OPTIMUM MACHINERY MANAGEMENT: A SOUTH AFRICAN PERSPECTIVE.

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ABSTRACT

Optimum machinery management involves deciding how to operate, maintain, schedule and replace machinery in order to maximise after-tax profit. This paper focuses on machinery replacement as this has probably been the most complex aspect for South African farmers to manage over the last decade, due mainly to significant changes in the macroeconomy. Trends show that the tractor fleet on commercial South African farms has aged and shrunk since the 1980's. Current replacement cycles are now ten to twelve years, almost double the average cycle of the early 1980's. Economic factors affecting these trends include rising real tractor prices (partly due to the Atlantis Diesel Engine project), a falling Rand exchange rate, variable annual crop incomes, changing tax legislation and fluctuating, but generally higher, interest rates. Technological advances in tractor manufacture and more efficient machinery planning, operating and scheduling have also extended optimum replacement time.

Introduction

Optimum machinery management involves deciding how to operate, maintain, schedule and replace machinery in order to maximise after-tax farm profit. Of these, operation and maintenance of machinery are straightforward functions based primarily on the technical specifications of each machine. Scheduling is influenced largely by the vagaries of climate but also entails choosing correct machine size and combinations to avoid unnecessarily high input costs. While this should be a routine management function, surprisingly few South African farmers actually have a proper machinery plan. Machinery replacement has probably been the most complex aspect for South African farmers to manage over the last decade, due mainly to major changes in the macroeconomy. This paper therefore focuses on those factors that have influenced optimum machinery replacement decisions in South Africa since 1980. Past research on the determinants of machinery investment and replacement decisions in South Africa is first reviewed. Trends in tractor replacement during the 1980's are then discussed to show which factors most influenced replacement decisions. These trends are considered to be representative of all farm machinery as new tractor sales account for the major share of annual South African farm machinery sales - some 56% in 1988 (Effective Farming, 1989: 312). Some thoughts on possible future trends in farm machinery replacement in South Africa are also included.

1 Past research

Nieuwoudt (1973) analyzed factors influencing investment in tractors and trucks in South Africa for the periods 1950-1964 and 1922-1964 respectively. Tractor demand was explained by the price ratio of tractors to labour (substitution of labour by mechanisation), the number of tractors lagged by one period (year) and gross annual crop income. Truck demand was explained by the price ratio of trucks to crops, the number of trucks lagged by one period and gross value of agricultural income. These results emphasise the effects of relative prices, service levels from existing stock and availability of funds (capital constraints) on machinery purchase decisions.

Viljoen and Groenewald (1977) studied agro-economic survey data for 46 farmers in the Ruens area of South Africa. More efficient farmers (those performing above expectations) had larger worked areas, smaller tractor investments and tractor costs per hectare operated, and older tractors than less efficient producers. Implement investment and implement costs per hectare operated were also significantly lower. More efficient farmers thus seemed able to spread tractor and implement costs over a larger area and achieve economies of size.

Braithwaite (1988) developed a model to estimate the optimum time to replace tractors on a large sugar estate at Sezela in the Natal province of South Africa. Traditionally on the estate, tractors were replaced on the basis of life in years or the number of hours run or kilometres travelled. Because of low sugar prices and rapidly rising new tractor prices at the time, he derived a practical technique to determine optimum tractor replacement time based on ownership and operating costs. Firstly, annual depreciation, interest on capital investment and maintenance and repair costs for estate conditions were projected for new, old and reconditioned medium sized tractors over four years. Secondly, these costs were adjusted for tax rebates on new asset purchases and productivity differences (in terms of haulage capacity in tons of sugarcane per hour) to reflect downtime/obsolescence. Finally the adjusted data were discounted to net present values to account for the time value of money. He concluded that reconditioning was not beneficial, while higher downtime as a tractor gets older made the new tractor the best choice on a cost/hour and cost/ton basis. It was recommended that after four years the old tractor be withdrawn from critical work such as haulage and used for lighter work where downtime was less critical.

van Zyl et al (1990) assessed the optimal replacement time for tractors in South Africa using the criterion of minimum cost per annum. Actual annual cash flows were projected and then discounted to net present values for small (45-54KW) and medium (65-75 KW) size tractors at different annual use, interest and marginal income tax rates for the period 1973 - 1989. Cash outflow comprised the purchase price of the new tractor, tax on profit from sale of the old tractor and repair costs. Cash inflow constituted the trade-in price of the old tractor, and tax rebates on new tractor purchases. The analysis implicitly accounted for inflation in repair costs and tractor replacement prices.

