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NEW MACHINERY OWNERSHIP COSTING PROCEDURE

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ABSTRACT

A quick conventional estimate of machinery operating costs is obtained by averaging the annual costs over the full period of ownership. This ignores the fact that depreciation is higher during the first year of ownership than in subsequent years, whilst repair and maintenance charges increase with age of the machine. This conventional estimating procedure provides a useful guide to average trends. The correct evaluation of annual costs is particularly important ascertain the economic life of a machine. For solutions to more complex machinery management problems, the annual machinery costs are calculated using the actual cash flows, which occur each year. The calculation of annual costs of machine ownership is based on three types of cash flows: (a) capital cost repayable by equal mortgage installments, (b) recurring annual repair and insurance charges and (c) income from selling the machine.

The net present value of an investment in farm machinery may be calculated using a series of steps. First and most important, the cash flow generated by the investment must be estimated for each year. Second, the cash flow is discounted by a present value factor. Third, the discounted cash flow is assumed over the number of years analyzed. The discounted annual interest charge paid on the borrowed capital is affected by the amount of the loan and its period. For a given standard tax rate, the tax relief is calculated for repair and insurance costs and annual capital allowances deducting the actual balancing charge. This study is aimed to give an accurate estimate of the annual costs of a machine and to provide a comparison of the present annual cost of machine ownership with and without the effects of tax allowance and tax relief.

The present annual cost of machine ownership is substantially altered by tax considerations. Allowing 30% tax rate in calculation of machine costs reduces tractor present annual cost from a current value (CV) of 2916 to a CV of 2032 (30% reduction) compared to a CV of 2440 calculated using the conventional method. The present approach yields an intermediate cost figure within the range spanned by the present annual ownership costs with and without tax.

Keywords: Current Value (CV), Capital Allowance (C_A), Balancing charge (B_c), annual interest charge (I_A), Repair cost (R_c), Mortgage value, (M_V), Insurance charge, (I_{NS},) Resale value (S_N), Annual cost (A_N), Loan rate I_r, and Inflation rate, j_f.

INTRODUCTION

Batterham (1973) and Liang *et al.* (1979) used terms of the present value of a future sum, which brings the future sum back to the value of the present sum at a discounted investment rate. Statistical models were developed by Schoney and Massie (1979), Schoney and Finner (1981) and Rotz (1985) to estimate "as is" value during periods of high inflation rate for five categories of farm tractors and three groups of combines. The results indicated that, at current inflation rates, most tractors and combines were likely to retain a very substantial portion of their original prices. Tractors and combines represent sizeable investments generating – substantial ownership costs for most farmers, where 60 to 70 percent of the total cost of ownership

and operation is associated with capital recovery. Although many analysts continue to use the average interest and depreciation methods, the capital recovery method is the appropriate method for determining annual charges. Smith and Oliver (1974) calculated the capital annual recovery factor based on discounting techniques by the form:

$$C_{rf} = (A_C - S_N (A/p)^i_N \quad \text{..... ....1.1}$$

where: C_{rf} = capital recovery factor;
$(A/P)^i_N$= Amortization factor, a uniform series of payments from a present value of 0.1;
A_C = acquisition cost, current value;
S_N = salvage value at the end of N years.

Whereas C_{rf}, is an annual charge to recover both the loss in asset value and the opportunity cost of capital and consists of two components. The first component amortizes the loss in asset value over the planning period and the second component consists of an annual charge for capital associated with the salvage value of the machine at the end of its life. Inflation affects both of these components, interest and salvage value.

Audsley and Wheeler (1978) produced a procedure to calculate the annual cost of a machine ownership. The procedure is based on four types of cash flows; the capital cost to buy the machine, recurring annual maintenance and repair charge, the resale value and interest paid on borrowed capital. They combined these cost elements to present the annual cost such as:

$$A_n = \left\{ pp + \sum_{n=1}^{N} R_C FL^n - S_N FL^N \right\} (FL-1)/FL(FL^N - 1) \text{.....1.2}$$

where: A_n = annual cost of ownership; $FL = (1+j_f)/(1+i_i)$;
i_i = interest rate; j_f = inflation rate; N = number of years the machine is used;
R_c = current value of repair cost in the nth year; PP = initial purchase price;
S_N =current resale value after N years old machine.

This procedure is used in the current study with further refinement to include the affect of taxation, tax allowance and balancing charges in the annual cost of the machine ownership.

