IMPROVING PERFORMANCE AND UTILISATION TO MINIMISE MACHINERY COSTS

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ABSTRACT

Machinery related costs typically contribute as much as 50% of total costs in a sugarcane production system. With decreasing profit margins, often due to increasing machinery costs, it is becoming more important to improve machinery performance and utilisation. Some approaches to improvement, which may result in reduced mechanisation costs, are discussed.

Keywords: Sugarcane, machinery, performance, utilisation and cost

INTRODUCTION

Millions of tons of sugarcane are produced annually around the world on farms of under five hectares in area. Many factories rely solely or heavily on small scale farmers for their cane supply. These farmers are finding it increasing difficult to grow and harvest their cane without some form of mechanical assistance or survive because of high machinery related costs (Hudson, 1996). Due to the small areas under cultivation most farmers cannot economically justify mechanical aids and rely heavily on contractors or co-operatives to satisfy their requirements.

When one considers that, for a typical sugarcane enterprise machinery related costs contribute as much as 50% of total production costs, it can be appreciated how important machinery management is. This paper is directed at both commercial and small scale farmers as well as contractors wishing to reduce their machinery and equipment costs by improved machinery management, utilisation and efficiencies, and by implementing cost effective farming methods or contracting businesses.

DISCUSSION

To minimise machinery costs sugarcane growers and contractors have to consider how to use their machines more fully and effectively. Mechanisation costs should be analysed not only on an individual machine basis but also with respect to machine selection, matching of equipment and various mechanisation system options. This paper discusses the main issues surrounding machinery management leading to improved performance and utilisation, and reduced costs. These issues can be broadly grouped into the following categories:

- Investment in machinery
- Improving machinery performance
- Improving machinery utilisation

INVESTMENT IN MACHINERY

It is important to understand basic machinery costing principles in order to appreciate the need for improving machinery performance and the need to utilise machines as fully as possible.
MACHINERY COSTING PRINCIPLES

The costing method used to illustrate certain principles in this paper is based on the classic machinery costing method and excludes management fees and profit margins (Murray and de Beer, 1978). The total costs involved in the ownership and use of machinery is usually divided into two categories:

FIXED COSTS:

Ownership costs are those which are incurred whether the machinery is used or not. They include depreciation, insurance, licence, interest, shelter and operators. Depreciation is simply a loss in value due to time and use. Interest is a direct expense item on borrowed capital. Even when cash is paid, money is tied up that otherwise might be available for other purposes. Insurance, licence and operators must be paid annually. Total annual fixed cost is largely unaffected by amount of use but fixed costs per hour changes dramatically according to the amount of annual machine usage.

VARIABLE COSTS

Operating costs are those that are dependent on the degree of utilisation of the machinery. Items in this category include fuel, lubricants, tyres and repair and maintenance costs. These costs are usually directly proportional to the amount of utilisation. Repair and maintenance costs usually increase with age but at a decreasing rate (Kepner et al., 1978).

A typical cost graph (fixed + variable costs) of agricultural machinery which clearly shows that, by increasing annual usage, hourly machinery costs are reduced, is presented in Figure 1. Therefore, one way of reducing costs is to utilise machinery fully. The machine must however be used productively and efficiently at all times.

![Figure 1. Typical cost curve for agricultural machinery](image-url)
MACHINERY ACQUISITION

New machinery:
When investing in new or used machinery careful consideration should be given to the impact on cash flow. The level of debt will indicate the risk attached to the decision to purchase. The actual method of acquiring machinery may have to be investigated further, i.e. use of own capital, leasing or hire purchase.

Used machinery:
Research has shown that a tractor purchased as late as six year of age can have lower operating costs than a new tractor. In a specific case a tractor purchased at the age of three years and sold at the age of six years had the lowest cost (Hunt, 1973). The purchasing of used machinery must be considered in the light of the enterprise's capital position. It may therefore be more financially sound for a farmer with limited capital to purchase second-hand machinery. However, higher repair and maintenance costs and machine reliability must be kept in mind.

