CURRENT COST DEPRECIATION METHODS AND THE VALUATION OF FARM TRACTORS AND HEADERS

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PREFACE

Inflation in farm machinery prices has led to concern that farmers may not be able to maintain production when present machinery needs replacing. At the same time accountants and economists have become increasingly aware that depreciation calculated on an historical cost basis may be underestimating the real cost to the firm of machinery depleted over an accounting period. This leads to overstatement of income and understatement of the value of assets in the Balance Sheet.

In New Zealand recently, the Richardson Report has recommended to government that a form of inflation accounting known as Current Cost Accounting be adopted. Using data on tractors and headers this research report demonstrates which of the traditionally used depreciation methods might best be adapted to determine book values under the guidelines set down in the Richardson Report. Depreciation measured on a current cost basis is then compared to that presently allowed for taxation purposes, and the idea that investment allowances on new machinery offset the inadequacies of historical cost depreciation measures is discussed.

This is the first Research Report published by the A.E.R.U. using data collected in the New Zealand

Wheatgrowers' Survey. It is hoped that it will open up meaningful discussion on the severe problems for cropping farmers of machinery replacement.

Professor J.B. Dent,
Director.

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CHAPTER 1

INTRODUCTION

Depreciation is a measure of the consumption of capital stock. For a number of reasons, including the difficulties involved in valuation of assets, depreciation has traditionally been based on historical costs which are apportioned over time according to one of a number of depreciation methods.

According to these depreciation methods, depreciation is calculated as a portion of the historical cost and the remaining undepreciated amount is the value (book value) assigned to the asset. Economic theory suggests that valuation should be the first step in determining depreciation rather than being defined as the residual after depreciation. Value, according to this approach, should be determined as the aggregate discounted values of future net earnings and thus depreciation is a measure of the reduced ability of an asset to produce future net earnings.

Because of the problems involved in measuring future net earnings there is general adherence to the accounting practice whereby depreciation is based on allocation (of historical cost) rather than on successive asset valuations. Although this approach provides a relatively objective and rapid method of determining depreciation a number of problems have persisted:

(1) The determination of the "life" of the asset.

(2) The estimation of salvage value, and

(3) The way in which the total depreciation should be allocated over the "life".

In addition, the high levels of inflation experienced in many countries in recent years has led to increasing concern that depreciation calculated from historical costs does not properly reflect the current cost to the enterprise of the assets used in the period. This leads to an overstatement of income in the Revenue Statement and an undervaluation of assets in the Balance Sheet.

In response to these and other distortions brought about by traditional accounting procedures, various accounting methods have been proposed which more adequately account for inflation. In general, these inflation accounting methods attempt to express costs and returns in similar units either by restating historical cost accounts in units of general purchasing power or by utilizing current values for income and valuation purposes.

In New Zealand recently, the Committee of Inquiry into Inflation Accounting [Richardson, 1976] has recommended the adoption of a form of inflation accounting known as Current Cost Accounting (CCA). Under the particular guidelines set down in the Richardson Report it is stated that asset valuation should reflect the current value of assets to the enterprise. Assets considered to be essential are to be valued at their current replacement cost whereas those considered non-essential are to be valued at their net realizable value.

The Committee recommends that the revaluation of assets may be carried out by the use of a range of official indices developed for the purpose.

The aim of this Research Report is to demonstrate which of the traditionally used depreciation methods might best be adapted to measurement of value and depreciation based on the principles outlined in the Richardson Report. The comparison of methods and rates is made using a cross-section of tractors and headers for which data on cost, age and value was collected in a recent survey of New Zealand wheat growers [Moffitt and Davey, 1977].

Optimum depreciation methods and rates are defined on the basis of minimum sums of squares of errors (SSE) between actual values (assessed by machinery dealers) and calculated book values. This approach attempts to reconcile accounting practices with economic concepts. The methods and rates of depreciation are chosen such that "book values" match "assessed values" as closely as possible, with depreciation being calculated subsequently. Thus, the approach is essentially economic, although the use of standard depreciation formulae with indexed historical cost values may be of relevance for accounting practice.

A second aim of the report is to compare depreciation calculated by the "optimum" current cost methods with that allowed under current tax legislation so as to gauge the likely effect on taxable income of adoption of the proposed depreciation methods.

4.

The results have implications for a variety of people involved in the interpretation and use of farm accounts.

CHAPTER 2

BACKGROUND

2.1 Concepts of Depreciation

Concepts of depreciation have tended to change over time [Burrowes, 1977].

Some 19th Century accountants felt that depreciation should be viewed as an allocation of profits rather than an expense. According to this proposal depreciation can only occur in years in which a profit is recorded.

In general, however, there have been two basic approaches in the development of the concept of depreciation. These are known as the "accounting" and "economic" approaches respectively. The accounting concept of depreciation has traditionally been one of cost allocation. The cost of an asset less salvage value, if any, is allocated over its life in some systematic and rational manner. On the other hand the economic approach considers cost to be irrelevant. Under this second approach depreciation is the difference in capital value at the beginning and end of the period under consideration. Thus the process is one of valuation rather than allocation. Capital value is defined as the sum of the discounted future net earnings of the asset and assumes a rational competitive market.

2.2 Causes of Depreciation

Depreciation is commonly attributed to physical and/or economic causes. The physical cause of depreciation refers to wear and tear or physical decay which reduces the ability of the asset to produce future net earnings. The "life" of an asset may also be influenced by economic factors. Mathieson [1963] argues that the economic causes of depreciation are more important than the physical causes since, theoretically, an asset might function indefinitely given appropriate repairs and maintenance. The economic causes of depreciation may be either the increasing cost of repairs and maintenance, or obsolescence. With increasing costs for repairs and maintenance over time, at some point it becomes economic to replace the asset with a new item. Repairs and maintenance may also increase relative to new prices where improved processes (e.g. assembly line techniques) may be employed in manufacture but not repair. Obsolescence, on the other hand, is generally attributed to technical advances resulting in improved efficiency in later models of the same machine. Obsolescence may thus be thought of as an opportunity cost of retaining assets for which improved versions exist. As a result of this the market value of the older version generally drops. The market value may also drop because of so called "induced-obsolescence". An example of this is in the automobile industry where model changes without significant technical advance result in a reduction in the market value of the older model.

Another cause of economic depreciation may be the prevailing economic conditions. Although the asset may be perfectly capable of continuing in production the discounted value of future net returns from operation at present may be felt to be significantly less than at the time of purchase, so that the value of the asset is reduced. Also, government policies such as investment allowances can influence depreciation by effectively reducing the cost of new assets relative to older ones.

An alternative classification (to economic and physical depreciation) is that into "use-depreciation" and "time depreciation" [e.g. Baxter, 1971:63-68]. Use-depreciation, refers to the fact that depreciation may be at least partly due to physical wear and tear. In this regard depreciation is an avoidable or variable cost. Time-depreciation emphasises the importance of economic factors in determining "life" and as such is an unavoidable or fixed cost. Time depreciation may also be due to physical deterioration from causes other than use (e.g. rust).

2.3 Depreciation Methods

A number of depreciation methods have been used under historical cost accounting to apportion the cost of an asset over time. Most of these methods are based on elapsed time which is in agreement with the proposal that depreciation is primarily a fixed cost. Some authors [e.g. DeGarmo and Canado, 1973:163], however, have suggested a service output method based on asset usage rather than strictly elapsed time. This approach would appear to favour the view that depreciation is primarily a physical rather than economic phenomenon.

The most commonly used traditional depreciation methods are the following (or variations of these):

(1) Straight Line (SL)

(2) Sum of the Years Digits (SOYD)

(3) Diminishing Value (DV)

Under the SL method depreciation is a constant proportion of the initial cost (minus salvage value) each year.

With SOYD the total depreciable asset value (cost less salvage value) is depreciated over the life of the asset with the depreciation charge decreasing with time according to a specific formula based on the age and "life" of the asset [e.g. Buck and Hill, 1977:80-81].

A number of variations of DV depreciation exist but all determine depreciation as a constant percentage of the depreciated asset value at the beginning of the accounting period. The depreciation rate may be fixed without attempting to estimate the length of working life. However, for several variations of DV depreciation "life" is taken into account.

The Double Declining Balance method (DDB) determines the percentage as ($^2/_N$) where N is the estimated life of the asset. Variations in DDB exist where fractions between one and two are used instead of two (e.g. $^{1.5}/_N$). With DDB the total depreciable value does not reach zero at a certain point in time without a method change over. In the Fixed-Percentage-of-a-Declining Balance (FPDB) method the DV constant percentage is fixed so that a predetermined value is reached at the end of the estimated life (N).

$$\text{FPDB percentage} = \sqrt[N]{S/C}$$

Where S = salvage value ($\neq 0$)

C = initial cost ($\neq 0$)

A problem with FPDB is that the size of the salvage value can greatly affect the depreciation rate.

Buck and Hill [1977] have defined a set of more general depreciation methods which include the classical methods as special cases. These methods are defined in terms of the elementary difference equation:

$$x(k+1) = \alpha\ x(k)+\beta$$

where $x(k)$ = depreciation charge in year k, and

α,β = constant value parameters.

Once $x(1)$, the first year depreciation, and the two parameters α and β have been specified, a unique sequence of depreciation charges result. Buck and Hill use this method in comparison with traditional methods to show which is the "best" in terms of maximizing the net present value of future cash flows where $x(1)$ is limited by taxation laws (as in the U.S.).