THEORETICAL JUSTIFICATION

2.1 Machine Purchase Index Price

Elbanna *et al.* (1987) used machinery available list prices and developed price equations for 2-WD tractors and common farm machines. However, they stated that purchase price data for only one year is severely limited in its usefulness. To extend their procedure to a current price guide is easier and quicker than reapplying the price equation. The availability of official price indices simplified the updating of machinery prices on a monthly or annual basis as Elbanna and Witney (1986) and Elbanna *et al.* (1987) stated . The list price of a machine varies from a year to another and from country to another; however, it is possible to convert historical prices to current values and vice versa by using the appropriate index price values (Table 2.1). For

example, updating machine prices from 1995 to 2000 requires the following conversion:

$$(TPP)_{2000} = (TPP)_{1995}\frac{I2000}{I1995} \quad \text{.....2.1}$$

where: $(T_{PP})_{1995}$ and $(T_{PP})_{2000}$ = tractor list prices for 1995 and 2000, C.V.;
$(I_{PP})_{1995}$ and $(I_{PP})_{2000}$ = tractor price indices for 1995 and 2000.

Table 2.1 10-index prices of tractor list prices in Egypt.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Aver. ,CV	100	103	107	110	114	118	122	127	130	134	139

CV. = monetary unit

2.2- Interest and Inflation rates

In calculating the cost of owning and operating an individual machine, a charge for interest on the capital invested in the machine must be considered. If the capital is borrowed, an interest has to be paid, or if it is owned, an opportunity cost, which is the highest return that the capital could earn from an alternative investment, has to be determined. The opportunity cost of a capital is by no means easy to define but a realistic allowance can be calculated from the earring power in a safe investment such as a building society.

Inflation and tax allowance make the real cost of borrowing much lower than indicated by overdraft interest rates, so it is much appropriate to use investment interest (i_i) and inflation rates (j_f). Thus, the real interest, i_r, using identical monetary values, is the total repayment related to the purchasing power of the loan and it can be expressed mathematically as in the form:

$$i_r = \frac{(i_i - j_f)}{1 + j_f}100 \quad \text{.....2.2}$$

2.3- Resale Value

The resale value of N-years old machine (eqn 2.3) and its coefficients (A_s and B_s) are given in Table (2.3). As a result of changes in the inflation and interest rates, the resale value of a machine will have changed in N-years' time. The present resale value of a machine after being inflated and discounted may be rewritten in the form:

$$S_N = A_s(B_s)^N FL^N(PP/100) \quad \text{.....2.3}$$

where: A_s and B_s = resale coefficient constants;
S_N = inflation/discounted machine resale value after N-years ownership, CV.;
PP = machine purchase price, current value;
FL = $(1+j_f)/1+i_i)$, ratio of inflation to interest rate.

The actual data in Table 2.2 for six popular models of two wheel drive tractors exhibit very close agreement to a single declining curve (Fig. 2.1) with the form of:

$$\frac{S_N}{PP} = e^{(-0.2n+0.008n^2)}$$

where e is the base of natural logarithms and n is the deprecation age of the tractor. The advantage of this relation is that the resale value of the tractor when new, at age zero, is identical to the current purchase price (Fig. 2.1). This resale value assumes an average annual use of 1000 h/y. Heavier or lighter use influences the condition of the tractor and its resale value. An indication of the operational age of a tractor is obtained by dividing the accumulated use by the average annual use (taken as 1000h/yr).

Because it accounts for the effect of ageing as well as utilization, the mean actual age and the operational age provide realistic depreciation age for assessing resale value:

Deprecation age, yr=(actul age operational age)/2.

Table 2.2: Ratio of current resale value to current purchase price for various 2-wheel drive tractors (Witney, 1988).

Age	Current resale value / Current purchase price					
	MF135	JD1120	Ford3000	MF165	Ford4000	IH574
2	---	---	---	0.68	---	---
3	---	0.49	0.52	0.60	0.52	0.43
4	0.46	0.40	0.43	0.54	0.42	0.34
5	0.42	0.34	0.37	0.43	0.35	0.29
6	0.38	0.29	0.33	0.37	0.32	0.25
7	0.34	0.25	0.29	0.33	0.29	0.25
8	0.31	0.22	0.28	0.30	0.26	---
9	0.29	0.19	0.26	0.27	0.25	---
10	0.28	0.17	---	0.27	0.25	---
11	0.25	---	---	---	---	---
12	0.24	---	---	---	---	---

2.4- Repair and Maintenance costs

An accurate record of repair and maintenance costs should be kept for each machine in the farm. As a guide, however, average repair costs are influenced by the size of the machine, as reflected by its price, and the amount of use. For any category of machine, there is an index of accumulated repair and maintenance costs to the initial purchase price (Eqn 2.4). The coefficients A_r and B_r in Table 2.3 (Elbanna, 1988) for Eqn 2.4 were used in times of little but some inflation by multiplying this equation by the inflation/discounted ratio, FL, such as:

$$(R_c)_N = A_r(X_n)^{Br}.FL^n.(PP/100)..... 2.4$$

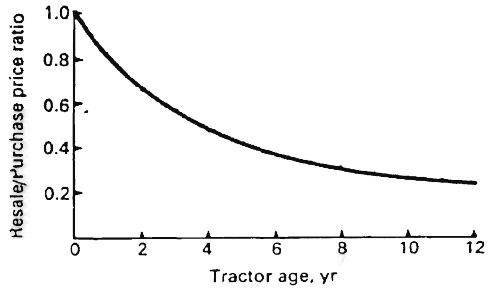

Fig. 2.1 The effect of tractor age on the ratio of the resale value to the initial purchase price in equivalent monetary terms.

