PC = purchase cost,

SV = salvage value,

N = years of useful life and

r = interest rate.

An arithmetic average annual investment cost would be computed by adding average depreciation to average annual interest cost:

$$\text{Arithmetic Average Annual Investment Cost} = \frac{PC-SV}{N} + \frac{PC + SV + (PC - SV)/N}{2}\, r.$$

No example of use of the Arithmetic Average Method could be found in the literature. However, the Arithmetic Average Method has the advantage of ease of calculation provided by the Traditional Method while accounting for repayments on an annual basis rather than using the less realistic assumption of the Traditional Method of a continuous flow of payments. The Arithmetic Average Method is in fact equivalent to the Present Value Method in two extreme cases. The first case is where years of useful life is infinity ($N = \infty$) and the salvage value is 100% of the purchase cost. The more interesting case is where the useful life is one year (N=1). The terms in the proof below are stated as a percent of purchase cost where

PC = 1

s = salvage value as percentage of purchase cost,

N = useful life in years and

r = discount or interest rate.

3.1 $$\frac{1-s}{N} + \frac{1+s+(1-s)/N}{2}\, r < \frac{1-\dfrac{s}{(1+r)^{-N}}}{1-\dfrac{(1+r)^{-N}}{r}}$$

3.2 $$\frac{1-s}{N} + \frac{1+s+(1-s)/N}{2}\, r < \frac{(1+r)^{N} - s}{(1+r)^{N} - 1}\, r$$

3.3 $$((1+r)^{N} - 1)\left(\frac{1-s}{N}\right) + ((1+r)^{N} - 1)\,\frac{1+s+(1-s)/N)}{2}\, r < ((1+r)^{N} - s)\, r$$

For N=1

3.4 $$(1+r-1)\left(\frac{1-s}{1}\right) + (1+r-1)\left(\frac{1+s+\frac{1-s}{1}}{2}\right) r > (1+r-s)\, r$$

3.5 $$r(1-s) + r^{2} = r\,(1-s) + r^{2}$$

In equation 3.1 of the proof, the Arithmetic Average Method is set less than or equal to the Present Value method. In equation 3.2, the right hand side is simplified. In equation 3.3, both sides of equation 3.2 have been multiplied by $((1+r)^{N} - 1)$. Equation 3.4 results from substituting N=1 into equation 3.3 and simplifying derives equation 3.5. Equation 3.5 shows that two methods are equivalent.

In all other cases the Present Value Method is more sound than the Arithmetic Average Method. Table 3.1 shows the percent error in using the Arithmetic Average Method. When the salvage value is 45% of purchase cost and the useful life is 2 years, the Arithmetic Average Method underestimates the average annual investment cost from .06 of 1% when interest is 5% to .6 of 1% when interest is 20%. When the salvage value is 10% and N is 10 the difference ranges from 1.5% when interest is 5% to 12.3% when interest is 20%. As one can see, the investment error gets greater as one goes from low to high interest rates, to longer useful lives and to smaller salvage values.

Since the Budget Generator uses the Traditional Method to calculate average annual investment costs, it will be useful to consider the adjustment in the interest rate that would be required for the Traditional Method to provide an equivalent estimate to the Present Value Method.

In order to make the Traditional Method and Present Value Method results the same, the interest rate for the Traditional Method would need to be adjusted upward. Table 3.2 shows what interest rate is needed for the Traditional Method to be equivalent to the Present Value Method when salvage is 20% of purchase cost at various interest rates. When the interest rate is 15%,the Traditional Method's adjusted interest rate would be 25% when the useful life is 1 year and decreases to 18% when N is 7 years and thereafter increases. When the present value

Table 3.2 Interest Rate Needed for the Traditional Method to be Equivalent to the Present Value Method for a Salvage Value = 20% of Purchase Cost.

	Interest Rate			
Years Useful Life	5%	10%	15%	20%
1	8.3	16.7	25.0	33.3
2	6.7	13.5	20.3	27.3
3	6.1	12.5	18.9	25.5
4	5.9	12.0	18.3	24.8
5	5.8	11.8	18.1	24.6
6	5.7	11.7	18.0	24.5
7	5.6	11.6	18.0	24.6
8	5.6	11.6	18.0	24.7
9	5.6	11.6	18.1	24.9
10	5.6	11.7	18.2	25.1
15	5.7	11.9	18.9	26.3
20	5.7	12.3	19.6	27.4
25	5.8	12.7	20.3	28.3

interest rate is 10%, the adjusted interest rate is 16.7% when N is 1 year and decreases to 11.6% when N is 8 years and thereafter increases. Different salvage values will also affect the results.

Taxes and Insurance

Farm insurance rates are usually based upon an "all risk" policy which includes fire, theft and liability insurance. Annual insurance costs for machinery can be computed on beginning of the year values of coverage and decreased over the useful life of the asset as it depreciates. Property tax rates depend on local or district rates. Annual taxes are ordinarily computed on standard tax schedules developed by taxing authorities. These schedules have built-in depreciation schedules. The shape of the Arizona tax depreciation schedule differs however from those so far discussed. Figures 3.3a, b, and c show three different depreciation schedules. Figure 3.3a shows a straight-line or constant annual depreciation schedule, Figure 3.3b shows the undepreciated balance decreasing at a decreasing rate as, for example, according to an RFV equation and Figure 3.3c, a schedule decreasing at an increasing rate as, for example, according to the Arizona tax schedule.

If the insured value decreases at a decreasing rate over the useful life of the machine as in Figure 3.3b, and the actual insurance rate is 1% of the insured value and the insured value each year is equal to the value of the machine at the beginning of the year, Table 3.3 illustrates the estimated insured value each year as a percent of the purchase cost for a farm tractor using the appropriate RFV equation.