MACHINERY REPLACEMENT

Machinery replacement decisions can and do have significant implications on cash flow and overall profitability of an enterprise, especially in the current economic climate and the need to remain competitive with other sugar producing countries. Often these decisions are based on intuition and physical conditions rather than valid economic justifications. Deciding whether to trade-in or continue to repair machinery and equipment is also an important factor in the present economy. To establish some guidelines on when to trade-in the following can be considered:

- The accumulated average cost per unit of use has reached its lowest point and is now increasing
- The machine has become obsolete
- The machine is no longer reliable
- The machine is worn out.

Although there may be many advantages to replacing early, such as tax concessions, machinery needs should ultimately drive the replacement decision. Over-estimation of initial depreciation defers replacement while high repair costs through heavy usage usually encourages early machine replacement. Several models have been developed to determine optimum machinery replacement cycles (Braithwaite, 1987; Murray, 1982; Witney and Saadoun, 1989). The bottom line is that a machine must be considered as an expense and not an investment. It has been purchased to perform a task efficiently and most often within prescribed times.

MACHINERY RECORDS

No meaningful financial decisions can be taken without the aid of certain vital machinery records being available to the owner or manager. It is therefore imperative to maintain some form of machinery records, especially of variable costs such as repairs and maintenance, fuel and tyres. This will enable the owner to make decisions regarding machinery replacement or calculating charge-out rates.

ALTERNATIVE METHODS OF FINANCING MACHINERY

Contracting:
Hiring a contractor is an alternative to owning machinery or equipment. However, it is important that one is able to determine when to use a contractor. It is necessary to compare the contractor's rate with the cost of owning and operating one's own machinery.
Owning, leasing and renting:
Machinery management involves evaluating the differences between ownership, leasing or renting.

Owning machinery is advantageous when:

- capital is not limiting
- the machine is not likely to become obsolete through size, capacity or technology.

Renting is advantageous when:

- specialised operations are required
- deferring capital expenditure
- critical operations need to be completed in good time

Leasing may be advantageous when:

- business expansion creates a shortage of capital
- a short term opportunity arises that will increase capital
- the rate of return to capital is higher than rates on borrowed capital
- the future is uncertain and it is therefore preferable to defer capital expenditure
- new technology needs investigation.

IMPROVING MACHINERY PERFORMANCE

Machinery selection
An effective mechanisation plan encompasses the correct matching of tractors and implements. "Tractors and implements cannot be considered separately, but must be chosen so that the tractor is fully utilised with respect to the power available, and so that the tractor-implement combination is matched to the size of the task in hand". (Murray and de Beer, 1978). Correct tractor-implement matching means that the tractor is fully utilised within acceptable speeds of operation and tractive efficiency while not overloading the implement, resulting in the lowest possible energy cost. If machinery is to perform only specific tasks (i.e. cane transport) it may be necessary to conduct an in-depth investigation into alternative machinery options (Braithwaite, 1984).

Field efficiency
Field efficiency is a measure of the amount of effective work done by a machine and can be defined as:

\[
\text{Field efficiency} = \frac{\text{Actual output}}{\text{Theoretical output}} \times 100
\]

There are many factors which determine field efficiencies:

- field layout and condition
- road infrastructure and haul-out distances
- machine setting and reliability
- type of machine
- training and operator performance
- management.

Field efficiency has a direct impact on work rates and therefore on unit costs. Users of mechanised agricultural machinery should strive to improve field efficiencies whenever possible.
Operator proficiency

The machine operator is possibly one of the most important factors when considering optimum machine utilisation, operational efficiency and operating costs. It is false economy to employ a "cheap" poorly trained operator (de Beer et al., 1993). It is vitally important that an operator has a good understanding of the basic principles concerning traction, wheel slip, rolling resistance, draft and depth control mechanism, weight transfer, matching of tractor-implement combinations and setting of implements, all of which affect machinery performance. Furthermore, a trained person is able to operate his machine in the correct gear ratio and throttle setting (Hansen et al., 1986; Boevey and Murray, 1983). Training of operators is one important way of increasing machine performance and efficiency as well as reducing overall costs.

Machinery maintenance

Agricultural machinery operating costs can be reduced to and maintained at acceptable levels by implementing a well planned servicing and preventative maintenance programme. Unreliable, poorly adjusted and badly maintained machines cannot operate at high field efficiencies. It has been shown that a simple, effective tractor maintenance plan can reduce downtime from 18 to 5% and increased tractor life from four to seven years (Statham, 1986). It is usually necessary to draw up different maintenance programs for different types of machines, machine applications and usage.