Table (2.3): Repair and resale coefficients for various farm machines.

Machine type	Repair coefficients *		Resale coefficients,	
	constant, A_r	exponent, B_r	first yr correction factor, A_s	annual depreciation factor, B_s
2-WD wheels tractors	0.015 [0.012]	1.82[2.0]	[68.0]	[0.920]
4-WD wheels tractor	------ [0.010]	---- [2.0]		
Combine (self propelled)	0.046 [0.12]	2.01 [2.1]	[64.0]	[0.885]
Tillage tools:			[60.0]	[0.885]
Chisel plough	0.152 [0.38]	1.82 [1.4]		
Mouldboard plough	0.296 [0.43]	1.98 [1.8]		
Disk plough	0.124 [0.18]	2.12 [1.7]		
Rotary-L-shape cultivator	0.111 [0.36]	2.08 [2.0]		
Disk harrows	0.178 [0.18]	1.97 [1.7]		
Seeding equipments			[60.0]	[0.855]
Grain drill	0.093 [0.41]	1.87 [1.3]		
Row crop planter	0.082 [-----]	2.30 [----]		
Transplanter	0.093 [-----]	2.01 [----]		
Irrigation pump	0.131 [-----]	1.91 [----]	[60.0]	[0.885]
Reciprocating mower	0.033 [0.46]	1.75 [1.7]	[60.0]	[0.885]

* Elbanna (1988); [ ] = ASAE (1996)

The ASAE (1996) model used accumulated hours X. However, Elbanna (1988) stated that the accumulated use, X, for a tractor is given as engine hours divided by 1000, whilst that for machinery is given as area covered in hectares divided by 1000. As the engine hours are recorded on a tractor hourmeter, which is only correct at a particular engine speed for that tractor model, an under-utilized tractor operating at low engine speeds will record a lower hourmeter reading than a tractor operating at maximum power for the same period. Thus, the accumulated use based on the hourmeter reading partly accommodates for different levels of power utilization in the calculation of tractor repair costs. For machines, however, hours of use can be misleading because high-speed operation would result in lower repair costs than low speed work on the same area. Area of use for field equipment provides a more realistic estimate for machinery repair costs. When the present annual repair cost is required on a yearly basis, it can be calculated by subtracting the accumulated repair costs for the previous accumulated years, $(R_c)_{N-1}$, from those for the current year, $(R_c)_N$, as in the form:

$$(R_c)_n = (R_c)_N - (R_c)_{N-1} \quad \text{.....2.5}$$

2.5-Road Tax and Insurance Costs

The accumulated use, X, for tractors and self-propelled machinery for use on the public highway involves an annual payment of vehicles excise at a nominal current values, CV of 15, provided that the governed engine speed as vehicle does not permit a road speed in excess of 32km/h. Otherwise, the tractor must be licensed as haulage vehicle, which attracts vehicle excise duty of CV 400/year and must use ordinary non-rebated diesel fuel. Insurance for tractors and self-propelled machines covers third party liability, fire and theft. In many cases, the insurance also covers attached trailers and accidental damage to trailed machinery when attached to the tractor, including internal damage to the machine caused by the ingress of foreign objects. Current premiums are based on a minimum charge of 2.5% up to a CV of 1000. Therefore, on a sliding resale rate of 1.20% on the next 4000 CV; 0.95% on the next 5000 CV and 0.85% on the next 15000 CV. The current market value of the machine is considered to be the resale value, $S_{(N-1)}$, of the machine at the end of the previous (N-1) th year:

$$S_{(N-1)} = A_s(B_s)^{(N-1)}.(PP/100) \quad \text{.....2.6}$$

After the insurance charge is identified from the sliding resale for a specific value ($S_{(N-1)}$) the inflation-discounted of the insurance charge over (N-1) years may be given in the form:

$$I_{Ns} = \sum_{n=1}^{N-1} (I_{NS})_n.FL^n \quad \text{.....2.7}$$

where: $(I_{NS})_n$ = insurance charge at the nth year, CV.;
For an individual year, the insurance charge may be given by:

$$(I_{Ns})_n = \sum_{n=1}^{N-1} (I_{NS})_n.FL^n - \sum_{n=1}^{N-2} (I_{NS})_n.FL^n \quad \text{.....2.8}$$