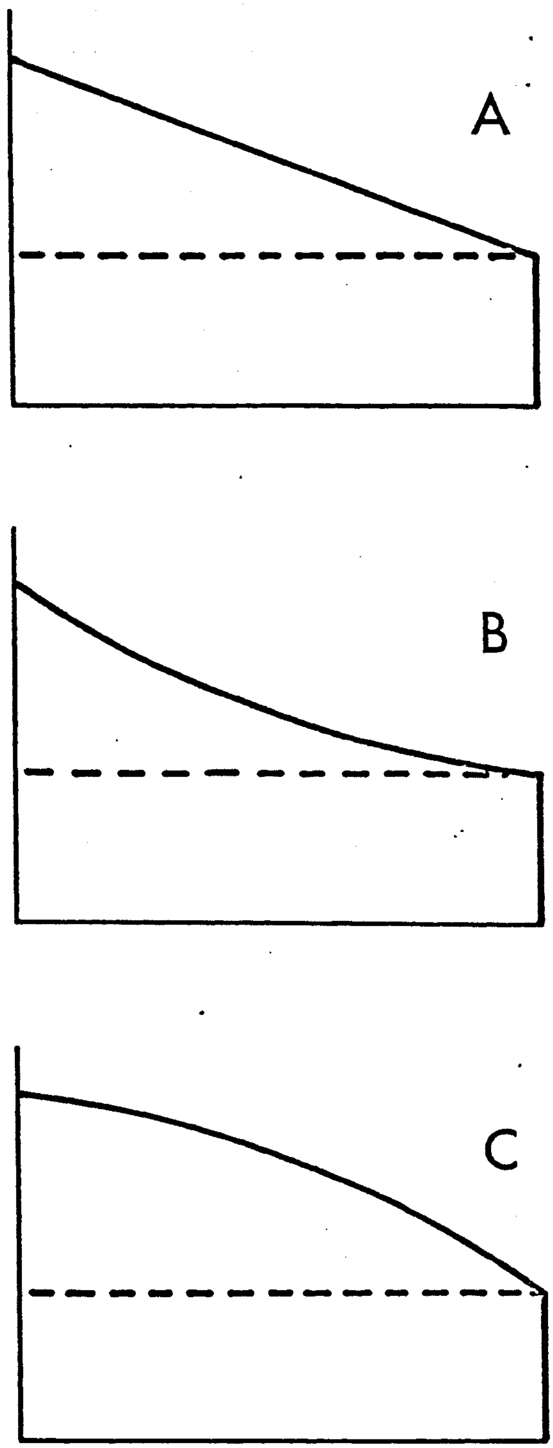

Figure 3.3. Representative Depreciation Schedules.

Table 3.3 Insurance Costs as a Percent of Purchase Cost for a Tractor with a Useful Life of 5 years.

Beginning of Year	RFV as % of PC	Insurance Cost @ 1% as % of PC
1	100	1.0
2	62.6	.626
3	57.6	.576
4	53.0	.530
5	48.7	.487
6	45.0	.450

The Traditional Method for estimating the average annual insurance costs uses the average of the purchase cost and sales value as an estimate of the average annual insured value i.e. (PC+SV)/2. Therefore, using a 1 percent insurance rate and the Traditional Method, would result in an estimated average annual insurance cost of $\frac{(1 + .45)}{2} .01$ = .725 percent of the purchase cost. The Arithmetic Average Method used earlier would result in an average annual insurance cost of $\frac{(100 + 48.7)}{2} .01 = .7435$ percent of the purchase cost.

The most accurate method for computing average annual tax and insurance is the Present Value Method. In this method, the actual annual insurance expense is discounted to find the present value insurance cost which is divided by the appropriate annuity factor to derive average annual insurance expense. Assuming a 15% discount rate, the average annual insurance costs as a percent of the Purchase Cost using the Present Value Method would be .78% as compared to the Arithmetic Average Method estimates of .7435.

Therefore as in the case of estimating the average annual investment costs (depreciation and interest), the Arithmetic Average Method provides a more accurate estimate of the Present Value average annual insurance costs than does the Traditional Method. Note that the Arithmetic Average Method provides a simple average of the investment cost but does not correspond to the simple average insurance costs since the simple annual average of insurance expenditure is

$\frac{(100 + 62.6 + 57.6 + 53.0 + 48.7)}{5} .01 = .6438$ per cent of purchase cost.

Annual taxes are computed over the first six years of useful life for a tractor in Arizona. Thereafter taxes are zero. If the tax rate is assumed to be \$13.70/\$100 of the assessed value and taxes are paid at the beginning of the tax year, the taxes each year would be as shown in Table 3.4. The \$13.70/\$100 tax rate, the relevent RFV equation and using the Traditional Method would result in an estimated average annual tax cost for 5 years of use of $(\frac{1 + .45}{2})$ (.18) (.1370) = 1.79 percent of the purchase cost where .18 is the assessment ratio. The Arithmetic Average Method provides an estimate of $(\frac{1 + .53}{2})$ (.18) (.1370) = 1.89 percent of the purchase cost and the Present Value Method estimate is 2.34 percent of the purchase cost. Therefore the Arithmetic Average Method again provides a more accurate estimate of the average annual tax cost in our example than does the Traditional Method. Note that a simple arithmetic average of the tax expenditure is $\frac{(100 + 92 + 83 + 69 + 53)}{5}$ (.18)(.1370) = 1.96 per cent of purchase cost, so that for Arizona taxes a simple arithmetic average is more accurate than either the Traditional or Arithmetic Average Methods.

Repairs

Estimation of repair cost is required for an accurate appraisal of total annual expenses of owning and operating farm machinery. Repairs in any one year are highly variable. Repairs calculated over the useful life of the machine include all parts and labor, whether made on or off the farm. Total accumulated repair (TAR) equations have been

Table 3.4 Personal Property Taxes as a Percent of Purchase Cost for a Farm Tractor in Arizona.

Beginning of Year	Full Cash Value* as % of PC	Taxes @ $13.70/100 as % of PC
1	100	2.5
2	92	2.3
3	83	2.0
4	69	1.7
5	53	1.3
6	36	.9
7+	0	

*Based upon Arizona Tax Provisions

estimated by agricultural engineers and are reported in the 1978 ASAE yearbook, which represent repair percentages based upon the hours of use. When repairs were made on the farm by farm laborers, the expense was estimated as if it had been made off the farm by a dealer or private mechanics. The TAR equations reported by machinery group are of the form:

$$TAR_N = \alpha(PCTUSE)^{\beta}$$

where

TAR_N = total accumulated repairs in year N,

α, β = constants estimated for each class function,

PCTUSE = the percentage of expected life that the machine has been used,

$$PCTUSE = \frac{USE*N*100}{WEAR},$$

USE = hours of average annual use,

N = use of machine expressed in years and

WEAR = life expectancy of the machine defined in hours.

Repair costs are based upon the purchase cost and the appropriate TAR equations for a particular asset. Alternative uses of a particular TAR equation can form different methods for computing repair cost. Two methods will be discussed and compared. The first method is the Arithmetic Average Method and the second is the Present Value Method.

The Arithmetic Average Method is used in computing annual repair cost in the Budget Generator. The cost of repairs is based upon the average of total accumulated repairs over the useful life of the machine. The repair equation is:

$$\text{Arithmetic Average Annual Repairs} = \frac{PC \ * \ TAR_N}{N}$$

where

PC = purchase cost,

TAR_N = appropriate total accumulated repairs equation and

N = useful life of the machine.