Results identified annual use in hours as the main factor affecting replacement decisions for both tractor models. The marginal tax rate had little effect while replacement age increased as interest rates rose. For example,

optimum replacement time at a 10% interest rate and 25% marginal tax rate fell from 8 years to 6 years for small tractors as annual use increased from 600 hours to 1200 hours. For an interest rate of 20% at the same marginal tax rate the corresponding ages were 11 years and 7 years. The study did not account for personal factors (self esteem etc.) or reliability (risk of breakdown). Where timeliness of operations is an important consideration, earlier replacement would probably be favoured.

With most farm machinery in South Africa being owned by individual farmers, and given that the broad principles governing machinery replacement as stated by Barnard and Nix (1979) are widely applicable, more research is needed on individual machinery replacement decisions. The apparent lack of research into the economics of machinery scheduling is probably largely the result of a lack of data due to the general reluctance of farmers to keep suitable records. One particularly neglected research field has been that of mechanisation in the developing (emergent farmer) sector. Very small farm sizes (1-2 hectares for example in KwaZulu) provide limited incentive to invest in own machinery, but there is much evidence of machinery contracting (Nieuwoudt and Vink, 1989).

2 Trends in tractor replacement since 1980

Price, income and tax factors have been shown by research to influence investment behaviour and have contributed to the trends in tractor replacement since the 1980's.

Rankin (pers. comm), who monitors and forecasts tractor sales, mainly for the manufacturers, has shown that the South African tractor fleet has aged and shrunk since the early 1980's (Effective Farming, 1990: 422; 1993: 124-295). Quantifying this:

* the total 'park' of working tractors has fallen from some 204000 to about 160000;
* the average age of all tractors has risen from eight to 10 years, with 61% of tractors older than 10 years, and 17% over 15 years old;
* the number of tractors under four years has declined from 70000 (34%) to 23000 (14%); and
* the aggregate age trends mask regional differences in tractor age distribution. Amongst maize farmers, for example, those in areas that are less drought prone have newer tractors.

In line with the above trends, current average replacement cycles are ten to twelve years, almost double the average time in the early 1980's (Effective Farming 1988: 278). These trends can be attributed to a combination of economic, political, technological and management factors.

2.1 Economic and political factors

Relatively higher tractor prices, the Atlantis Diesel Engine (ADE) project, a falling Rand exchange rate, variable annual crop incomes, special tax provisions, and fluctuating interest rates, have influenced tractor replacement decisions over

the last decade.

* New tractor prices rose by about 1,4% per annum in real terms over 1970-1980. They then increased by a real 4,6% per annum during 1980-1990 (Abstract of Agricultural Statistics: 95-98). In nominal terms for example, a large tractor priced at R42 000 in 1981 was selling for over R100 000 in late 1989 (Effective Farming, 1989 : 312).

* The post 1980 price rise coincided with a government decision, for political reasons (self-sufficiency), to start local production of diesel engines for tractors by establishing the ADE project in 1980. Import tariffs were used to protect ADE engines in the two to seven litre range (80-85% of the total engine market) against lower priced imports from the United Kingdom, Italy, Germany, France and the United States.

  An ADE study in 1991 showed that ADE engines were, on average, 75% more expensive than comparable imports, effectively raising new (nominal) tractor prices by 16% annually (Effective Farming, 1991 : 496). Representatives of ADE claim, however, that tractor buyers will recoup much of this higher capital cost over the working life of a tractor because ADE parts are cheaper/more readily available than imports. Dr Rankin criticizes this comparison, pointing out that current ADE parts cannot be compared with those for obsolete, pre-ADE imported models.

* Import prices have risen as the South African Rand has depreciated against Western European currencies and the United States dollar since 1985. The currency depreciation has, however, meant larger Rand incomes from exports of maize and sugar in good production years, wool, deciduous fruit and citrus.

* The period 1979-1982 saw record maize, wheat, sunflower and cotton crops. With capital readily available and farmers able to write-off 100% of the cash price of machinery against taxable farming income in the year of purchase, tractor sales peaked at 24 862 units in 1981. This was markedly above the long-term annual average of 14 000 units at that time (Effective Farming, 1986 : 18-20).

  Severe drought in 1982-1983 reduced gross maize and wheat incomes to 54% and 76% of their record levels respectively. Income recovered during 1984-1985, but by 1985 annual new tractor sales were down to 7 061 units. Gross annual crop receipts in 1988-1989 approached the record levels, but 1992 saw the onset of South Africa's severest ever drought. Annual new tractor sales between 1988-1992 fell from 5854 to 2207 units as capital was less plentiful and bankrupt farmers sold their second-hand models to less indebted farmers (Abstract of Agricultural Statistics : 7-10; Effective Farming, 1993 : 124).