2.6 Annual Interest Charge

When repaying the purchase price of a machine by means of a mortgage in equal installments, the initial installments largely comprise interest, whilst later installments are mainly repayment of the principle. The annual interest charge is given by the interest on the outstanding balance of the loan after repayment of mortgage installments in the preceding period of the loan as in the form:

$$I_A = PP\ \frac{(1+i_\ell)^N - (1+i_\ell)^{n-1}}{(1+i_\ell)^N - 1} i_\ell \quad \text{.....2.9}$$

where: I_A = annual interest charge at nth year, CV ;
$(i_A)_N$ = total discounted of annual interest charge over N years loan payment, CV. ;
i_i = investment interest rate; i_ℓ = loan interest rate.
and the total discounted sum of the annual interest charge is given by:

$$(I_A)_N = \sum_{n=1}^{N} PP \frac{(1+i_\ell)^N-(1+i_\ell)^{n-1}}{[(1+i_\ell)^N-1](1+i_i)^n} i_\ell \quad \text{.....2.10}$$

2.7 Annual Repayment of Loan Capital:

The capital cost of the machine may occur as a payment, on outward cash flow, at the beginning of machine ownership at time zero, or else borrowing the money and paying a series of equal annual mortgage payments as may buy the machine:

$$M_V = PP \frac{(1+i_\ell)^N}{(1+i_\ell)^N-1} \quad \text{.....2.11}$$

M_V = mortgage value, CV.; i_ℓ = investment interest rate, CV.

If it is assumed that the period of the loan is the same as the period of ownership (N), payment of one's own capital may be viewed as borrowing from oneself at a lower interest rate. Thus, the concept of opportunity cost of capital may be also included. The discounted cash flow or present cost of cash flow (C_n) is the net present annual value, which must be invested to pay the cash flow in the n^{th} year as in the form:

$$NP_V = \frac{C_n}{(1+i_i)^n} \quad \text{.....2.12}$$

where: C_n=annual cash flow for nth year, CV. ; M_V=annual mortgage value, CV. ;

For a series of equal annual cash flows, the form gives M_V, over the life of the machine; the total net discounted present mortgage value over the machine life can be represented such as:

$$NPM_V = M_V \sum_{n=1}^{N} \frac{1}{[(1+i_i)^n} \quad \text{.....2.13}$$

Rearranging terms and combining equations 2.9 and 2.12 give the total sum of mortgage cost as:

$$NPM_V = PP_P \frac{(1+i_\ell)^N-[(1+i_i)^N-1]}{[(1+i_\ell)^N.[(1+i_\ell)^N-1]} (i_\ell/i_i) \quad \text{.....2.14}$$

where: NPM_V = net present cash flow, CV. ; NPM_V = total present mortgage value.

If the interest rate on the investment is the same as the loan interest rate, the total present mortgage cost is the same as the purchase price. The present annual ownership cost excluding tax allowances (An) is the present value in today money of N equal value annual payments made during the ownership of the machine. These annual payments are again influenced by inflation and discounting, so that combining the three cash flows (Table 2.4) eqns 2.14, 2.5 and 2.8, subtracting eqn 2.6 yield the following:

$$A_n = NPM_V + R_C + I_{NS} - S_N \quad \text{.....2.15}$$

2.8 Investment Grants and Net-Taxation

Investment incentive and tax considerations affect farmers' decisions regarding the total investment in equipment and the timing of individual machinery purchase. Investment grants are made available to farmers as incentive for further mechanization. The grants are a straightforward payments which reduce the net cost of a machine making them a Government discount to the buyer. This form of Government incentive benefits all farmers equally, irrespective of the level of business profitability or taxable income. These grants are being decreased or discounted with the shift in emphasis from increasingly efficient production techniques to conservation of the rural environment.

In order to make a true comparison, any investment that must be paid back over a period of time in the future must have the income discounted at the percent it could have earned in its alternative use. Taxation for machinery ownership is a complex matter in valuing most of the farm businesses and the personal circumstances of the farmer. It is sometimes stated that machinery is purchased in order to reduce tax liability (Witney, 1988).

2.8.1 Annual capital allowance value:

Capital allowance in buildings and machinery is also eligible for tax relief by means of annual capital allowance. In contrast with the investment grants, capital allowances only benefit farmers who make sufficient profit to pay tax. The more profitable the business the higher the marginal tax rate and the greater the benefit from the capital allowance (Figs 2.2 and 2.3). In discounted cash flow terms, the tax relief on annual capital allowance is worth progressively less relative to an investment grant of the same total amount received soon after the time of purchase. The effect of various tax allowances can be more readily understood by using the discounted cash flows to calculate the present annual ownership costs for a machine, taking into account tax relief at the standard rate.