In Table 3.5 the annual average repair cost expressed as a percentage of purchase cost is shown using different TAR equations and useful lives. When N = 2, TAR equation 3 shows the smallest amount of annual repairs while TAR equation 7 shows the largest. Also for each specific TAR equation, as the useful life increases, the amount of annual repairs also increases.

The alternative and more correct method for evaluating repair cost is the Present Value Method, since it takes into account the time value of money. The equation for average annual repair cost using the present value method is

$$\text{PV Average Annual Repairs} = \sum_{n=1}^{k} \frac{(TAR_k - TAR_{k-1}) \ PC/(1+r)^k}{1 - (1-r)^{-N}/r}$$

where

Table 3.5 Average Annual Arithmetic and Present Value Average Annual Repair Cost as % of Purchase Cost*.

Various TAR Equation	Years Useful Life	Arithmetic Average Annual	Present Value Average Annual at Various Discount Rates r=5%	r=10%	r=15%	r=20%
2	2	4.08	4.05	4.03	4.00	3.97
	5	6.45	6.30	6.16	6.02	5.89
	10	9.13	8.69	8.26	7.87	7.50
3	2	2.47	2.45	2.44	2.42	2.41
	5	3.56	3.49	3.42	3.36	3.30
	10	4.69	4.50	4.32	4.15	3.99
7	2	5.83	5.81	5.78	5.76	5.73
	5	7.68	7.56	7.45	7.34	7.24
	10	9.45	9.15	8.86	8.59	8.34

* Annual use of 1,000 hours and 12,000 hours to wear out

where TAR_N = .00120 X (PCTUSE) 1.5 for TAR equation 1,
TAR_N = .00096 X (PCTUSE) 1.5 for TAR equation 3,
TAR_N = .00301 x (PCTUSE) 1.3 for TAR equation 7 and

$$PCTUSE = \frac{USE * N * 100}{WEAR} .$$

TAR_k = total accumulated repairs equation for year k,

TAR_{k-1} = total accumulated repairs equation for year k-1 and

PC = purchase cost.

The repair cost as a percent of purchase cost is determined for each year in the Present Value Method. Yearly repair costs are computed by subtracting Total Accumulated Repairs in Year k from Total Accumulated Repairs in k-1. Each year's repair costs are discounted and then summed to find the present value of repairs as a percentage of purchase cost. This percentage is divided by the annuity factor to derive the average annual repair cost expressed as a percentage of purchase cost. The total average annual repair cost is then computed by multiplying the purchase cost by the average annual repair cost as a percent of purchase cost divided by 100. Table 3.5 shows how Present Value Average Annual repair costs, expressed as a percentage of purchase cost, will vary using different discount rates, useful lives and TAR equations. Assuming that N=10 and using TAR equation 7, the average annual repair cost as a per cent of purchase cost varies from 9.15% when the discount rate is 5% to 8.34% when r is 20%. When N is 2, using TAR equation 7, the difference ranges from 5.81% when r is 5% to 5.73% when r is 20%. The above relationship illustrates that the Present Value Average Annual repair costs decrease as the discount rate is increased.

Comparison of the Arithmetic Average Method with the Present Value Method shows that the former method tends to overestimate repair costs over the useful life of an asset. Table 3.6 shows the overestimation of repair costs resulting from use of Arithmetic Average

Table 3.6 Error in Arithmetic Average Annual Repair Cost as a Percent of Present Value Average Annual Repair Cost.

TAR Equation	Years Useful Life	Percent Overestimate at Various Discount Rates*			
		r=5%	r=10%	r=15%	r=20%
2	2	0.7	1.2	2.0	2.8
	5	2.4	4.7	7.1	9.5
	10	5.1	10.5	16.0	21.7
3	2	0.8	1.2	2.1	2.5
	5	2.0	4.1	6.0	7.9
	10	4.2	8.6	13.0	17.5
7	2	0.3	0.9	1.2	1.7
	5	1.6	3.1	4.6	6.1
	10	3.3	6.7	10.0	13.3

* See Table 3.5

Annual repair cost, with different discount rates, useful lives and TAR equations. Using TAR equation 2 and a useful life of 10 years, the Arithmetic Method overestimates the Present Value Method ranging from 5.1% when r is 5% to 21.7% when r is 20%. When N = 2 using the same TAR equation, the difference ranges from 0.7% when r is 5% to 2.8% when r is 20%.

Therefore, as the useful life is increased and the discount rate is increased, the Arithmetic Average Method does a poorer job of estimating repair costs. Reference has been made to a Traditional Method for all previous cost calculations. The Arithmetic Average Method using TAR equations is used to also represent the Traditional Method.

Summary: An Example

An attempt was made to show how estimates of average annual costs vary by method used. Since variation in results occur, an example demonstrating each method will help in comparison and summarization of the results.

Let us assume a 100 HP Tractor whose purchase cost is $24,542. The salvage value of the tractor at the end of 5 years is $11,000. This value is based upon RFV equation 4, appropriate for the farm tractor from the 1978 Agricultural Engineers Yearbook. Repairs are based upon TAR equation 2 from the same source. The annual hours of use are 1,000 and wear-out is 12,000 hours. Taxes are based upon the full cash values in Table 3.4. Insurance premiums are based upon remaining farm values at the beginning of each period as computed by the RFV equation 4. The premium rate is 1 percent. The annual cost of fuel and oil is assumed to be $3,044 annually. The annual interest rate is 15 percent. Table 3.7 shows the actual "out of pocket" cash flow over the 5 years useful life of the tractor based upon self-financing. The last line in Table 3.7 shows total annual cost and simple average annual costs for each cost category.

The results from using the Present Value Method for analyzing investments assuming self-financing are shown in the last row of Table 3.8. The average annual costs are computed by discounting the actual cash flows of each cost category of Table 3.7 and dividing by the annuity factor. The present value average annual investment cost shown in Column 1 includes depreciation and interest. The other cost columns are self-explanatory. The sum of the average annual costs is the Present Value Method's total average annual cost.

The results from using the Traditional Method for calculating investment cost are shown in Table 3.9. Average annual interest cost was computed by using the 15 percent interest rate on the average investment $\frac{(PC+SV)}{2}$. Average annual depreciation was derived by using $\frac{PC-SV}{N}$. The sum of average annual interest and average annual depreciation yields average annual investment cost. Average annual interest/tax was computed by multiplying the actual insurance/tax rate times $\frac{(PC+SV)}{2}$. Average Annual Fuel cost was assumed to be $3,404. The sum of the average itemized costs derives the total average annual cost for the Traditional Method.