Several attempts have been made to determine which is the best depreciation method in terms of accurately calculating values and measuring "true" depreciation. Most of these attempts have involved a study of the decline in second hand values. Boiteux [1956, reported in Mathieson, 1963] studied the second hand prices for one popular model of car over the period 1931-39 and for another model during 1946-52. After examining the effects of possible complicating factors such as changes in money values he decided that annual depreciation was of the form:

$$\frac{C}{A\ k}$$

Where C = initial cost

A = age, and

k = constant.

This method indicates higher depreciation in early years. Cramer [1958] extended this type of calculation for British cars by comparing values for second hand cars with those suggested by a model based on biological population methods. Despite the theoretical weakness of this argument he found quite a close connection for the period under review. The final conclusion reached was that depreciation took an exponential or diminishing balance form. Mathieson [1963] used market guides to buying-in and resale prices of farm machinery to further support the contention that depreciation is best expressed by an exponential form. Mathieson [1963:456] concluded -

> An approach based on standard depreciation curves calculated from second hand values goes a long way towards reconciling the accountant and the economist. Such an approach gives a degree of uniformity and ensures that annual valuation figures bear some relation to reality.

He stressed that the depreciation rate should be carefully watched and revised over time in view of changes in the trend of second hand prices.

Despite the evidence that actual values decline exponentially over time, Penson, Hughes and Nelson [1977] found that the productive capacity of tractors in their study did not show this characteristic. Based on engineering data they found that deterioration was of a concave rather than the convex pattern. That is, "decay" was slower in the early years of the asset's life. If value (productive value) is measured according to discounted future net earnings then the amount required to maintain productive capacity intact should presumably also be of this form. In that economic depreciation does appear to be of a convex (diminishing value) form they suggest that studies should be undertaken to identify those factors that explain why the current market price for used tractors in secondary machinery markets differs from the average productive value of tractors of like vintage retained on farms. This could be due at least partly to obsolescence. As discussed previously, this can reduce the value of the same quantity and quality of service rendered by the property in successive periods. In addition, Penson et al. suggest possible reasons why the current market value of farm tractors might differ from their productive value. For example, a systematic negative bias may be incurred if used tractor prices are employed to value all tractors of identical size, technology and age still on farms due to those being sold having been used more or treated less well than those retained. A second hypothesis is that the risk-averse farm operator assigns a greater weight to the likelihood of acquiring a tractor with less than average remaining productive life. Thus he discounts the price he would have been willing to pay if he had perfect knowledge of the tractor's remaining productive value. Finally, the farm operator may encounter less favourable financing arrangements with respect to the length of loan, the downpayment required and interest rate charged on loans to purchase used machinery compared with those available for loans to finance new machinery purchases.

2.4 Deficiencies of Historical Cost Accounting

The chief criticisms of traditional historical cost accounting are the inaccurate representation of profit in the Revenue Statement and the inaccurate fixed asset and proprietorship values in the Balance Sheet [e.g. Kirkman, 1974:33, Richardson, 1976:58, Mathieson, 1963].

Kirkman [1974:33-39] outlines the problems associated with measuring business profit according to either:

(1) the concept of matching costs (expenses) with revenue, or

(2) the concept of comparing capital figures in opening and closing Balance Sheets.

In matching revenue and expenses it is essential both are stated in equivalent units. When input prices are rising the historical cost method fails to make an adequate charge against revenue for the current cost of assets consumed during the period. All profit is allocated to the period of sale and no separate identification is made of:

(1) operating profit, and

(2) gains made from holding assets in times of rising prices.

Depreciation and the cost of goods sold are two items which are under-estimated in historical cost Revenue Statements in inflationary periods.

There are similar difficulties involved in the measurement of business profit from comparison of capital figures in the opening and closing Balance Sheets. The figures shown for long-term assets and for stocks of goods are in most cases based on historical cost and may be well below current values. In fact, accountants have traditionally avoided this approach for measurement of business profit because of lack of "objectivity" in measuring values. If strict historical cost procedures were followed however, the Balance Sheet approach to income determination would give the same result as the Revenue Statement approach and the same problems would be associated with each. As mentioned above, the understatement of asset values in the balance sheet is, of itself, a problem associated with historical cost accounting during periods of inflation.

The problems associated with historical cost accounting and the proposed solutions (inflation accounting methods) have been the subject of numerous reports and publications [e.g. the Sandilands Report in the U.K., the Australian Exposure Draft and the Matthews Report in Australia, the New Zealand Exposure Draft and the Richardson Report in New Zealand].

Here the concern is with the measurement of asset values and depreciation of these assets under inflationary conditions. The discussion above indicates that both of these are considered to be underestimated by traditional historical cost accounting methods. In this regard the proposed inflation accounting methods attempt to focus greater attention on maintenance of capital prior to recognition of profit or income. This point is further developed in the following section.

2.5 Inflation Accounting Methods

Although the deficiencies of historical cost accounting are obvious there is no universally accepted inflation accounting method as an alternative. In calculating depreciation, for example, although it is widely accepted that capital should be maintained before a profit can be declared, difficulties arise in the definition and calculation of exactly what "capital" should be maintained.

The approaches of three of the more generally approved methods of inflation accounting are outlined in the Inflation Accounting Research Project No. 2 [Warrell, 1977:1-4]. A general price change approach such as the Current Purchasing Power (CPP) method provides for adjustment of existing records for changes in the general level of prices. With this method capital is maintained in terms of some index of general purchasing power. A specific price change approach such as Current Cost Accounting (CCA) recognizes the price changes of individual assets held by the firm. An example of this method is the approach described in the Richardson Report [Richardson, 1976] whereby assets essential to the continuation of the enterprise are to be valued on the basis of their current replacement costs. This method is based on the premise that the operating capacity of the enterprise, in terms of being able to continue in operation, must be maintained rather than maintenance of the purchasing power of the initial investment.

A third approach is one which recognizes both specific and general price increases so that the difference (which is referred to as the "real" increase or decrease) may be incorporated in the accounts. An example of this method is Continuously Contemporary Accounting (CoCoA) which reports asset values in terms of current money equivalents (net market selling prices). The concept of capital to be maintained "is the current money equivalent of net assets and profit is viewed as the increase in the money equivalent of net assets after allowing for the maintenance of the purchasing power of the opening balance" [Warrell, 1977:3].

The basic difference between calculation of depreciation under CCA and CoCoA would appear to be the valuation of assets in relation to entry values (replacement cost) under CCA and in relation to exit prices (net realizable value) under CoCoA. In many cases, particularly where there is a strongly developed second hand market, there may be little difference between the two. Certain enterprises, however, may require investment in assets with low resale values (for example, equipment or plant which requires high cost or specific installation and is not easily removed).

The most appropriate method of valuation in fact depends on the needs of the user. If a firm is intending to remain in business (or expand) the relevant values to consider in decision making are replacement values. If, on the other hand, a change of enterprise is being contemplated disposal prices may be more relevant.

2.6 Depreciation and Replacement

The idea that depreciation should provide funds for replacement is discussed by Graham [1969], Kirkman [1974:66] and Richardson [1976:116]. These authors agree that although depreciation may assist in the provision of funds for replacement this is not a primary function. They argue that availability of sufficient funds for replacement is a question of funds management rather than accounting for depreciation. Depreciation should be an amount which is set aside at the end of the period (year) equal to the amount of capital assets consumed during that period (year). In that further inflation may occur in later years the total of amounts set aside each year may not equal the amount required for replacement at the end of its "life". If the annual depreciation is based on current replacement costs, however, and the amount retained each year reinvested at a rate equal to the rate of inflation the total amount at the end of the life will be sufficient for replacement.[1]

[1]The difference between cumulative depreciation plus end of year book value, and the end of year replacement cost of the asset (new) is referred to as a "backlog" adjustment [e.g. Richardson, 1976:113-114]. This "backlog" adjustment may be positive or negative depending upon whether the asset's current cost has increased or decreased.

CHAPTER 3

DATA AND METHODOLOGY

The approach followed in this study is to compare the values derived from different depreciation methods with the assessed market values of the same machinery items.

The depreciation methods used are adaptions of traditional historical cost methods which might be considered under the Current Cost Accounting proposals of the Richardson Report. According to the Richardson Report depreciation should be based (in general) on the replacement cost of the asset and that this may be determined from historical cost by the use of an appropriate index.

3.1 Data

Information on a sample of 230 tractors and 99 headers was collected in a survey of 180 New Zealand wheat-growing farms over the 1976/77 year [Moffitt and Davey, 1977]. This information included details on make, age, years owned, cost, size and, where possible, hours run. In order to determine an approximate value for each item, the details were presented to a farm machinery firm in Christchurch which dealt with the appropriate type and make of machine. These assessments are estimates of the price a farmer would have had to pay to buy a machine equivalent to his own at the end of the 1976/77 season.

In that each item was not valued after an individual inspection the variation in values provided by the machinery dealers may be less than those prevailing under actual market conditions.

The population from which the sample of wheatgrowers was taken was based on the records of the New Zealand Wheat Board. Any farm which had delivered wheat to the Wheat Board in the period 1969 to 1975 was eligible for selection. However, machinery details were collected from only those farms which grew wheat in 1976/77. These include a wide range of different farming systems from intensive crop to predominantly livestock farmers.

The distribution of tractor and header ages and lengths of ownership are shown in Figures 1-4.

The average tractor recorded on the survey was 7.0 years old and had been owned for 5.2 years. Seventy percent of tractors were less than 10 years old. The average header was 9.6 years old and had been owned for 6.4 years. Only 53 percent of headers were less than 10 years old.