For taxation purposes, the annual rate of capital allowance for a building is 4% to the purchase price using straight-line depreciation over 25 years. For machinery, the annual rate of capital allowance is 25% on diminishing balance basis that is on the written–down value of the machine. Thus, the annual capital allowance for an (n) year old machine is:

$$(C_A)_n = 0.25(0.75)^{n-1} PP \quad \text{.....2.16}$$

where: $(C_A)_n$ = annual capital allowance for an n^{th} year old machine, CV.

The form gives $(CA)_N$, over N years of machine ownership, the discounted annual capital allowance may be given as:

$$(C_A)_N = \sum_{n=1}^{N} (C_A)_n / (1+i_i)^n \quad \text{.....2.17}$$

Table 2.4 Proforma to calculate the annual cost of machine ownership, excluding tax relief.

Col 1	Col .2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8
Yr	Inflat-ion factor	Inter-est factor	Current repair cost, CV	Current insurance cost, CV	Current repair & Insurance, CV	Current resale value, CV	Annual mortgage repayment, CV
1	1.050	1.080	161	91	252	----	3626
2	1.103	1.166	496	84	580	----	3626
3	1.158	1.260	839	77	916	----	3626
4	1.216	1.360	1186	71	1257	----	3626
5	1.276	1.469	1537	65	1602	6006	3626

Table 2.4 Continued

Col . 9 (Col 2x Col 6)	Col .10 (Col 2 x x Col 7)	Col .11 (Col 8+Col 9 - - Col 10)	Col 18 (Col 11+ Col 3)	Col 19 (Col 2/ Col 3)
Actual repair & insurance, CV	Actual Resale value, CV	Gross cost outgoings, CV	Discounted cash outgoings, CV	Inflation - discount factor
265	----	3891	3603	0.972
640	----	4266	3659	0.946
1061	----	4687	3720	0.919
1529	----	5155	3790	0.894
2044	7664	-1944	-1357	0.860
			Box 18=	Box 19=
			13514	4.600
			Box 20=Box 18/Box 19 = 2916	

Table 2.5 Proforma to calculate the annual cost of machine ownership, including tax relief, (for use inconjection with Table 2.4).

Col. 1	Col .2	Col. 3	Col. 4	Col. 5	Col. 7	Col. 6	Col. 8	Col . 9 (Col 2 xCol 6)	Col .10 (Col 7 xCol 7)
Year	Inflation factor	Interest factor	Curr. repair cost, CV	Curr. insurance , CV	Curr. resale value, CV	Current repair & Insurance, CV	Annual mortgage, CV	Actual repair & ins., CV	Actual resale value, CV
1	1.050	1.080	161	91		252	3626	265	
2	1.103	1.166	496	84		580	3626	640	
3	1.158	1.260	839	77		916	3626	1061	
4	1.216	1.360	1186	71		1257	3626	1529	
5	1.276	1.469	1537	65	6006	1602	3626	2044	7664

Table 2.5 Continued

Col . 11	Col. 12	Col. 13 (Box 12+ +Col. 10-PP)	Col. 14	Col. 15 (Col 9+Col 12+ +Col 14-Col 13)	Col. 16 (Col 14 xTr)	Col. 17 (Col 11- -Col 16)	Col. 18 (col 17/ Col 3)	Col . 19 (col 2/ Co l 3)
Gross cash out -going CV	Actual Capital allow., CV	Actual balancing charge, CV	Actual interest charge, CV	Total tax allwance, CV	Total tax relief, CV	Net Cash outgoing, CV	Discounted cash flow, CV	Inflated discounted factor
3891	3350		1474	5089	1527	2364	2189	0.972
4266	2513		1237	4390	1317	2949	2529	0.946
4687	1884		975	3920	1176	3511	2787	0.919
5155	1413		683	3625	1088	4067	2990	0.894
-1994	1060	4484	359	-1021	-308	-1688	-1149	0.860
	Box 12						Box 18	Box 19
	10220						9346	4.600
							Box 20= Box 18/box 19 = 2032	

2.8.2 Balancing Adjustment:

When the machine is sold or ceased, a balancing adjustment is made to bring the total capital allowance, excluding any investment allowance, equal to the net cost. The net cost is the acquisition cost paid for the old machine less resale value. If the resale value exceeds the written-down value, then it is necessary to have a balancing charge on which tax must be paid. Alternatively, if the resale value is less than the written-down value, then there is a balancing allowance (i.e. a negative balancing charge) and additional tax relief is available (Tables 2.4 and 2.5). This balancing charge, which is balancing the initial cost of the machine, the summation of the capital allowance values and the inflated-discounted salvage value, in the last year of ownership of a machine ownership may be given by the form:

$$(B_c)_N = \left\{ S_N + \left[\sum_{n=1}^{N} (C_A)_n - PP \right] \right\} / (1+i_j)^N \quad \text{.....2.18}$$

where: $(B_c)_N$ =balancing charge over N years, the machine is owned, CV.;
S_N = resale value of the machine, CV.