Table 3.7 Example Cash Flows with Self-Financing.

	Year	PC/SV	Insurance	Taxes	Repairs	Fuel-Oil	Total Cash Flow
	0	$24,542	$245	$614			$25,401
	1		154	564	$709	$3,404	4,831
	2		141	491	1,293	3,404	5,329
	3		130	417	1,679	3,404	5,630
	4		120	319	1,985	3,404	5,828
	5	-11,000	0	0	2,253	3,404	-5,343
Total		$13,542	$790	$2,405	$7,919	$17,020	$41,676
Simple Average		$2,708	$158	$481	$1,584	$3,404	$8,335

Table 3.8 Example Present Value Annual and Average Annual Costs with 15 Percent Discount Rate.

Year	Investment Cost	Insurance	Taxes	Repairs	Fuel-Oil	TOTAL
0	$24,542	$245	$614			$25,401
1		134	490	$616	$2,960	4,200
2		107	371	978	2,574	4,030
3		85	274	1,104	2,238	3,701
4		69	182	1,135	1,946	3,332
5	-5,468			1,120	1,692	-2,656
Total Present Value	$19,074	$640	$1,931	$4,953	$11,410	$38,008
Present Value Average Annual Cost @ 15%	$5,690	$191	$576	$1,478	$3,404	$11,339

Table 3.9 Example Traditional and Arithmetic Average Annual Costs.

	Traditional Method	Arithmetic Average Method
Average Annual Investment	$17,771	$19,125
Depreciation	2,708	2,708
Interest at 15%	2,666	2,869
Investment Cost	5,374	5,577
Insurance at 1%	178	191
Taxes at $13.70/100	438	472
Repairs	1,584	1,584
Fuel-Oil	3,404	3,404
Total Average Annual Cost	$10,978	$11,228

The results from using the Arithmetic Average Method for calculating investment cost assuming self-financing are also shown in Table 3.9. Average annual interest cost was measured by multiplying the 15 percent interest rate times average investment (PC+SV+(PC-SV)/N)/2. Annual average depreciation is computed in the same manner as the Traditional Method, as are repairs. Annual Average Insurance/Tax cost is computed by multiplying the actual insurance/tax rate by average investment (PC+SV+(PC-SV)/N)/2. The sum of the average annual itemized costs derives the Arithmetic Average Method's total average annual cost.

Table 3.10 shows a summary of the average annual costs for the three Methods. Also shown are the percent errors between the Traditional Method and Present Value Method for each cost category and the percent errors between the Arithmetic Average Method and Present Value Method for the same categories.

The average annual investment cost is shown for each method in the Depreciation and Interest Column of Table 3.10 . The present value average annual investment cost is $5,690. Looking at the Traditional Method result, average annual investment cost is 5.6% less than for the Present Value Method due to the Traditional Methods failure to account for the time value of money. In order for them to be equivalent, either average investment or the interest rate applied to average investment will need to be adjusted upward. Since the Arithmetic Method's average investment is an upward adjustment to the Traditional Method's average investment by one-half of the depreciation, the average annual

Table 3.10 Summary of Average Annual Costs for the Present Value, Traditional and Arithmetic Average Methods.

	Interest and Depreciation	Insurance	Taxes	Repairs	Fuel-Oil	Total
Present Value Method Average Annual Cost	$5,690	$191	$576	$1,478	$3,404	$11,339
Traditional Method Average Annual Cost	5,374	178	438	1,584	3,404	10,978
Percent error between PV and Traditional Estimates	-5.6	-6.8	-24.0	7.2	0	-3.2
Arithmetic Average Method Average Annual Cost	5,577	191	472	1,584	3,404	11,228
Percent error between PV and Arithmetic Average Estimates	-2.0	-0.0	-18.1	7.2	0	-1.0

investment cost increases to $5,577, thereby decreasing the percent error to -2.0%.

The average annual insurance costs are shown for the three methods in the "Insurance" column of Table 3.10. The average annual insurance cost for the Present Value Method was $191. The Traditional Method underestimates the present value average annual insurance cost by 6.8%. By coincidence the Arithmetic Average and Present Value Method provide identical estimates.

Average Annual Taxes are shown in the "Taxes" column. The Present Value Method's average annual taxes are $576. On the other extreme, the Traditional Method's annual average taxes are $438, 24% lower than the Present Value Method. The Arithmetic Average Method's average annual taxes are $472, 18.1% lower than the Present Value Method.

Average Annual Repair costs and error are summarized in the "Repair" column. Here the Traditional Method and Arithmetic Average Method give the same average annual repair costs at $1,584, 7.2% higher than the Present Value average annual repair cost of $1,498.

In the fuel-oil column of Table 3.10, the average annual fuel-oil cost is the $3,404 for all three methods, thus there is no error. The total estimated average annual cost in the last column of Table 3.10 includes interest, depreciation, insurance, taxes, repairs, and fuel-oil costs. In the Present Value Method the total average annual cost is $11,339 while it is $10,978 for the Traditional Method, a 3.2% underestimate. The Arithmetic Average Method's total average annual cost is $11,228, a 1.0% underestimate.

The example just discussed asssumed self-financing. If borrowed funds were used, "would the total estimated average annual cost using the Present Value Method be the same as under self-financing?" The answer is "yes" only when the opportunity cost of your own funds is equal to the cost of borrowed funds. To illustrate, Table 3.11 shows the actual cash flow for five financing alternatives for the previous example. Alternative A, shown in the previous example, is self-financing. Alternative B is financing with an $11,000 down payment, Alternative C is financing with $9,000 down payment, Alternative D is financing with a $11,000 balloon payment and Alternative E is financing with a $9,000 balloon payment.

The average annual investment (interest and depreciation) cost under self-financing in Table 3.11 assuming a 15% discount rate is $5,690. Under self-financing the farmer is paying the purchase cost of the tractor, $24,542, with his own funds in year 0 and at the end of the useful life receiving a sale or salvage value price of $11,000. The average annual investment cost is calculated by amortizing the present value of the salvage value and the purchase cost as discussed above.

Financing with a down payment is a combination of self-financing and borrowing. The down payment is a dollar amount "paid" by the farmer, at purchase time. The borrowed portion is derived by subtracting the purchase cost from the down payment. This difference can then be amortized over the 5 years. The amortized loan payments include principal and interest. The annual amortized payments, the down payment, the sale price and the opportunity cost of the down payment

Table 3.11 Actual Cash Flows: Comparison of Self-Financing and Commercial Financing with a 15% Discount (Interest) Rate.