FIGURE 1

Distribution of Tractors by Age

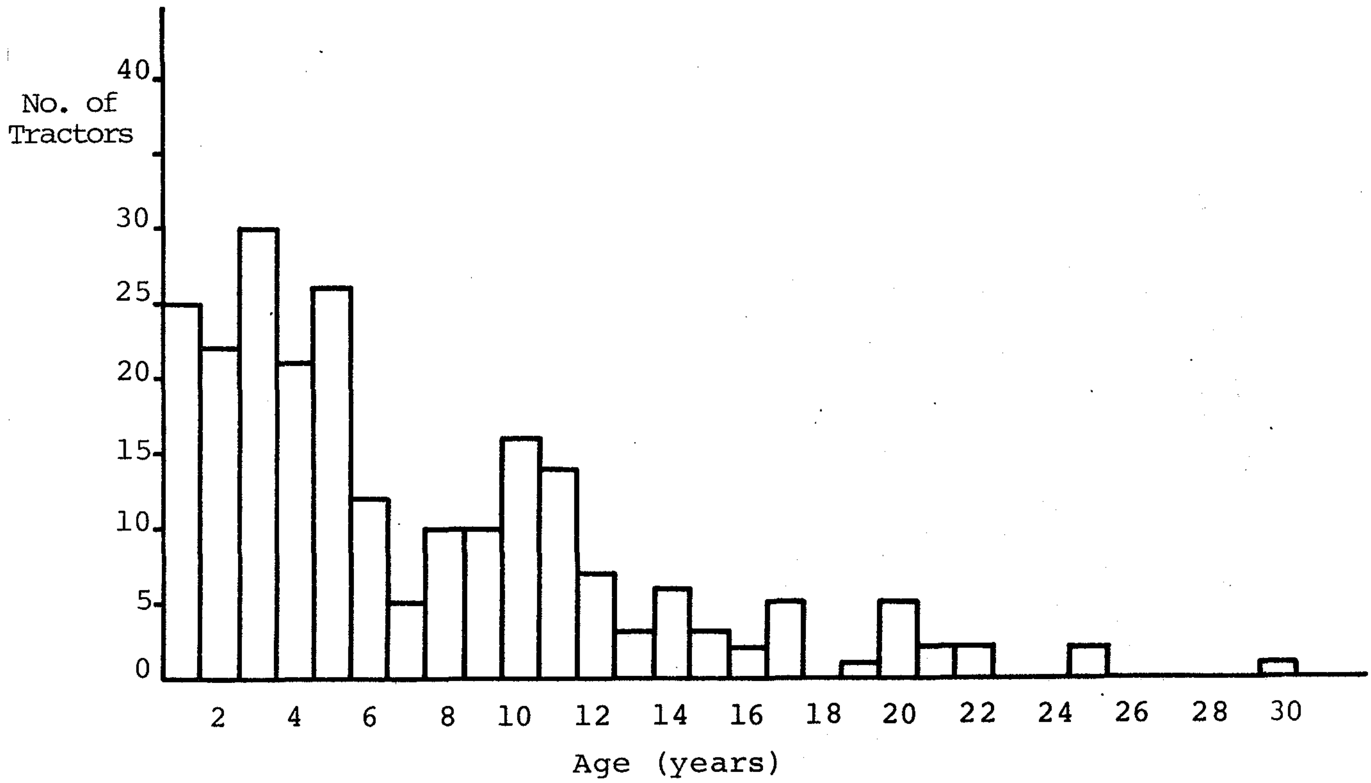


FIGURE 2

Distribution of Tractors by Length of Ownership

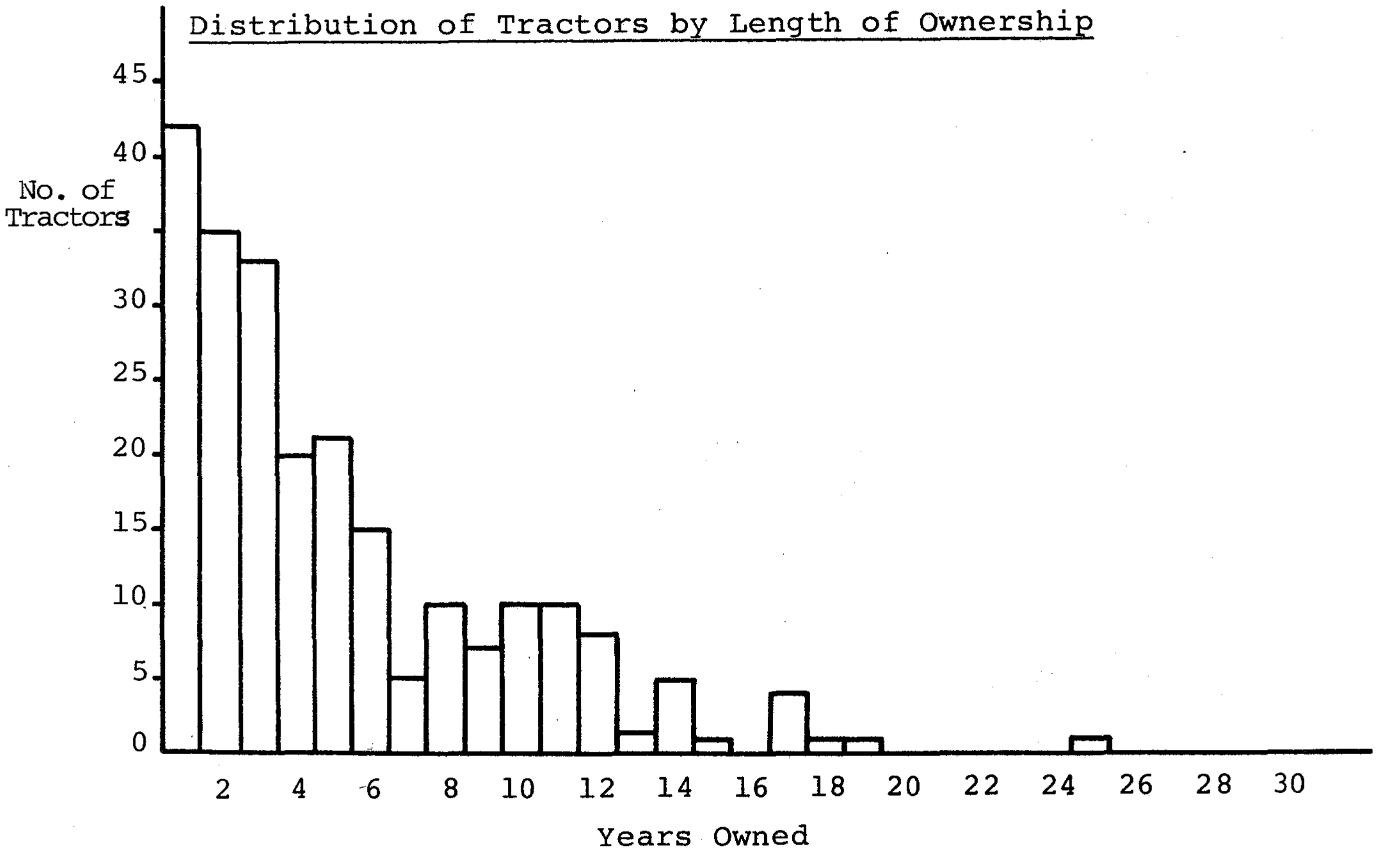


FIGURE 3

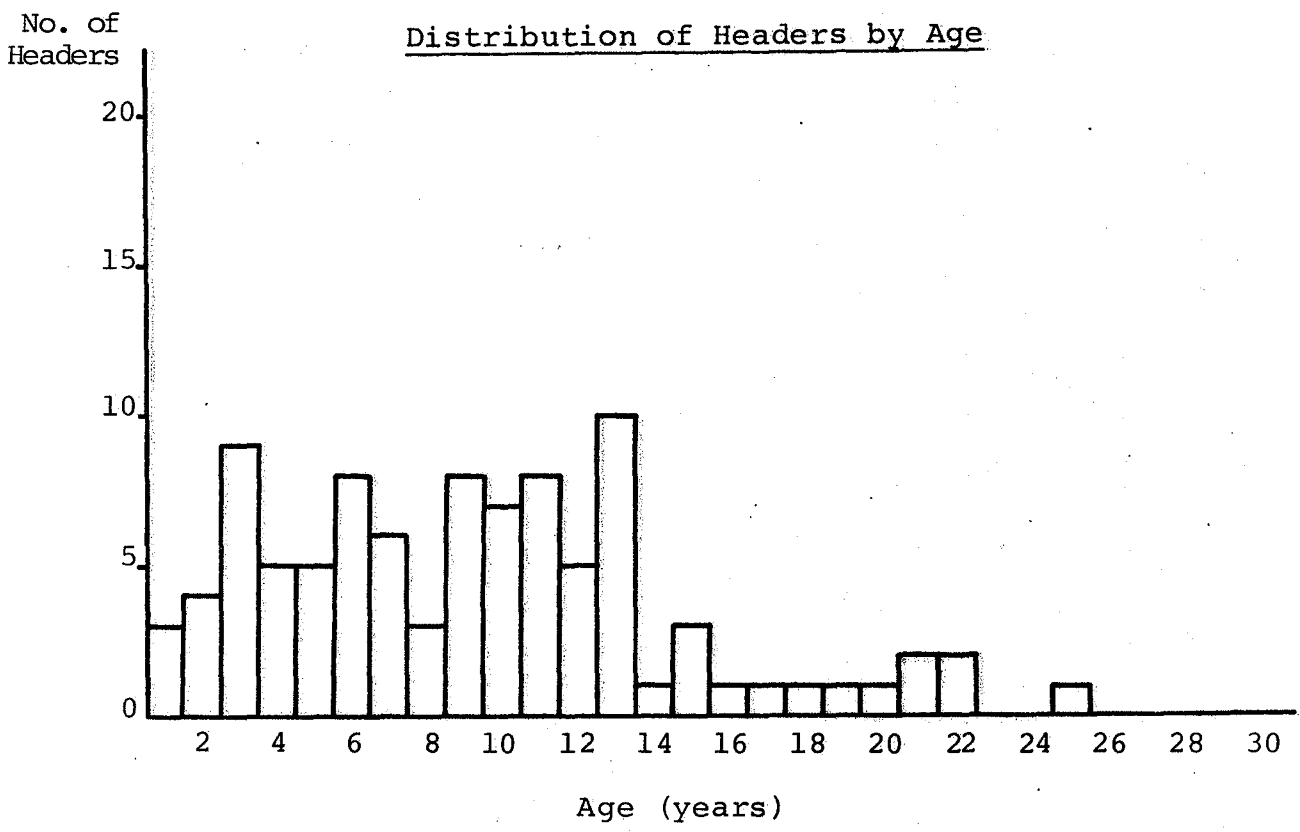
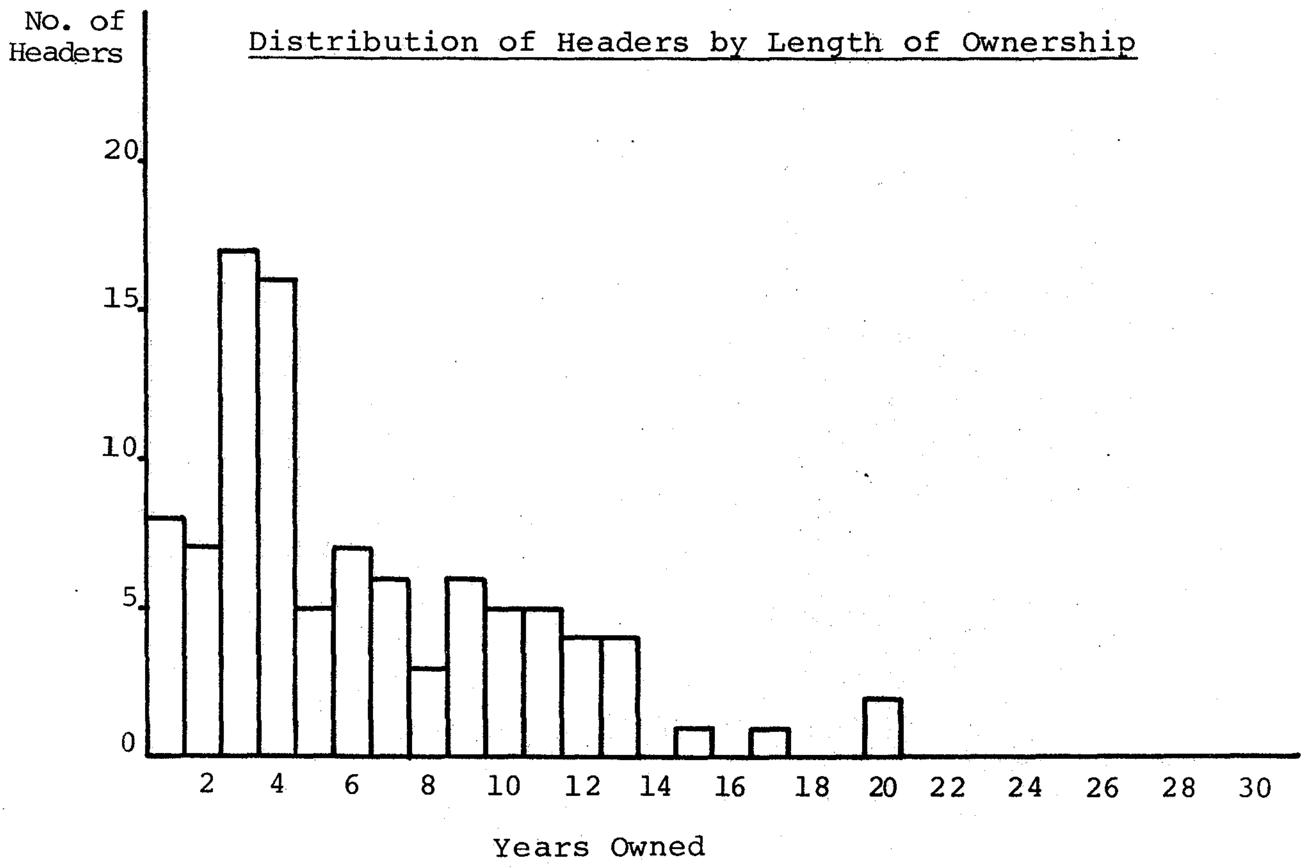


FIGURE 4



The Tractor and Farm Machinery Price Index produced by the New Zealand Statistics Department appears to be the most suitable index available for estimating current replacement costs from historical costs. However, this index only dates from 1971. Hussey and Philpott [1970] in updating previous work on productivity and income of New Zealand Agriculture, present indices of farm inputs for the period 1921/22 to 1968/69. Johnson [1976][2] has extended the plant and machinery portion of this latter series and linked it to the combined Statistics Department Tractor and Farm Machinery Index and Farm Transport Vehicles Index (Figure 5). This extended index was used to estimate replacement costs for this study.