However, for the maintenance programme to be successful owner/operators or service personnel will require training and should attend regular refresher courses. Furthermore, servicing of farm machinery should be conducted in hygienic facilities equipped with the necessary tools. Major machine component overhauls are usually carried out more efficiently and cost effectively by professional outside agencies unless fleet numbers dictate otherwise.

IMPROVING MACHINERY UTILISATION

Under-utilisation of machinery results in higher ownership cost per hour. A survey of small scale contractors delivering cane directly from field to mill at a South African factory showed extremely poor machinery dilisation (Table 1). Assuming that the majority of these contractors are not involved in other community tasks such as land preparation or carting water/building material, the economic viability of most of these contractors must be seriously questioned.

Table 1. Summary of contractor vehicle performance

<table>
<thead>
<tr>
<th>Tonnage Category</th>
<th>No of Vehicles</th>
<th>Tons/vehicle annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-500</td>
<td>101</td>
<td>137</td>
</tr>
<tr>
<td>500-1000</td>
<td>44</td>
<td>744</td>
</tr>
<tr>
<td>1000-1500</td>
<td>24</td>
<td>1242</td>
</tr>
<tr>
<td>1500-2000</td>
<td>15</td>
<td>1741</td>
</tr>
<tr>
<td>2000-2500</td>
<td>4</td>
<td>2257</td>
</tr>
<tr>
<td>2500-3000</td>
<td>4</td>
<td>2687</td>
</tr>
<tr>
<td>3000-3500</td>
<td>1</td>
<td>3446</td>
</tr>
<tr>
<td>3500-4000</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4000-4500</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4500-5000</td>
<td>1</td>
<td>4938</td>
</tr>
</tbody>
</table>

There are numerous ways by which machinery utilisation can be improved. These include:
MECHANISATION PLANNING

The aim of mechanisation planning is to determine the optimum number and size of machines required for a given farming enterprise. The best set of machinery may be defined as that combination which satisfies the farmer's requirements, completes the various tasks in the specified time and results in the lowest cost per hectare or per ton of produce.

The number of tractors, loaders, implements and trailers and the timespans to complete the various farming activities, based on machinery operating capacities, working widths and payloads are calculated and plotted on yearly work schedule or activities chart (Haynes and Greef, 1980). Using this information the daily, monthly and yearly machinery requirements are easily computed, and it can be determined whether the machinery complement is adequate or excessive. If the grower wishes to go into part-ownership of equipment a mechanisation plan will show immediately where bottlenecks are likely to occur. At the same time the plan clearly indicates any spare capacity and at what time of year.

To achieve optimum machinery productivity and utilisation it is usually necessary to make some adjustments to the original programme of work. An example whereby a farmer (generally regarded as an efficient operator) changed his crop re-establishment method and timing as well as his fertiliser application equipment, is presented in Figure 2. Because of the improved workload distribution his tractor fleet was reduced from six to five without sacrificing spare machinery capacity at critical periods.

Figure 2. Monthly tractor requirements
No enterprise can afford to over-capitalise, i.e. to have machinery and equipment standing idle. On the other hand there is a cost penalty attached to not having adequate machine capacity or performance, especially for critical operations such as weed control.

**TIMELINESS**

Timeliness costs normally appear in the form of reduced yield or a lower grade product. An example of the latter is a reduction in sucrose yield due to an increase in the period between harvesting and crushing sugarcane. An example of such a situation in South Africa is given in Table 2, where the burn to crush delay for small scale growers can be as long as 10 days. Assuming a 1-2% loss in recoverable sugar per day this amounts to a significant revenue loss to both the growers and the industry. Although the causes of these delays are numerous, one of the main factors is the generally poor performance by local contractors. In many cases the contractor’s daily allocation is very low, and the haulage distances are too long for the relatively small payloads and poorly maintained machinery.