Year	0	1	2	3	4	5	Average* Annual Cost
A. Self Financing							
Purchase Cost	24,542						7,321
Sales Value						-11,000	-1,631
							$ 5,690
B. $11,000 Down							
Down Payment	11,000						3,281
Sales Value						-11,000	-1,631
Loan Payment		4,040	4,040	4,040	4,040	4,040	4,040
							$5,690
C. $9,000 Down							
Down Payment	9,000						2,684
Sales Value						-11,000	-1,631
Loan Payment		4,637	4,637	4,637	4,637	4,637	4,637
							$5,690
D. $11,000 Balloon							
Balloon Payment						11,000	1,631
Sales Value						-11,000	-1,631
Loan Payment		4,040	4,040	4,040	4,040	4,040	4,040
Interest on Balloon		1,650	1,650	1,650	1,650	1,650	1,650
							$5,690
E. $9,000 Balloon							
Balloon Payment						9,000	1,334
Sales Value						-11,000	-1,631
Loan Payment		4,637	4,637	4,637	4,637	4,637	4,637
Interest on Balloon		1,350	1,350	1,350	1,350	1,350	1,350
							$5,690

* Determined by amortizing the present value of each line item.

over the useful life are shown in Table 3.11. The annual amoritized payments of $4,040 for a $11,000 down payment were computed by dividing total borrowing by the annuity factor. The average annual equivalent of the down payment is $3,281 and is calculated by dividing the down payment by the amortization factor. The average annual investment cost is $5,690. If the down payment is $9,000, the amoritized loan payments would be $4,637 and the average annual equivalent of the down payment is $2,684. The sum of average investment cost is again $5,690. Thus, the average annual investment costs under self-financing and financing with varying down payments are the same.

The fourth alternative considered is financing totally with borrowed capital. The capital borrowed is broken into an amortized loan and a balloon payment. The balloon payment, sales price, loan payment, and annual interest on the balloon payment are shown in Table 3.11. Annual amoritized payments are $4,040 with a $11,000 balloon payment which is computed by subtracting the $11,000 balloon payment from the $24,542 purchase cost and dividing by the annuity factor. The average annual investment cost is again $5,690. If the balloon payment is $9,000, the amortized loan payments are $4,637. The sum of the average investment cost under self-financing, financing with varying down payments and financing with various balloon payments are the same.

CHAPTER 4

COMPARISON OF BUDGETED ESTIMATES WITH ACTUAL FARM RECORDS

The purpose of this chapter is to measure and discuss the error between actual farm records and the budgeted estimates derived from the Budget Generator. Actual costs provided by four case farms came from their records and accounting statements. These costs include chemical costs (includes chemical custom service), other custom service (excluding ginning costs), seed costs, wages, salaries and fringe benefits cost, pump electricity cost, fuel-oil cost, project water cost, pump repair cost, machinery repair costs and supplies. Actual costs are not reported here to keep data confidential by farm. Table 4.1 column 1, under each farm shows the proportion of each predicted itemized cost to the total predicted, i.e. predicted cost shares, column 2 shows percent difference between actual and predicted itemized costs, i.e. percent error in predicting that item, and column 3 shows the error in the total itemized cost accounted for by the prediction of each itemized cost.

In Table 4.1, Column 1 for each farm is derived by dividing each predicted itemized cost into predicted total itemized cost. The values in this column sum to 100 percent. A large percentage means the cost makes up the major portion of total itemized cost and is of

Table 4.1 Summary of Prediction Error of Costs for Case Farms.

	FARM A			FARM B			FARM C			FARM D		
Itemized Costs	Predicted as $ of Total	Percent Actual Differ from Predicted	Predicted $ Error in Total	Predicted as $ of Total	Percent Actual Differ from Predicted	Predicted $ Error in Total	Predicted as $ of Total	Percent Actual Differ from Predicted	Predicted $ Error in Total	Predicted as $ of Total	Percent Actual Differ from Predicted	Predicted $ Error in Total
Chemical and application	20.5	- 18.9	- 3.87	32.0	-5.47	-1.75	33.8	-11.59	-1.08	36.2	1.19	.43
Other Custom Services	12.8	- 4.69	- .60	31.9	-12.1	-3.86	11.9	16.7	1.99	11.1	- 3.5	- .39
Seed	3.1	+ 57.9	1.79	.4	44.7	.18	1.9	-10.7	- .20	1.0	-50.4	- .50
Pump Electricity	12.1	- 23.9	- 2.89	9.3	7.2	.67	--	--	--	--	--	--
Project Water	--	--	--	--	--	--	5.6	- 6.4	- .36	11.4	-10.5	-1.2
Fuel-Oil	5.6	- 6.01	- .33	2.1	-93.8	-1.96	4.5	- 2.1	- .09	3.5	-28	- .98
Wages, Salaries, Fringe Benefits	24.8	- 2.73	- .68	17.1	- 8.7	-1.49	26.8	- 2.5	- .67	24.9	- 6.15	-1.53
Machinery Repairs	10.3	- 28.1	- 2.89	1.90	-62.5	-1.19	10.9	42.4	4.62	7.8	-20	-1.56
Pump Repairs	5.6	-135.6	- 7.59	2.7	32.8	.88	--	--	--	--	--	--
General Farm Maintenance	4.9	58.5	2.85	2.2	55.4	1.22	4.3	7.04	.30	3.7	-38.1	-1.41
Total Itemized Cost	100$		-13.87	100$		-7.3	100$		4.51	100$		-7.14
Total Itemized Cost W/O Repairs			- 3.39			-6.99			- .11			-5.58
Wages, Salaries, Fringe Benefits, Repairs and General Farm Maintenance	45.6	- 18.1	- 8.25	24	- 2.5	- .6	42.1	10.1	4.25	36.5	-12.4	-4.52

importance in estimating while a smaller percentage makes up a minor portion of the predicted itemized cost and is of lesser importance. For example, chemical and application cost composes a major part of predicted total itemized cost for all case farms while seed cost composes the least.

Again referring to Table 4.1, Column 2 for each farm was derived by dividing the predicted itemized cost into the actual. These percentages tell how close the predicted was to the actual. Positive percentages indicate over-estimation while negative values indicate under-estimation. Those costs which are highly variable would be expected to show the greater amount of error and vice-versa.