3.2 Methodology

The method used to determine the "best" overall depreciation method and rate was to minimize the sums of squares of errors (SSE) between calculated book values and the assessed values provided by machinery dealers. This method minimizes actual dollar deviations between book values and assessed values rather than percentage deviations. Since the error (difference between calculated value and assessed value) is squared in determining SSE, large deviations contribute relatively more than small deviations and hence, are penalized more heavily in a method where SSE is minimized.

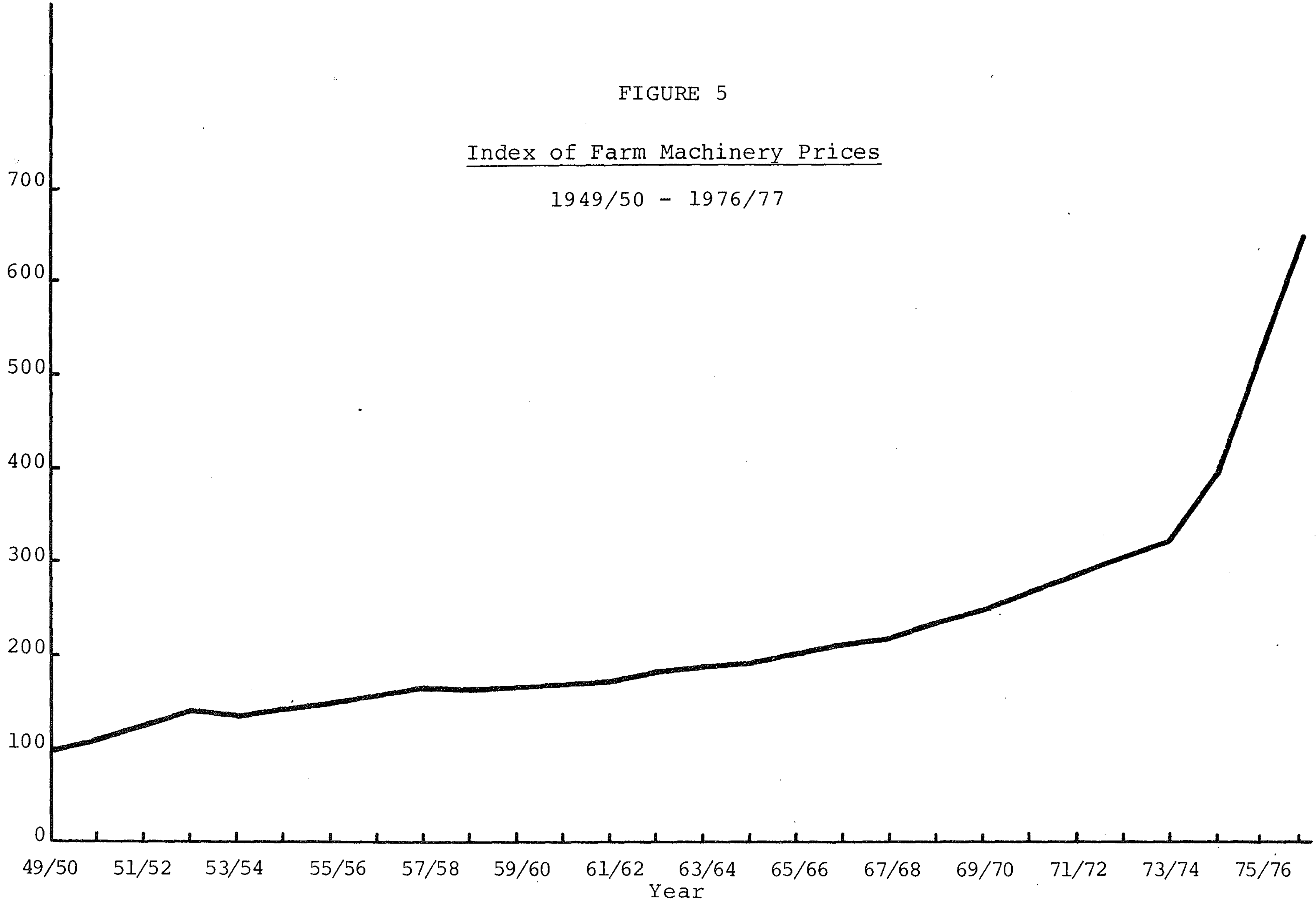
For each depreciation method SSE was calculated

[2] Johnson, R.W.M., 1976, Ministry of Agriculture and Fisheries, pers. comm.