* The 100% accelerated depreciation allowance was changed in 1988 on the

recommendation of the Margo Commission. The new provision allowed machinery to be written-off against taxable farming income over three years, at rates of 50%, 30% and 20% respectively (AgriReview : 1-3). This has probably discouraged tractor replacement in recent years, but has also provided less incentive to over-invest in good years (improving farm cash-flows).

* Prior to 1983, qualifying farmers could borrow funds via the Land and Agricultural Bank of South Africa (Land Bank) and agricultural co-operatives at interest rates below the prime lending rate of commercial banks. This was due to liquid assets (debentures, bills and advances) used to finance the Land Bank (and hence co-operatives) being issued to commercial banks at below market interest rates.

  The de Kock Commission recommendation in 1983 that monetary control change from a liquid asset requirement system to a cash holdings system, led to higher costs of Land Bank financing, as only bills kept their liquid asset status (Jacobs : 7-8; Human : 10-12). Borrowers felt this adjustment, as nominal Land Bank interest rates rose from 10% to 17% during 1983-1991.

  The monetary authorities also introduced a general policy of higher, market-related interest rates in the early 1980's to try and reduce double-digit annual inflation. Nominal interest rates thus became more volatile - the prime overdraft rate rose from 9,5% to 22% over 1980-1984, fell to 12,5% by 1987, rose to 21% in 1990 and is currently 17%. Thus, higher nominal and real interest rates implied more onerous interest charges and later tractor replacement for farmers who had to borrow capital.

2.2 Technological and management factors

Tractor replacement decisions have also been influenced by technological developments and changing machinery management practices in response to variable capital availability and rising replacement costs.

* Tractors in use today are slightly bigger than 15 years ago. The modal tractor size is now 55-60 kW, compared with 46-50 kW then. New tractors today also last longer (if properly maintained) and are of higher quality (much improved fuel consumption and gear-boxes, increased hydraulic power, extended transmission life etc.).

* Farmers are using a wider range of alternatives to replacement with a new tractor. Options include: (1) buying re-manufactured tractors (used tractors with components subject to wear and eventual failure replaced) at some 60% of new tractor retail prices; (2) large fleet operators buying second-hand tractors and rebuilding them in their own workshops; (3) overhauling old tractors; and (4) buying second-hand tractors - which large fleet users advise should be under five

years old with a detailed history file and warranty (Effective Farming, 1988 : 278-282).

* Farmers with sophisticated workshops and those doing their own refurbishing have increased the demand for spares and servicing.

* Machinery planning/scheduling/operating is being conducted on a more organized basis to reduce costs per hectare and per ton. Better managers use their tractors more efficiently (e.g. combining planting and fertilizing operations) and for longer each year. Some manufacturers offer mechanisation planning services (e.g. to match tractor capacities to soil conditions and implement capacities) and insist drivers are properly trained before delivering tractors. Manufacturers have also put time and money into raising the quality of tractor care and maintenance courses at Agricultural Training Centres such as Boskop in the Western Transvaal and Baynesfield in Natal (Rankin).

3 Possible future trends in machinery replacement

While it is inevitably difficult to predict future trends in the South African farm machinery market, some comments on the prevailing influences may be appropriate. On the positive side with regard to tractor sales, advancing technology, closely linked with the need for more efficient machinery planning, will make older models of tractor obsolete more quickly than in the past. This may lead to a minor upturn in the market, but there are some offsetting negative factors: the severe drought currently affecting most of the country; a turbulent political environment with farmers facing great uncertainty about issues like land reform; and the removal of artificial support mechanisms (such as subsidies, and high prices for grains like maize and wheat) that have not only sheltered farmers from reality, but actively encouraged inefficient farming systems and indefensible land use practices.

Conclusions

There is probably an optimum level of machinery replacement on each commercial farm, and ideally this level should form an integral part of the overall farm plan. Past local research and aggregate trends in tractor replacement in South Africa identify the following key determinants of optimum replacement: capital availability; purchase price (ownership costs) and operating costs; taxation allowances; interest rates; technological change; relative costs of alternatives to purchasing new machines; and more efficient machinery planning, scheduling and operating.

For individual farmers, the importance of these factors is likely to vary. Reliability (risk of down-time), availability of parts and personal factors (self-esteem) will also play a role. Capital availability, technological change, reduced tariff protection, more efficient machinery planning, less government support and land reform will be key factors for managers to watch in the 1990's.

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