Column 3 for each farm was derived by multiplying each itemized percentage in Column 1 by the same in Column 2. The itemized percentages in this Column are directly affected by the factors which determine Columns 1 and 2. For example, a cost which makes up a sizeable portion of total itemized cost, multiplied by a high negative predicting error for that cost will make up a large amount of error in the total itemized error.

Chemical and Chemical Custom Service Cost

Chemicals used on the case farms include fertilizers, herbicides, fungicides, insecticides and defoliants. Where a farmer used many chemicals in a mixture, the proportion of each chemical's cost devoted to the total mixture was estimated and summed and a "mixture cost" reported for each mixture in the Budget Generator. Chemical

Custom Service Cost is provided in the Budget Generator for any typical chemical application. Chemical custom services used on case farms included aerial spray applications for insect control and defoliation and manure spreading. The cost of chemical custom service was included in the chemical cost in the accounting statements of each case farm. For the budget estimates to be compared to the actual, the chemical cost and application cost is summed. The proportion of estimated chemical and application cost to the predicted total itemized cost in Column 1 for each farm in Table 4.1 ranges from 20.5% to 36.2%. These percentages make up a large portion of the total itemized cost. A major factor which influences this is cotton. Cotton requires fertilizers, insecticides, defoliants and in some cases herbicides and fungicides. Different kinds, quantities and prices of chemicals and application costs will affect each case farm differently.

The difference between actual chemical and application cost and the predicted cost on the case farms ranges from +1.19% to -18.9%. Since different levels of chemicals may be put on a single crop and in the same field, variation in predicting and actual will occur. Price changes in chemicals from month to month will also affect predicting error. The portion of error which chemical and application cost make up the total itemized error ranges from +.43% to -3.87%. The estimates were low for three of the four farms.

Other Custom Services Excluding Ginning Costs

Other custom services required by the case farms included sugar beet weeding, thinning and harvesting, cotton weeding, corn and sorghum silage chopping and hauling, custom combining and hauling, alfalfa swathing, raking, baling and roadsiding and cotton picking and rooding. Ginning costs were omitted from custom service cost on the farms because it was not reported on the accounting statements. In Table 4.1, the proportion of predicted other custom services cost to the predicted total itemized cost ranged from 11.1% to 31.9%. This range was affected by amount of custom service used on the particular case farms. For example, Farm B had 33.7% of itemized operating cost being Other Custom Services. This was due to all cotton being custom picked.

The error which exists between actual Other Custom Services and the budgeted estimates, in the second column of Table 4.1 for each farm, ranges from +16.7% to -12.1%. A major factor in the 16.7% over-estimation of Other Custom Service on Farm C came from labor for cotton weeding. Here, labor was paid on an hourly basis rather than on an acre basis. In order to get an estimate of this cost for the farmer, both acres per hour and wages had to be specified. Depending on the weed condition of the cotton fields, acres per hour will be highly variable.

A major factor in the 12.1% under-estimation of Other Custom Services on Farm B can be attributed to inaccuracy in estimation of custom cotton picking. In the Budget Generator, custom cotton picking is based upon yield per acre. Unless actual yields for any crop whose custom service is based upon yields are specified exactly then error in estimation will occur.

The predicted percent error of Other Custom Service to the total itemized cost error ranges from a +1.99% to -3.86%.

Seed Cost

Seed Cost incurred by the case farms included wheat, cotton, corn, sorghum, sugar beets, safflower and barley. The proportion of predicted seed cost to predicted total itemized cost ranges from .40% to 3.1%. Since each farm has different crop plans and uses different kinds and quantities of seed at different acquisition prices, the range will vary. As one can see, seed cost is a minor part of the total itemized cost on all case farms.

The percentage error between actual and predicted seed cost varied from 57.9% to -50.40%. All farms had carryover of seed from the previous year and also did some replanting on some crops. Also no attempt was made to adjust the accounting data for changes in inventory. Thus, depending on the kind and quantity of seed in carryover and the kind and quantity purchased and the amount of replanting, the net expected could contain a positive or negative error.

The predicted percent error in total itemized cost ranges from 1.79% to -.50%. Even though difference between actual and predicted seed costs were high at both extremes, the predicted error in total was low due to the fact that seed cost was a minor part of total operating cost.

Pump Electricity Cost

Two farms reported total use of wells and pumps for irrigation water purposes. All pumps used by the case farms were powered by electric motors. Referring to Table 4.1, pump electricity cost as percent of predicted total itemized cost ranged from 9.3% to 12.1%. The amount of water pumped on each crop and cost will affect this portion.

Deviation(s) between predicted and actual pump electricity cost range from +7.2% to -23.9%. A major reason for the large range is due to averaging, since an average size well and pump was specified for each farm and costs derived. Also condition of the well will have a direct effect on the error in predicting pump electricity. The pump electricities' portion of total itemized cost error ranges from +.67% to -2.9%.

Project Water Cost

Two case farms in Maricopa County used project water totally, although auxiliary pumps were available. Project water for use on the case farms was available through Roosevelt Irrigation District, Roosevelt Water Conservation District and Salt River Project. Since most of the water for the farms came from the Salt River Project, all water specified in the Farm Budgets was assumed to have come from the Salt River Project. This assumption was needed for simplicity since varying combinations of water from each project would be used on varying crops at various times of the year.

The proportion that predicted project water cost contributed to predicted total itemized cost ranged from +5.6% to +11.40%. The quantity of water each farmer used was the main factor affecting the range.

Differences between predicted project water cost and actual vary from -6.4% to -10.5%. The bulk of the error lies in differences in the cost of water between projects. Although this error may seem to be large, the predicted project water cost error in relation to the total itemized cost error ranges from -.36% to -1.2%. This is a small part of total error.

Fuel and Oil Cost

The fuel and oil cost on the case farms is composed mainly of gasoline and diesel. The proportion of predicted fuel and oil costs to predicted total itemized cost ranges from 2.1% to 5.6%. The range is affected by size and use of tractors and other machines the farmer uses. The error between actual and predicted fuel and oil cost ranges from -2.1% to -93.8%. Under-estimation of fuel and oil cost was due to the fact that farmers used machinery and equipment for operations other than what was included in the Budget Generator or extended existing operations by completing the operation on part of the field and not reporting that work. The error in Farm B (-93.8%) is an adjusted error. This farm as discussed below in the Wages, Salaries and Fringe Benefits had a lot of extra land leveling of his own and also did custom land leveling. The farm labor had spent 30% of its time on custom jobs. Thus the predicted fuel oil cost was reduced by 30%. This adjustment is only for land leveling. The amount of fuel and oil in storage at the beginning of the year will introduce error in either direction depending on whether the farmer's storage of fuel and oil was empty or full at the beginning of the year since change in inventories were not determined. Error will also be affected by the load factor and condition of the particular machine the farmer uses.