FIGURE 5

Index of Farm Machinery Prices

1949/50 - 1976/77



Source: (1) New Zealand Dept. of Stats., (August 1976), <u>Farming Capital Expenditure Indices</u>, Monthly Abstract of Statistics.

(2) Johnson, R.W.M. 1976. Ministry of Agriculture and Fisheries, pers comm.

for a range of depreciation rates. That rate resulting in the minimum SSE for a given method was defined as the optimum rate and that method with the lowest SSE at its optimum rate was defined as the best method. Optimum rates and best methods were determined for (1) the 230 tractors, and (2) the 97 headers for which survey data was available.

A number of criteria and tests were then used to indicate the goodness-of-fit between assessed and calculated values. The means and variances of book values and assessed values were compared using the t and F tests respectively. The proportion of the total variation in assessed values explained by the book values was calculated as was the average absolute percentage error between pairs of book and assessed values. The χ^2 statistic was used to compare the distribution of book values against the distribution of assessed values. Although the average absolute percentage error is presented it does not, in fact, give a realistic measure of goodness-of-fit because there was a very wide range in the value of machines surveyed. This is illustrated by the following example:

If a $100 tractor has a calculated book value of $200, the absolute percentage error is 100 percent. A $5000 tractor with a calculated book value of $5100 has an absolute percentage error of two percent. Thus the average absolute percentage error for the two tractors is 51 percent although each tractor was valued within $100 of the true value.

3.3 Depreciation Methods Used

The depreciation methods tested by the procedure outlined above were:

(1) Straight Line, no salvage value (SL,0),

(2) Straight Line, 10 percent salvage value (SL,10),

(3) Sum-of-the-year's Digits (SOYD), and

(4) Diminishing Value (DV).

The formulae for determining book values and depreciation for each of these methods based on replacement costs are presented below, where;

A = age (years)

k = years owned

L = estimated life (years)

R = diminishing value depreciation rate (%)

Io = replacement cost inflation index at time of purchase (new or second-hand)

Ik = replacement cost inflation index at the end of year k

Vo = initial cost ($)

Vk = book value at end of year k ($)

Xk = current cost depreciation in year k ($)

(1) Straight Line, no salvage value (SL,O).

$$Xk = Vo \frac{Ik}{Io} \left(\frac{1}{(L-(A-k))}\right) \qquad (A \leq L)^{3}$$

$$Xk = 0 \qquad (A>L)$$

$$Vk = Vo \frac{Ik}{Io} \left(1 - \frac{k}{(L-(A-k))}\right) \qquad (A \leq L)$$

$$Vk = 0 \qquad (A>L)$$

(2) Straight Line, 10 percent salvage value (SL,10).

$$Xk = (1-0.1) \quad Vo \frac{Ik}{Io} \left(\frac{1}{(L-(A-k))}\right) \qquad (A \leq L)$$

$$Xk = 0 \qquad (A>L)$$

$$Vk = Vo \frac{Ik}{Io} \left(1 - \frac{(1-0.1)k}{(L-(A-k))}\right) \qquad (A \leq L)$$

$$Vk = 0.1 \; Vo \frac{Ik}{Io} \qquad (A>L)^{4}$$

(3) Sum-of-the-years-Digits (SOYD)

Let Effective life[3] (L-(A-k)) = E

$$Xk = Vo \frac{Ik}{Io} \left(\frac{2(E+1-k)}{E(E+1)}\right) \qquad (A \leq L)$$

$$Xk = 0 \qquad (A>L)$$

$$Vk = Vo \frac{Ik}{Io} \left(\frac{E(E+1) - 2kE+(k-1)}{E(E+1)}\right) \qquad (A \leq L)$$

$$Vk = 0 \qquad (A>L)$$

(4) Diminishing Value (DV)

$$Xk = Vo \frac{Ik}{Io} \left(1-\frac{R}{100}\right)^{(k-1)} \qquad \frac{R}{100}$$

$$Vk = Vo \frac{Ik}{Io} \left(1- \frac{R}{100}\right)^{k}$$

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[3] The value (L-(A-k)) is the effective life from the time of purchase. It is used in place of L (life) to account for the machines which were purchased second hand.

[4] This formula permits book value (salvage value) to increase with inflation in replacement costs after depreciation has ceased (i.e. A>L).

CHAPTER 4

RESULTS

4.1 Tractors

4.1.1 Best Depreciation Method

Of the four current cost depreciation methods tested the Diminishing Value (DV) method at a depreciation rate of 17 percent per annum resulted in the minimum sums of squares of errors (SSE) between assessed and calculated values (Table 1).

TABLE 1

Optimum Depreciation Rates - Tractors

Current Cost Depreciation Method	Optimum Depreciation Rate	SSE ($\$x10^8$)	Proportion of Variation Explained[a]	Average Absolute Percentage Error
SL,O	8 year life	11.4696	0.70	55
SL,10	7 year life	9.4837	0.76	41
SOYD	13 year life	7.4662	0.81	44
DV	17 %p.a.	5.7422	0.85	30

[a]The proportion of variation explained is calculated as for R^2 in regression analysis [Wonnacott and Wonnacott, 1970:120]. It is important to note, however, that because of the use of postulated depreciation relationships, the calculated values (book values) are not determined by normal regression analysis.

Each of the four methods at their respective optimum depreciation rates resulted in average book values which closely approximate the average tractor values as assessed by the machinery dealers (Table 2). The t-statistic for paired observation indicated no significant difference (p=0.05) between average book

TABLE 2

Comparison of Means and Variances for Book Values and Assessed Values - Tractors

	Current Cost Depreciation Method			
	SL,O	SL,10	SOYD	DV
Optimum Depr. Rate	8 year life	7 year life	13 year life	17% p.a.
Average Book Value ($)	4600	4731	4879	5058
Average Assessed Value ($)	4964	4964	4964	4964
Significance of t-statistic (paired observations)[a]	**	NS	NS	NS
Standard Deviation of Book Values ($)	5210	4975	4915	4542
Standard Deviation of Assessed Values ($)	4110	4110	4110	4110
Significance of F Statistic[a]	**	**	**	NS

[a] NS - no significant difference at 95% level.

** - significant difference at 95% level.

value and average assessed value for each of the methods except Straight Line, zero salvage value (SL,O). However, the four methods all resulted in a variance of book values greater than the variance in assessed values although the difference was not significant ($p=0.05$) for the Diminishing Value (DV) method.

Although each of the four methods tested gave results (at the optimum depreciation rate) in which average book values closely approximate average assessed values, they all over-estimate the number of higher and lower values and underestimate the number of middle values. The difference between expected and observed frequencies for each of the four methods is statistically significant at the five percent level of significance (χ^2 test). From Table 3, for example, it can be seen that although there were actually only 73 tractors with a value less than $2500 the DV method indicated that there were 84, SOYD 86, SL,O 102 and SL,10 105.

TABLE 3

Observed and Expected Frequency

of Book Values - Tractors

Class Interval ($ Value)	Expected Frequency[a]	Observed Frequency Current Cost Depreciation Method			
		SL,O	SL,10	SOYD	DV
0-2500	73	102	105	86	84
2500-5000	67	31	32	46	47
5000-7500	54	34	34	39	45
7500-10000	15	31	28	29	24
10000-30000	21	32	31	30	30
Total Observations	230	230	230	230	230
χ^2 statistic		61.10	55.75	29.99	18.38
Significance of χ^2 statistic[b]		**	**	**	**

[a]The expected frequency of book values for the given class boundaries is the frequency of assessed values.

[b]Critical Value of χ^2 (df=4, p=0.05) is 9.49

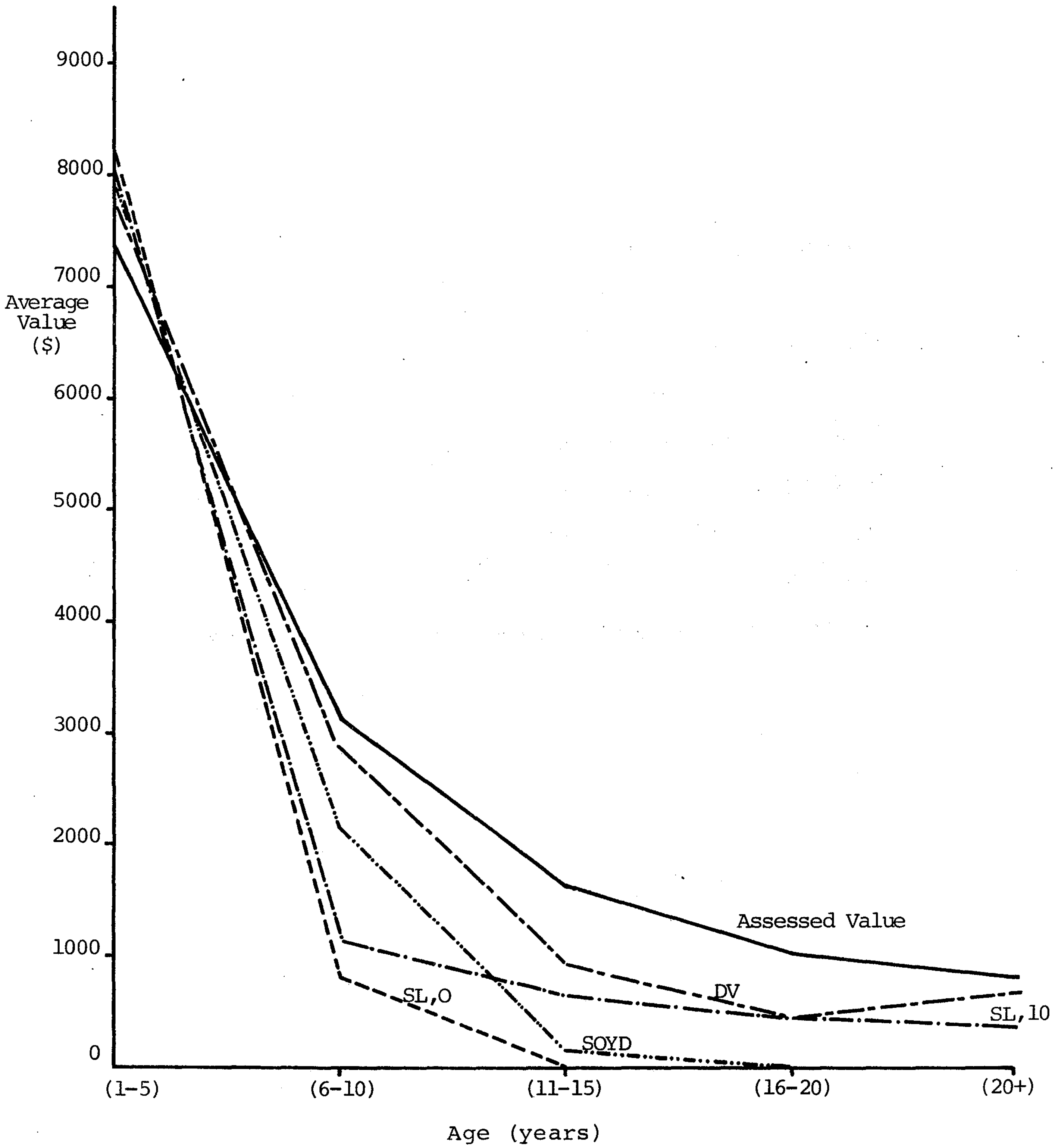
NS = no significant difference.
** = significant difference.