2.8.3 Present annual cost with tax relief:

The above procedure has described how to calculate the separate cost elements of operating machinery. These costs were determined with discounted cash flows, which in many cases may be an over complication. Discounted cash flows are necessary when looking at problems of machinery ownership, such as replacement and taxation when the calendar time at which cash flow occurs is important.

The currently accepted method for agricultural costing, used most frequently for comparing alternative machine, is based on straight line depreciation with repairs and maintenance charged at a constant annual rate as a percentage of initial capital cost of the machine This approach is deficient for a number of reasons. It does not take into account the variation in machinery costs (i.e. repair and maintenance as the machine becomes older). Partly for this reason, it does not provide an annual cost for a machine, which is comparable to other farm costs and returns such as contractor hire charge or crop gross margin. The inability to take into account charges in the costs form year to year does not allow the effects of inflation on machinery costs to be determined.

Various aspects relevant to agricultural machinery costing were discounted in Kolarik *et al.* (1979) but they did not give a general description of a comprehensive method of including tax relief in machinery costing. Thus, the present procedure of machinery costing is based on the determination of an annual cost with tax allowance for owning and using a machine which is comparable to other annual returns and costs, and gives an accurate estimated cost (Tables 2.4 and 2.5). The annual cost of a machine is defined as the annual income, which exactly balances the machine costs over its life, taking into account the effect of inflation and taxation (Table 2.5), where the depreciation term is avoided. This makes the change in farm bank balance the same with \nd without the machine.

The various tax allowances are multiplied by the marginal tax rate to give the tax relief. There is a series of taxable income bands, each with its own tax rate, ranging from standard tax rate of 25% up to 60% at higher levels of taxable income. The annual tax relief is deducted from the outgoing gross cash to give the net amount for discounting. The cost elements influencing the tax liability are the total sum of annual repair and maintenance costs (eqn 2.5) and insurance costs (eqn 2.8), annual interest charges (eqn 2.9), annual capital allowances (eqn 2.17) and balancing charge (eqn 2.18). Joining the net present mortgage value (eqn 2.14) and the inflated-discounted salvage value (eqn 2.3) with the allowance elements above with eqn 2.19, the present annual ownership machine cost including tax relief is given by an algebraic expression as in the form:

$$A_N = \{NPMV - [(B_c)_N + (C_A)_N + (I_A)_N]Tr + + (1-Tr)[(R_c)_N + (I_{NS})_N] - S_N\}(FL-1)/\left(FL(FL^N-1)\right) \quad \ldots\ldots 2.19$$

where: A_N = present annual cost of a machine ownership, CV.;
$(B_c)_N$ = balancing charge over N years, the machine is owned, CV.;
$(C_A)_N$ = summation of annual capital allowance over N years, machine is owned, CV.;
$(I_A)_N$ = summation of annual interest charge over N years, CV.;
FL = $(1+j_f)/(1+i_i)$, inflated/ discounted ratio;
NPM_V= net present mortgage value, CV.; Tr = tax rate;
S_N = salvage after N years, the machine is owned, CV.

Fig. 2.2 shows the effect of optimum period of machine ownership using Table 2.2 data when the marginal holding cost is equal to the marginal ownership. Fig. 2.3 shows the effect of three-tax rates of 0, 30 and 60% on the present annual cost of the 2-wheel drive tractor purchase at 16000 CV and the optimum period of machine ownership replacement using tax allowance method

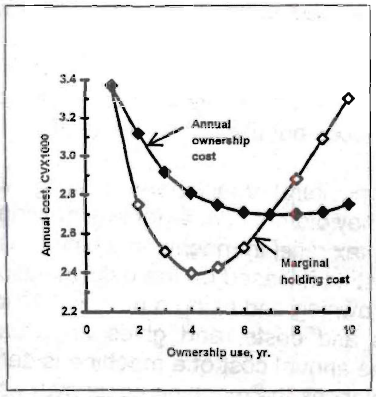

Fig 2.2:Present annual and margin ownership costs plotted again machine period ownership use

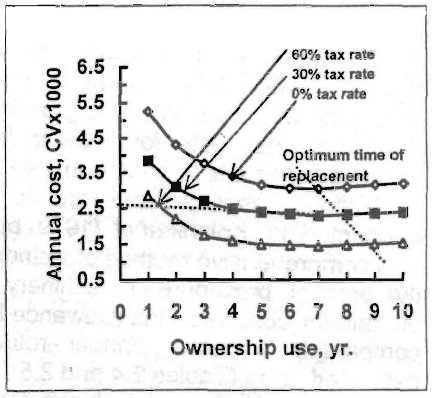

Fig. 2.3: The effect of tax rate on 62 kW -2-WD tractor annual cost at three tax rates of 0, 30 & 60% and optimum time of replacement plotted against accumulated use hours.