![Table 2. Summary of burn to crush delay survey (1997/98 season)](image)

<table>
<thead>
<tr>
<th>Mill</th>
<th>Tonnage</th>
<th>Burn to crush distribution (% of tonnage)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0-3 days</td>
</tr>
<tr>
<td>Sezela</td>
<td>329050</td>
<td>34</td>
</tr>
<tr>
<td>Eston</td>
<td>171745</td>
<td>47</td>
</tr>
<tr>
<td>Maidstone</td>
<td>243699</td>
<td>19</td>
</tr>
<tr>
<td>Glendale</td>
<td>144119</td>
<td>29</td>
</tr>
<tr>
<td>Amatikulu</td>
<td>397757</td>
<td>22</td>
</tr>
<tr>
<td>Felixton</td>
<td>415061</td>
<td>19</td>
</tr>
<tr>
<td>Umfolozi</td>
<td>361622</td>
<td>7</td>
</tr>
<tr>
<td>Komati</td>
<td>345133</td>
<td>74</td>
</tr>
<tr>
<td>Total</td>
<td>2408186</td>
<td>30%</td>
</tr>
</tbody>
</table>

Source: South African Cane Growers’ Association

**SYSTEMS ANALYSIS**

By carefully analysing cane production systems it is often possible to improve both machinery productivity and utilisation and thereby reduce overall system costs. An example of such a analysis is presented in Figure 3, where the introduction of a mechanical loading system and a reduced haul-out distance reduced the number of haul-out tractors by 50% and total cane handling costs by about 20%. (R6.2 = 1 US $)
The concept of self-drive hire is being successfully used by small farmers in Portugal (Hudson, 1986).

Self-drive hire pays the supplier whilst adding a small "hire commission." In contrast, the supplier and consumer are independent. The self-drive hire contract is a written agreement outlining the terms and conditions of the hire. The supplier is paid in advance, and the consumer is responsible for returning the equipment in good condition.

Mechanized farming can be expensive, and the costs can be reduced by minimizing machine idle time. The use of machinery can result in increased mechanization and reduced labor costs. Alternative methods of achieving optimal machinery utilization are discussed below.

**Figure 3:** Summary of alternative can handing systems

<table>
<thead>
<tr>
<th>Alternative 1</th>
<th>Alternative 2</th>
<th>Alternative 3</th>
<th>Existing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cut &amp; Stalk</td>
<td>Cut only</td>
<td>Stalked</td>
<td>Cut only</td>
</tr>
</tbody>
</table>

**Harvesting System Cost** (Rand)

- **Harvesting System Cost**
  - Alternative 1: 12
  - Alternative 2: 14
  - Alternative 3: 16
  - Existing: 20

**Syndication and Co-operation**

Mechanized farming is common in some countries, but the costs can be reduced by utilizing machinery effectively. The use of machinery can result in increased mechanization and reduced labor costs.
CONCLUSIONS

The standard of machinery management largely determines the cost effectiveness of all sugarcane production systems. This paper has highlighted numerous ways by which machinery performance can be improved and operating costs can be reduced. The main factors affecting machinery performance and utilisation are management related, such as planning and system analysis, while costs can be reduced by operator training and by implementing effective servicing and preventative maintenance programmes.

REFERENCES


MEJORAMIENTO DEL DESEMPEÑO Y UTILIZACION DE LAS MAQUINAS PARA MINIMIZAR COSTOS

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RESUMEN

Los costos ligados con la maquinaria típicamente contribuyen hasta un 50% de los costos de producción de caña. Con los costos crecientes de la maquinaria agrícola, los márgenes de utilidad decrecen, lo cual hace muy importante mejorar el desempeño y utilización de las máquinas. Se discuten algunos métodos para el mejoramiento, que pueden resultar en costos reducidos de la mecanización.

OPTIMISER L’UTILISATION DES MACHINES POUR EN REDUIRE LES COÛTS

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RÉSUMÉ

En culture de canne à sucre, l’expérience montre que les coûts de mécanisation représentent environ 50% des coûts de production.

Avec la diminution des marges de profits souvent due à une augmentation des coûts de mécanisation, il devient important d’optimiser l’utilisation des machines. Quelques approches d’amélioration visant à diminuer les coûts de mécanisation sont traités dans ce document.

MC: canne à sucre, machinisme, performance, utilisation et coût