One reason why the methods overestimated the number of both higher and lower valued tractors would appear to be related to the fact that there is a strong correlation between age and value, older tractors being worth considerably less than newer ones. It appears that each of the depreciation methods resulted in an under-depreciation of newer tractors (hence the overestimate of higher valued tractors) and an over-depreciation of older tractors (hence the over-estimate of lower valued tractors). This theory is supported by the breakdown of book values for various age groupings shown in Figure 6.

Of the methods tested DV resulted in the closest fit of observed to expected frequencies followed by SOYD (Table 3). An even better fit might have been obtained by the use of a method which allowed even higher depreciation in the early years than that permitted by DV, and a slower fall-off thereafter.

FIGURE 6

Average Value Vs Age-Tractors



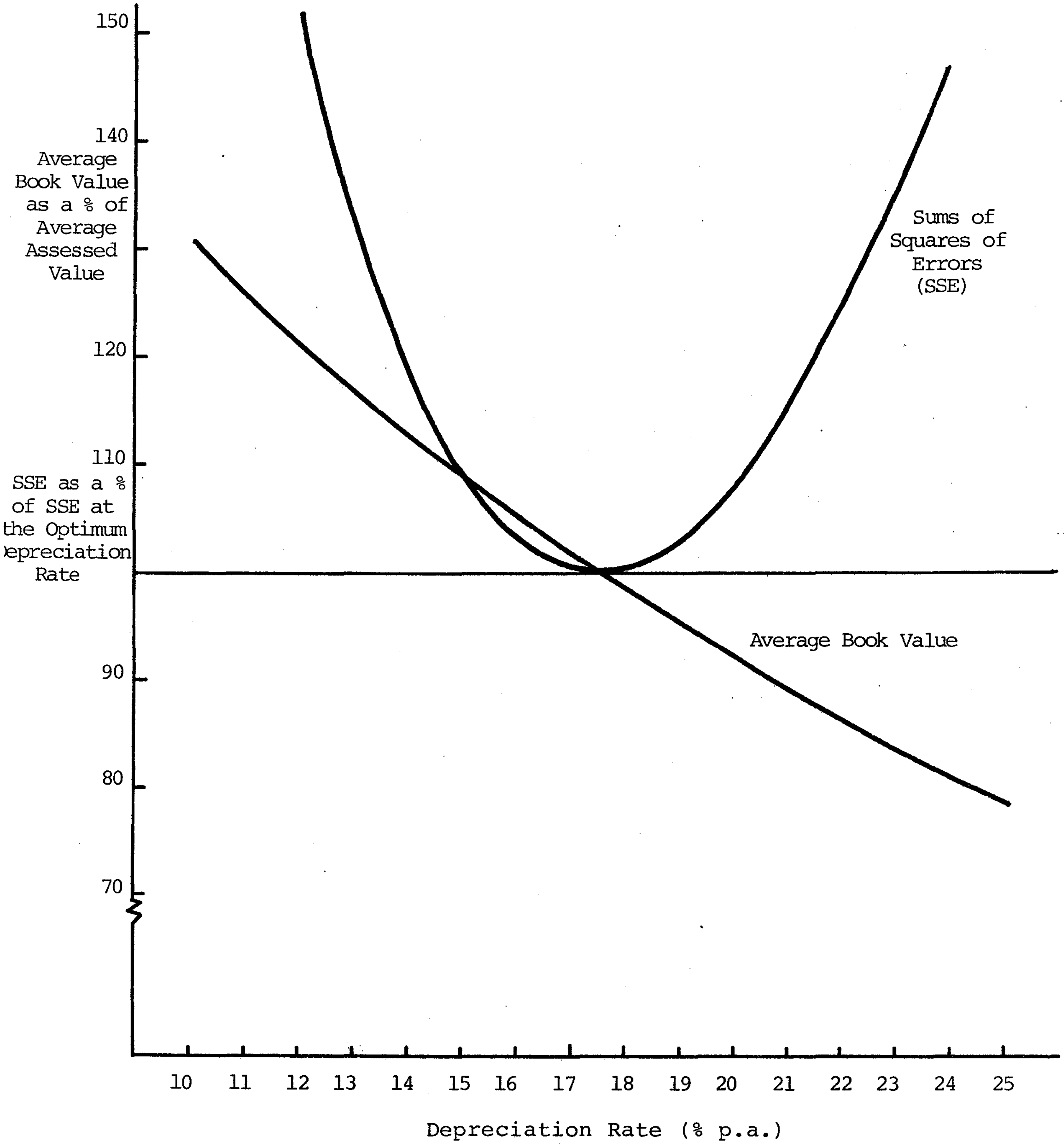
4.1.2 Sensitivity to Depreciation Rate

The results presented above indicate that, for the cross-section of tractors analysed, the DV method at a rate of 17 percent per annum was the "best" of the depreciation methods tested. In practice, rates allowable for taxation purposes are specified by the Inland Revenue Department, hence it is interesting to note the effect on average book value if a DV rate other than 17 percent was specified under Current Cost Accounting. Figure 7 relates average book value to average assessed value (as a percentage) for varying depreciation rates. It can be seen, for example, that altering the rate from 17 percent to 20 percent changed the average book value from 102 percent to 92 percent of average assessed value. At 15 percent the average book value was 109 percent of the average assessed value. Figure 7 also shows that the SSE increased quite rapidly for depreciation rates higher or lower than the optimum rate.

FIGURE 7

Effect of Depreciation Rate on SSE and Average Book Value

Diminishing Value Method - Tractors



4.1.3 Depreciation Allowances

Under the current cost depreciation methods used (at optimum rates) the average depreciation allowance for the 230 survey tractors for the 1976/77 year would have been approximately $1000 (Table 4). Current taxation laws relating to farm machinery permit a maximum 25 percent diminishing value (historical cost) depreciation in the first year of ownership and 20 percent thereafter. On this basis the average depreciation for the 230 tractors for the 1976/77 year would have been $764. An investment allowance of 40 percent of cost is also permitted as a tax deduction for new machinery. This allowance averaged

TABLE 4

Depreciation Allowances and Book Values, 1976/77 - Tractors.

Depreciation Method	Average Depreciation Allowance (1976/77) ($)	Average Book Value (end of 76/77 year) ($)
Current Cost		
(at Optimum Deprec. Rate)		
SL,O	1038	4600
SL,10	1029	4731
SOYD	1093	4879
DV	1036	5058
Historical Cost[a]		
(i) DV (25% 1st year 20% p.a. thereafter)	764	2631
(ii) 40% Investment Allowance	533	
Total Allowance ((i) + (ii))	1297	-

[a]Current New Zealand allowances for taxation purposes.

$533 over all tractors so that the total allowance (depreciation plus investment allowance) was $1297. This is a greater amount than that indicated under the current cost depreciation methods proposed. This finding is in agreement with the Inflation Accounting Research Project, Report No. 1 [Warrell, 1977:33] which found that the existing depreciation allowance exceeded the current cost figure for several of the farms and small businesses analysed. The overall average $533 investment allowance was in fact attributable to only 25 of the 230 survey tractors at an average of $4904 per tractor.

The average book value of the tractors under the historical cost depreciation method permitted is $2631 (Table 4) which is approximately half the average assessed value ($4694).

4.2 Headers

4.2.1 Best Depreciation Method

Of the four current cost depreciation methods tested the Diminishing Value (DV) method at a depreciation rate of 14 percent per annum gave the best fit between assessed and calculated values (Table 5). All four methods gave optimum rates lower than those recorded for tractors. If it is assumed that the inflation index is equally applicable to both tractors and headers the results indicate a lower depreciation for headers. This might be due to either physical (fewer hours worked) or economic (e.g. lower obsolescence) factors.