9.1 Tabular method to calculate the annual cost of a machine (excluding tax relief)

The tabular methods are designed to calculate the annual ownership cost of a machine by completing a pro forma (Table 2.4). The following example illustrates the procedure.

Machine: 60 kW (2-WD); Purchase price: CV: 13400; Annual use : 1000 h ;Period of ownership (5 years); Loan interest rate (11%); Inflation rate (5%); Investment interest rate (8%).

The inflated cost of purchasing one of today's CV worth of goods is entered in column 2 of Table 2.4. The amount to which CV invested now will grow due to an appropriate interest rate is centered in column 3. The annual repair costs are calculated from eqns 2.4 and 2.5 using data listed in Table 2.3. The annual insurance costs are calculated by means of resale values at the end of each previous year from eqn 2.5 using the procedure in section 2.5. These current annual costs for repairs and insurance are listed in columns 4 and 5, respectively, and added together in column 6.

The current resale value at the end of the period of ownership is also obtained from eqn 2.3 using the factors listed in Table 2.3. The resale value is inserted in column 7 against the final year of use. Eqn 2.11 is used to calculate the annual mortgage repayment for each year as it entered in column 8. The actual repair and insurance costs in column 9 are obtained by multiplying the current repair and insurance costs in column 6 by the inflation factor in column 2. Similarly, the actual resale value in column 10 is obtained by multiplying the current resale value in column 7 by the inflation factor in column 2.

The actual outgoing on an annual basis is found from the sum of the annual mortgage payment and the actual repair and insurance costs less the actual resale value (column 8 + column 9 – column 10). These gross cash outgoings (excluding tax relief) are entered in column 11 and divided by the interest factor in column 3 to give the discounted cash outgoing in column 18. Columns 12 to 17 (Table 2.4) are discarded because they account for tax allowance as in Table 2.5. The sum of the discounted cash outgoings in column 18, for every year of ownership, is listed in box 18. This calculates the right hand side of equation 2.15. The inflated discount factors for each year are entered in column 19 by dividing the inflation factor by the discount factor (column 2/ column 3). The sum of the inflated discount factors in column 19, for every year of ownership, is entered in box 19. Dividing the sum of the discounted cash outgoing by the sum of the inflated discount factors (box 19/ box 19) gives the annual cost of machinery ownership as shown in box 20.

9.2 Tabular method to calculate the annual cost of machine ownership including investment grants and taxation

Repair and insurance costs have already been determined previously (eqns 2.5 and 2.8) and fuel costs can be considered separately as they are already in percent value terms. The various tax allowances are multiplied by the marginal tax rate (Tr) to give the tax relief. There is a series of taxable income bands, each with its own tax rate, ranging from standard tax rate of 30% up to 60% at higher levels of taxable income (Fig. 2.3). The annual tax

relief is deduced from the gross cash outgoings to give the net amounts for discounting. Joining equations 2.10 and 2.18 with the inclusion of tax relief, the present annual ownership cost is given by eqn 2.19. The pro forma in Table 2.5 is extended in Table 2.4 to include tax allowances. The gross cash outgoings from Table 2.4 are represented in Table 2.5. The capital allowances for each year of ownership are calculated from eqn 2.16 and entered in column 12. The sum of these capital allowances in column 12 for the whole period of ownership is entered in box 12 and used in eqn 2.18 to calculate the balancing charge for final year of ownership which is entered in the last line of column 13. Annual interest charges from eqn 2.9 are inserted in column 14. The tax allowances for repair and insurance, for capital investment and for interest less the balancing charge (column 9+column 12-column 14–column 13) are entered in column 15. These values when multiplied by the marginal tax rate give the total tax relief in column 16. In this example, the standard tax rate of 30% is used. The actual cash outgoings in column 17 are the gross cash outgoings less the tax relief for each year (column 11-column 16).

As in all previous examples, the actual cash outgoings are individually discounted in column 18. The sum of the discounted cash flows in box 19 is divided by the sum of the inflated discount factors in box 20 to give the present annual ownership costs for the machine after tax.