The portion of the total error of itemized cost that fuel and oil make up ranges from -.90% to -1.96%.

Wages, Salaries and Fringe Benefits

Wages, Salaries and Fringe Benefits include payments to day, part-time, supervisory and management labor. Fringe Benefits provided to labor by case farms were comprised of housing, utilities, paid vacation, pension plans, telephone, vehicles and health insurance. Some fringe benefits were not included in accounting statements but an estimate of their value was given by management.

The value of management labor was estimated for each farm based upon what it might cost to hire the owner/operator. This was necessary because some management received no salary or an extremely high salary. Also, time spent managing varied and the adjustment in actual management cost was based upon the size of the farm and the amount of time the manager actually spent managing. For example, a manager who spends half of his time managing will receive a lower salary than one who spends all of his time managing on the same size farm. The "part-time" manager usually has a farm manager and office manager completing part of the management function.

A substantial part of predicted total itemized cost came from wages, salaries and fringe benefits. Referring to Table 4.1, the proportion of the adjusted Wages, Salaries and Fringe Benefits to predicted total itemized cost ranges from 17.1% to 26.8%. The quantity and kind of labor available, wages, salaries and fringe benefits paid by each farmer will affect this range.

Differences between actual and budgeted wages, salaries and fringe benefits ranged from -2.5% to -8.7%. Differences may be due to under-estimation of scheduled labor hours, which the Budget Generator directly estimates. Discrepancies in scheduled labor hours may result from incorrect data being specified in the Budget Generating program. Some data which a farmer fails to designate or designates incorrectly forces estimation to what we think occurs on his farm. For example, acres per hour specified in the crop operations file of the Budget Generator may be different from what actually occurs on the farm. When a farmer fails to designate acres per hour, the estimate we compute may contain incorrect machine sizes, field efficiences and operating speeds. Incorrect specification of acres per hour will cause over or under-estimation of scheduled labor hours and cost. Another difference between budgeted versus actual scheduled labor hours and cost may result from alteration of scheduled and timed crop operations. Problems associated with scheduling and timing can arise from variability in weather conditions, variable field conditions, unavailable inputs and major down-time.

Variation in field conditions may also allow some fields with the same crop to be handled differently than others. When a crop is planted in a series of fields where field operations vary, the result may lead to discrepancies between actual and budgeted scheduled labor hours and cost, although the net effect may show no differences. Major down-time and unavailable inputs may cause alteration or "tooling-up" of planned operations in order to get a complete operation done or crop in by a specific date.

Deviations will also be caused by specification of wages in the Budget Generator. Here actual wages were averaged since a variety of wages may be paid for performing identical jobs.

The proportion of error which adjusted wages, salaries and fringe benefits contribute to total itemized error ranges from -.67% to -1.53%. Predicting error was relatively low after adjustment and although the proportion of wages, salaries and fringe benefits to total itemized cost was high, the net effect realized a low portion of error in total itemized error.

As explained in Chapter 2 on Labor Requirements, some jobs performed by farm laborers are unscheduled and are not directly estimated in the Budget Generator. Since unscheduled labor is included in On-farm Machinery Repair and General Farm Maintenance, the error in estimating wages and salaries will be somewhat lower than indicated above.

Machinery and Equipment Repair

The Repair Cost section of Chapter 3 is used by the Budget Generator to generate repair costs. The repair costs are based upon annual hours of field use for each machinery item. Each case farm involved in the study reported a list of his own machinery inventory. The Budget Generator assumed machinery operated 9 hours of a 10-hour day working day. It also assumed that machinery would be used until worn out and useful life of the mahcine could not exceed 20 years. The hours a machine is used to complete a field operation depends on field efficiency, travel speed and equipment width.

Some equipment used on the case farms do not correspond exactly with the equipment in the equipment file of the Budget Generator. In these cases, the equipment that most nearly matched the equipment on the case farm was chosen. Thus, some errors will exist in estimating repair costs on particular prices of equipment.

The repair costs computed by the Budget Generator includes all parts and labor, whether repairs were made on or off the farm. Money spent for repairing machinery in a dealer's or private mechanic's shop and for parts purchased for installation on the farm are direct out-of-pocket expenses. No attempt was made to account for parts purchased for inventories for "on the farm" repairs.

An attempt was made to estimate the portion of the wage bill, including laborers, supervisory staff and management devoted to major repairs of machinery and equipment. The labor cost of on-farm labor for major repairs is valued at dealer/machanic repair rates.

Machinery and equipment repair cost include tractors, harvesting machinery, tillage equipment, planting equipment, residue disposal equipment, pickups and trucks for each case farm. The portion of predicted machinery repair cost to predicted total itemized cost ranges from 1.9% to 10.9%. Any above-average year's repair record will contribute a low proportion of error to the total itemized cost while a poor year's repair record will be significant. Discrepancies between budgeted and actual machine repair costs for the case farms ranged from +42.4% to -62.5%. As explained in Chapter 3 in the Repair Cost section, budgeted repair estimates are computed as an average annual repair cost for each machine and the total average annual repair cost is the sum. Since actual repair costs in any one year on a particular machine are highly variable, the budgeted estimate is going to be over or under estimating the actual repair cost depending on the age and condition of the machine. If actual repair cost in any year on each machine is under or over the average annual repair cost, the sum of the differences could net to zero and thus no error would be shown.

As mentioned in Chapter 3, the Present Value Method should give a more accurate estimate of average repair cost. However, one would expect a new piece of equipment to have low actual annual repair cost relative to the average annual repair cost.

Another problem arising out of estimating repair costs is that the number of years or hours to trade as computed in the Budget Generator is based upon wear-out and thus may be different from the farmer's actual trade-in schedule. For example, if a farmer trades a certain machine every five years no matter the hours of use, and the Budget Generator computes trade in at wear-out to be ten years, the budgeted average annual repair cost will be different from actual repair cost.

An additional point that causes error is that major breakdowns on a big machine, such as a 4-wheel drive tractor, could cause most of the error while other repairs are normal.

As pointed out in the Fuel and Oil section, Farm B did extra land leveling on land out of production and also custom land leveling with his own machinery. Adjusting repair costs for machinery used 30% of the time places the error at -62.56%. The portion of error in machinery repair that is a part of the total itemized error ranges from +4.6% to -2.89%.