TABLE 5

Optimum Depreciation Rates - Headers

Current Cost Depreciation Methods	Optimum Depreciation Rate	SSE ($\$x10^9$)	Proportion of Variation Explained[a]	Average Absolute Percentage Error
SL,0	12 year life	2.9648	0.70	57
SL,10	11 year life	2.7544	0.72	48
SOYD	18 year life	1.9125	0.80	44
DV	14 % p.a.	1.3022	0.87	37

[a]The proportion of variation explained is calculated as for R^2 in regression analysis [Wonnacott and Wonnacott, 1970:120]. It is important to note, however, that because of the use of postulated depreciation relationships the calculated values (book values) are not determined by normal regression analysis.

The optimum rates for both tractors and headers may be influenced by the relative proportions of newer and older machines. Given an exponential type of decay curve, any method which does not closely approximate this shape will indicate a low depreciation rate if a large proportion of the machines are old and a high depreciation rate if a large proportion of the machines are new. In fact, the percentage of survey headers five years old or less (38 percent) is less than that for tractors (54 percent) (Figures 3,5). However, this in itself might be taken as an indication of a lower rate of depreciation in headers than tractors. Because of the influence of economic factors on depreciation rates it would be necessary to periodically review the optimum rates suggested in this study if a close fit was to be maintained between actual and calculated values.

The average book value for each of the methods is not significantly different (p=0.05) from the average actual value (Table 6). As for tractors the variance in book values for each of the four methods is greater than variance in assessed values although the difference is not significant for the DV method (p=0.05). As discussed previously, the variation in assessed values may have been different if on-farm valuations had been carried out.

TABLE 6

Comparison of Means and Variances for Book Values and Assessed Values - Headers

	Current Cost Depreciation Method			
	SL,0	SL,10	SOYD	DV
Optimum Depr. rate	12 year life	11 year life	18 year life	14% p.a.
Average Book Value ($)	10198	10613	10508	10463
Average Assessed Value ($)	10807	10807	10807	10807
Significance of t-statistic[a] (paired observations)	NS	NS	NS	NS
Standard Deviation of Book Values ($)	14022	13854	12862	11543
Standard Deviation of Assessed Values ($)	10047	10047	10047	10047
Significance of F-Statistic[a]	**	**	**	**

[a]NS - no significant difference at 95% level.

** - significant difference at 95% level.

The methods tested tend to overestimate the number of higher and lower valued headers and underestimate the number of middle values, though not as severely as for tractors (Table 7).

TABLE 7

Observed and Expected Frequencies of Book Values - Headers.

Class Interval ($ Value)	Expected Frequency[a]	Observed Frequency: Current Cost Depreciation Method			
		SL,O	SL,10	SOYD	DV
0-2500	22	41	37	26	20
2500-5000	7	10	11	19	19
5000-7500	18	5	7	12	15
7500-10000	19	6	7	4	8
10000-20000	15	17	17	20	20
20000-60000	16	17	17	15	14
Total observations	97	97	97	97	97
χ^2 statistic		36.31	27.14	36.87	29.54
Significance of χ^2 statistic[b]		**	**	**	**

[a]The expected frequency of book values for the given class boundaries is the frequency of assessed values.

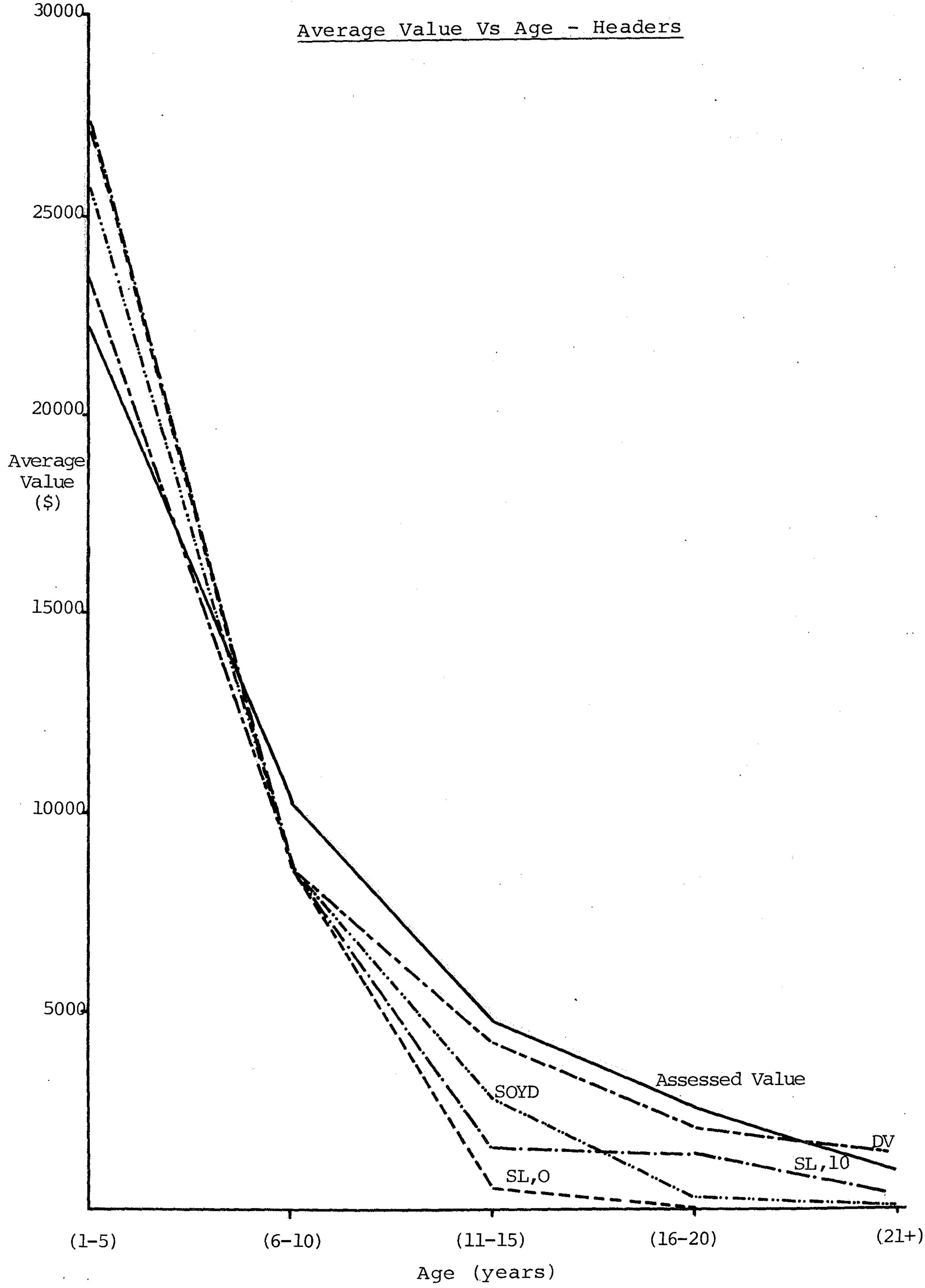
[b]Critical value of χ^2 (df = 5, p = 0.05) = 11.10

NS = no significant difference
** = significant difference

Figure 8 relates average book value to average assessed value for headers of different age groups. The DV method gave the closest fit between the two average values for each age group.