The present annual cost of machine ownership is substantially altered by tax considerations. In the example, the effect of allowing for tax reduces the present annual cost of tractor ownership from 2916 to 2032 CV (a reduction of 30%), which is, by coincidence, the same tax rate used. For the same tractor and considering the same fixed and running costs, the average annual ownership cost is 2440 CV using the simple procedure outlined in depreciation method. The present approach yields an intermediate cost figure within the range spanned by the present annual ownership costs with and without tax. There are, however, substantial rooms for error and absence of information on cash flows compared with the discounted cash flow approach which has further flexibility of incorporating tax allowances.

CONCLUSION

The resale value of a machine is determined by the effect of age and level of use on the rate of discounted depreciation. Net interest is a simple concept which minimizes the effect of inflation when calculating average operating costs for machinery. Insurance charge is calculated based on the current premiums value of minimum charge of 2.5% up to 1000 CV, then on a sliding resale rate of 1.20% on the next 4000 CV, 0.95% on the next 5000 CVand 0.85% on the next 15000 CV. The current market value of the machine is considered to be the resale value at the end of the machine previous year. Repair and maintenance charges, as a proportion of the purchase price of a machine, increase logarithmically with the accumulated use of the equipment during the period of ownership

Average operating costs for machines are readily calculated but tend to underestimate the high level of ownership costs during early years. Calculation procedures for the present annual cost of machine ownership from actual cash flows provide a detail appraisal of both the annual cash flow throughout the period of ownership and the opportunity to include tax allowance. It can be concluded that the present annual cost of machine ownership is substantially altered by tax relief and allowances. By applying a 30% tax on calculation of tractor annual cost, the present annual cost was reduced from 2916 CV to 2032 CV (30% reduction). However, the present annual cost was calculated to be 2440 CV using the conventional.

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نظام جديد لتقدير تكاليف ملكية الآلة

الشحات بركات البنا ، خالد علي القعدي
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هناك طريقة سهلة وسريعة لتقدير تكاليف تشغيل الآلة وتتم عن طريق أخذ متوسط التكاليف السنوية على مدى سنوات اقتناء الآلة، ولكن هذه الطريقة تهمل حقيقة أن استهلاك الآلة يكون عاليا في السنوات الأولى من ملكيتها مقارنة بالسنوات التالية بينما تكاليف الصيانة والإصلاح تزداد بزيادة عمر الآلة. هذه الدراسة تقدم أسلوبا جديدا ودقيقا لتقدير تكاليف ملكية الآلة وذلك بالأخذ في الاعتبار العمر الاقتصادي للآلة، والأسلوب الجديد يستخدم التدفقات النقدية الحقيقية في حساب التكاليف السنوية لاقتناء الآلة وهذه التدفقات النقدية تنقسم إلى ثلاثة أنواع هي: (١) الفوائد التي تحسب على رأس المال المستثمر في شراء الآلة بأقساط متساوية تدفع سنويا، (٢) تكاليف الصيانة والإصلاح والتأمين السنوية، (٣) القيمة النقدية العائدة من بيع الآلة.

إن القيمة النقدية الحالية لأي استثمار في آلة زراعية يمكن حسابه عن طريق ثلاث خطوات، الخطوة الأولى والأكثر أهمية تتمثل في حساب التدفق النقدي السنوي الناتج عن الاستثمار، وفي الخطوة الثانية يتم تخفيض هذا التدفق بمعامل القيمة الحالية، أما في الخطوة الثالثة فيتم إفتراض هذا التدفق النقدي على عدد من السنوات المأخوذة في التحليل. إن الفوائد السنوية المخفضة والمدفوعة على رأس المال المقترض تتأثر بقيمة القرض ومدة الاقتراض، ولمعدل ضريبي معين فإن الإعفاء الضريبي يحسب لتكاليف الصيانة والإصلاح والتأمين وقروض رأس المال مطروحا منها الميزان النقدي للآلة.

هذه الدراسة تهدف إلى إيجاد تقدير دقيق للتكاليف السنوية لآلة معينة، ومقارنة هذه التكاليف السنوية الحالية لاقتناء الآلة عند أخذ دفع الضرائب والإعفاء الضريبي في الاعتبار وعند عدم أخذهما، والدراسة بينت أن هناك تغيرا جوهريا في قيمة التكاليف السنوية الحالية لاقتناء الآلة. فعند أخذ الضرائب في الاعتبار وإدخال معدل ضريبي مقداره ٣٠% في حساب تكاليف الآلة قلت التكاليف السنوية الحالية من ٢٩١٦ وحدة جارية إلى ٢٠٣٢ وحدة (بنسبة تخفيض ٣٠%) مقارنة بـ ٢٤٤٠ وحدة جارية محسوبة بالطريقة التقليدية، والنظام المقترح من هذه الدراسة يعطي قيمة متوسطة للتكاليف السنوية الحالية (تطبيق الضرائب) لاقتناء الآلة بين حالتي عدم أخذ الضرائب فيى الاعتبار والطرق التقليدية.