Pump Repair Cost

As mentioned in the previous section on Pump Electricity, two case farms used wells and pumps for irrigation. The budgeted pump repair costs were based on an average well and pump for that particular case farm. The proportion of pump repair cost to predicted total itemized cost varies from 2.70% to 5.6%. The amount of variation in predicted pump repairs will depend on the amount of water pumped.

The deviation in predicted and actual pump repair cost ranges from extremes of +32.8% to -135.6%. Since any repair cost is highly variable, and pump repair costs were based upon average annual cost for a representative well for that farm, this was not to be unexpected. The portion of error due to pump repair costs to the total itemized cost ranges from +.88% to -7.59%. The former percentage is relatively small while the latter percentage makes up a significant part of the error in total itemized costs for that farm.

General Farm Maintenance and Supplies Cost

General Farm Maintenance is an estimate of expenditures which a farmer incurs for maintaining irrigation ditches, buildings, weed control, etc. Supplies were taken from each farmer's actual farm records and are made up of expenditures for building repair, ditch repair, tires, farm supplies, etc.

General Farm Maintenance is a fixed per acre cost in the Budget Generator. General Farm Maintenance can be broken down into cost of supplies and cost of labor, the labor being unscheduled labor as discussed in Chapter 2 on Labor Requirements. The proportion of supplies to labor is not known.

The portion of predicted General Farm Maintenance to Total Itemized Cost ranges from 2.4% to 4.9%. Predicting error varied from 58.5% to -38.1%. Since predicted General Farm Maintenance and actual supplies are not the same but similar, this was to be expected. The portion of error of General Farm Maintenance to the total itemized error ranged from 2.8% to -1.41%.

Total Itemized Cost

The sum of the errors by item as a percent of total itemized cost results in the error in total itemized cost. This error ranges from 4.51% to -13.87%. Since discussion led to the conclusion that repair costs were highly variable, subtracting error in repair cost would give an estimate of total operating error excluding repair cost. The error ranged from -.11% to -6.99%, all under-estimates.

Wages, Salaries, Fringe Benefits, Repairs, General Farm Maintenance and Supplies

Grouping wages, salaries and fringe benefits, repairs and general farm maintenance together gives an estimate of "all" labor costs, repairs and supplies. The predicted proportion of this group of costs to total itemized cost ranges from 24.0% to 45.6%. The predicting error for the group ranges from 10.1% to -18.1%. Most of the 10.1% overestimate is due to over-prediction of repair costs, while the 45.6% underestimate is also due to under-prediction of repair cost. This further reflects the fact repair costs are very unpredictable. The proportion of total itemized error that this group of costs makes up ranges from 4.25% to -8.25%.

CHAPTER 5

CONCLUSION

Total farm budgets which estimate production cost, yields and prices before the crop is planted will assist farmers in decisions concerning input procurement, crop mixes, marketing strategies and financing. The objective of this thesis was to 1) review the features of the Budget Generator 2) evaluate the methodological alternatives for estimating farm machinery costs and 3) attempt to generate actual cost for case farms.

In predicting the cash cost for farms it is useful to first predict past costs based upon the farmer's most recent accounting data available and compare them to actual farm records in order to verify the model. Since most costs cannot be compared directly, pooling of some costs is needed.

The procedure to predict past costs based upon the finding of this study includes:

Step (A) Estimate cost of the Supervisory and Management function by using the actual wages, salaries and fringe benefits paid to the owner/operator, managers, foremen, office managers and farm managers reduced by the time spent in nonsupervison and nonmanagement functions times the labor wage rate.

Step (B) Scheduled labor should be estimated through the use of the Budget Generator and should be based upon the farmer's actual average wage rate and hours based upon the number of acres per hour for the particular crop and factor mix. The fringe benefit percentage should be based upon the actual cost of fringe benefits provided to the employees.

Step (C) Using the Budget Generator estimate of expected General Farm Maintenance Cost as a fixed per acre cost that includes labor and materials.

Step (D) Predicting annual repair cost for the farmer's specific machines based upon TAR equations or actual repairs on machines that have had major overhauls. If a machine had normal repairs during the year then TAR_k-TAR_{k-1} should be used. If a farmer had his own mechanic in employment then the value of his labor would be already included in the TAR equation but the mechanic's labor should be estimated for those machines where estimates are based upon major overhaul costs.

Step (E) Average annual Pump Repair Cost should be computed using the pump water Budget Generator on the average size well and pump which the farmer uses.

Step (F) Other costs, which include project water cost, fuel and oil cost, chemical and chemical application cost, seed cost and other custom services should be estimated directly from the Budget Generator with appropriate factor costs and rates provided by the farmer. In some cases a farmer will have to provide yields since some custom service costs are based upon this. A farmer's actual accounting records should not be used unless changes in inventories are available since inputs such as seed, fuel and oil and chemicals are affected by changing inventories.

Since unscheduled labor is included in Steps C, D and E, it is necessary to pool the results from Steps A thru E to compare with actual farm records. Actual costs collected from a farmer should include total wages, salaries and fringe benefits (including estimated value of housing, for example), total repair cost (includes parts and dealer labor for machinery and pump repair) and total supply cost. Actual total wages, salaries and fringe benefits and actual total repair cost should be adjusted for any outside work performed by labor and machines.

When predicting cash costs for the upcoming year the above procedures, Steps A thru F, should be used for the planned factor and crop mix.

Further research is recommended in the area of estimating repair costs. The TAR equations developed by agricultural engineers have not been revised for several years. Since pump repairs are based upon a constant value in the Pump Water Budget Generator, further research is recommended for the development of TAR equations for pump and well repairs. A further research recommendation in the area of estimating repair cost is "what effect does a farmer hiring his own on-farm mechanic versus using 'dealer' mechanics have on repair costs?"

The previous conclusions centered on predicting actual annual cash flows by first verifying the model by predicting past cash flows and comparing to actual farm accounting statements and then predicting upcoming cash costs based upon the proposed factor and crop mix.

The procedure suggested for estimating average annual costs is the same as discussed above except for the following alterations:

Step (A) The owner/operator's salary should be based upon what it would cost the farmer to hire a farm manager to perform the same function. This is important since many owner/operator's salaries are set arbitrarily.

Step (D) Machinery average annual repair costs should be computed by using the Present Value Method discussed in Chapter 3 based upon the farmer's trade-in schedule and hours of annual use.

Also estimating average annual costs would require estimation of average annual investment costs. It is recommended the Present Value Method be used.

Further research should be considered into the value of the management function. Also, additional research is needed into "what general farm maintenance is" and "how it should be computed". Also, as more data is available it is recommended that the Present Value Method be used to derive average annual General Farm Maintenance Costs.

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