FIGURE 8

Average Value Vs Age - Headers



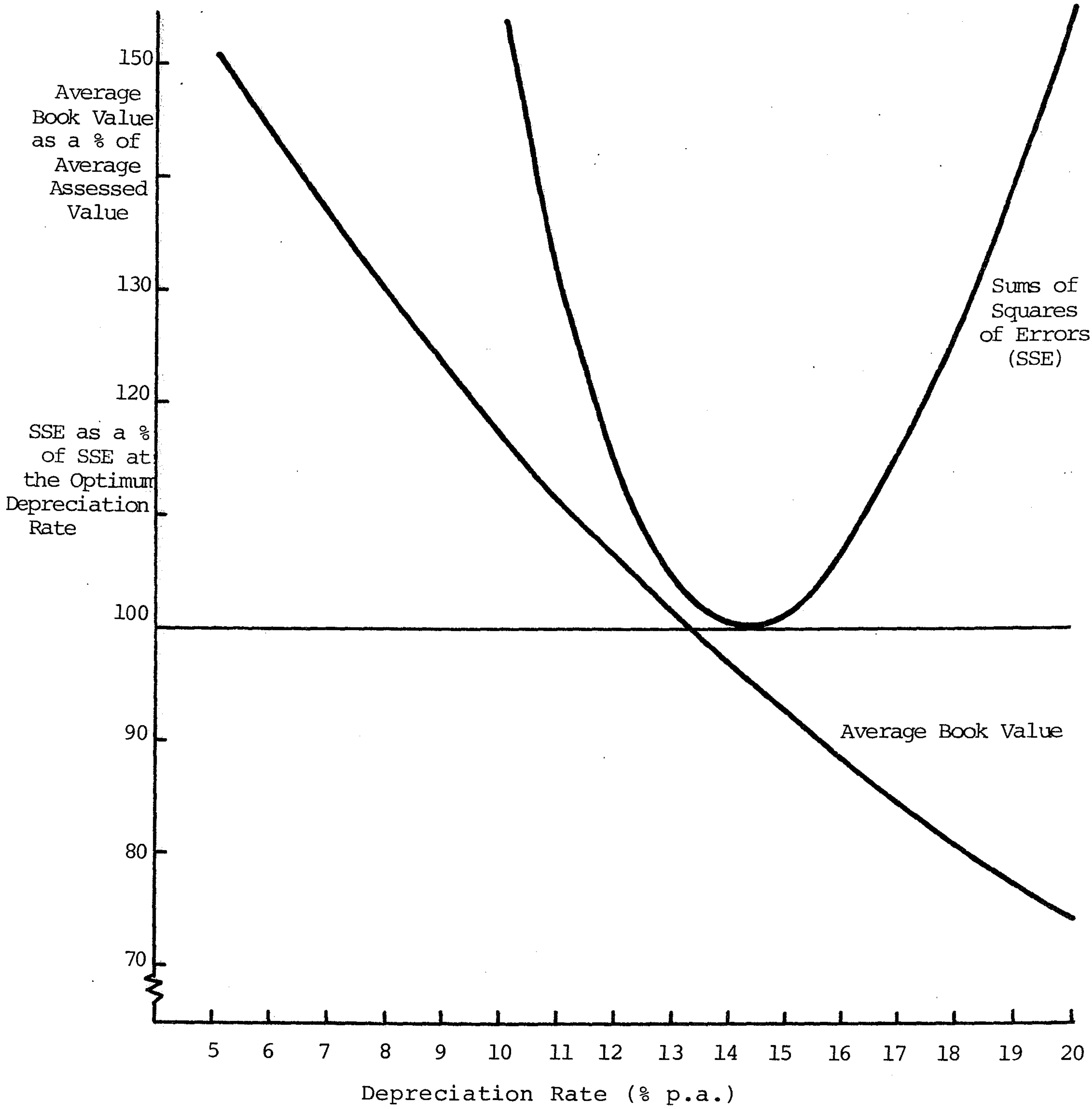
4.2.2 Sensitivity to Depreciation Rate

In Figure 9 the effect on average book value and SSE of varying the depreciation rate is shown for the DV method. At 14 percent (optimum depreciation rate) the average book value was 97 percent of the average assessed value. For a rate of 15 percent rather than 14 percent the average book value dropped to 93 percent of average assessed value and at a depreciation rate of 20 percent this figure falls to 74 percent. SSE increased rapidly either side of the optimum rate. If a single depreciation rate was to be used for a wide range of headers, such as those covered in this report, it would be important to use a value close to the optimum rate and to update the figure periodically.

FIGURE 9

Effect of Depreciation Rate on SSE and Average Book Value

Diminishing Value Method - Headers



4.2.3 Depreciation Allowances

Under the current cost depreciation methods proposed the average depreciation on the 97 survey headers for the 1976/77 year would have been around $1700 (Table 8). The amount of depreciation allowable for this period under the current taxation laws would have averaged $1094 plus an overall average $380 investment allowance giving a total allowance of $1474.

TABLE 8

Depreciation Allowances and Book Values, 1976/77 - Headers.

Depreciation Method	Average Depreciation Allowance (1976/77) ($)	Average Book Value (end of 76/77 year) ($)
Current Cost (at optimum depreciation rate)		
SL,O	1709	10198
SL,10	1636	10613
SOYD	1774	10508
DV	1703	10463
Historical Cost[a]		
(i) DV (25% 1st year, 20% p.a. thereafter).	1094	4039
(ii) 40% Investment Allowance	380	
Total Allowance ((i)+(ii))	1474	

[a]Current New Zealand allowances for taxation purposes.

In contrast to the situation with tractors, the depreciation allowance under the current cost methods proposed was higher than that under the present situation. The difference between tractors and headers was due to the smaller proportion of new headers on which the investment allowance may be taken. Of the 97 headers only three were new in 1976/77 and hence, the overall average of $380 resulted from an average allowance of $12316 on those three headers.

The average book value under historical cost accounting ($4039) was approximately 40 percent of the average assessed value ($10807).

CHAPTER 5

SUMMARY AND CONCLUSIONS

More accurate valuation of fixed assets in the Balance Sheet and calculation of depreciation in current cost terms are aims of inflation accounting. This report demonstrates which of the commonly used traditional depreciation methods might best be adapted to measurement of fixed asset values and current cost depreciation under the guidelines established in the Richardson Report. Also, depreciation allowances and book values are compared for the proposed current cost methods and the present historical cost system.

The comparison of methods (and rates) of depreciation was made using a cross-section of tractors and headers for which data was collected in a recent survey of New Zealand wheat growers. The best method and optimum rate of depreciation was defined on the basis of minimum sums of squares of errors (SSE) between assessed values and calculated book values.

This approach attempts to reconcile the accounting and economic viewpoints with regard to measurement of depreciation. The use of standard depreciation formulae and indexed historical cost means that the results may be useful for accounting purposes. However, since depreciation is calculated by valuing assets first and then computing the depreciation, the approach conforms to economic theory.

Of the traditional methods tested the results of this study indicate that the diminishing value method results in the best fit between calculated and assessed values. For tractors the optimum diminishing value depreciation rate was 17 percent per annum and for headers 14 percent. If the replacement cost index used in the depreciation formulae is assumed to be equally appropriate for both headers and tractors the results indicate a lower depreciation for headers than tractors. In that depreciation is due partly to a number of economic factors these rates would need to be reviewed periodically if they were to be adopted for general usage. One factor, for example, which might be expected to have an effect on depreciation rates would be a change in the amount of investment allowance on new machinery purchases.

A comparison of average assessed values and average book values derived for tractors and headers of different ages indicates that a depreciation method with a slightly faster rate of depreciation in the early years than normal diminishing value might give an even closer fit between assessed and calculated values.

Although straight line depreciation based on replacement cost has some appeal on the basis of simplicity it did not result in as good an indication of actual (assessed) values as did the diminishing value method. The SSE between book values and assessed values for the straight line method was, in fact, approximately double that for diminishing value. Straight line and sum-of-the-years digits depreciation methods have the further disadvantages of requiring estimates of "life" and salvage value. Since changed economic circumstances may alter the most appropriate time to dispose of an asset, the concept of the "life" of an asset appears inappropriate. In addition, the results of this study show that at the optimum depreciation rate for straight line and sum-of-the-years digits, many machines in operation were, in fact, older than the estimated "life". Thus, these machines are theoretically unable to contribute to the total depreciation allowance of the business although depreciation almost certainly continues to occur. Book values presumably must be entered in the balance sheet at zero value or some arbitrary salvage value which may or may not be allowed to increase in value with inflation.

For each of the current cost depreciation methods tested, the average assessed book value closely approximated the average book value at the optimum depreciation rate. At rates other than the optimal rate, SSE increased rapidly and the average book value diverged significantly from the average assessed value.

In order to assess the implications of adoption of the proposed depreciation methods, current cost depreciation allowances were calculated for the 1976/77 year for the survey tractors and headers. These were compared with depreciation currently allowed for taxation purposes and based on historical cost.

For each of the current cost methods tested the average depreciation allowance at the optimal depreciation rates for the survey tractors was around $1000. Under the current taxation rates allowable (25 percent DV first year and 20 percent thereafter) an average $764 would have been allowed. In addition to normal and first year depreciation a 40 percent investment allowance is currently permitted on new machinery. For the 230 survey tractors the investment allowance averaged $533 and if this is added to the $764 normal and first year depreciation the average total allowance is $1297. The average $533 investment allowance was, in fact, attributable to only 25 of the 230 survey tractors at an average of $4904 per tractor. If the current investment allowance on tractors is seen as offsetting the inadequacies of depreciation based on historical cost, two points arise. Firstly, the average total allowance (depreciation and investment) for the survey tractors was greater than it would have been under current cost depreciation. However, the distribution of allowances would appear to be highly inequitable. Owners of new tractors in 1976/77 were allowed depreciation (plus investment allowance) at rates much higher than those indicated by current cost whereas those who had not purchased new tractors were allowed depreciation at approximately two thirds of that indicated by the current cost methods.

If all farmers purchased new tractors on the same regular basis it could be argued that the benefits would be evened out over time. However, since actual savings on purchase price depend on marginal tax rates the investment allowance favours farmers with higher incomes. A certain proportion of farmers, therefore, are more likely to buy new machines. These farmers receive the benefits of the investment allowance and, also, base depreciation calculations on values closer to replacement cost than those who retain older machines. The "depreciation" claims for the higher income farmers are therefore likely to be considerably above those indicated on a current cost basis and considerably lower for the remainder.

For headers, each of the current cost methods at their optimum depreciation rates gave an average depreciation allowance of approximately \$1700. Under the current tax laws an average \$1094 would have been allowed as normal and first year depreciation. As for tractors this historical cost depreciation figure is approximately two thirds of that indicated by the current cost depreciation methods used. In the case of headers, however, the average investment allowance for 1976/77 was only \$380 and hence the average total allowance (depreciation plus investment) of \$1474 was less than that indicated by current cost depreciation.

The comparison of average investment allowances between tractors and headers illustrates a further problem in attempting to use the investment allowance to offset the inadequacy of historical cost depreciation: the variation in recorded income from year to year resulting from large investment allowances in certain years. In years in which there is little outlay on new machinery the allowance (depreciation plus investment allowance) will be lower than that indicated by current cost measures and vice versa in years of high outlay. Purchase of new machinery is, in fact, used as a means of averaging taxable incomes by reducing taxable income in years when it would otherwise be high. It does, however, result in a further distortion of accounts.

Under the historical cost depreciation methods currently allowed for taxation purposes the average book value of the survey tractors was approximately half of the average assessed value. The average book value of the survey headers was approximately 40 percent of the average assessed value.

In conclusion, the results of this report indicate that adoption of current cost depreciation measurement as proposed by the Richardson Report offers significant improvements over the present historical cost accounting methods in estimation of depreciation and in the valuation of fixed assets in the balance sheet. The use of the diminishing value method (at an appropriate depreciation rate) rather than straight line or sum-of-the-years digits methods would ensure an even closer fit between actual values and book values in the Balance Sheet. Finally, if current cost accounting is adopted in

New Zealand, it may be an appropriate time to review the need for, and equity of, current investment allowances on purchases of new machinery.

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