SECTION TEN

Machinery Operations

Contents

SECTION 10:
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KEY CONCEPTS

- Mowing is one of the highest maintenance costs in golf course operations.
- Mowing can produce significant noise pollution with neighbouring properties and requires new strategies in mowing practices.
- Maintenance of machinery should focus on ensuring optimal performance as well as minimising pollution
- There are alternatives to mowing including:
  - Use of growth retardants
  - Revegetation of play areas

10.1 INTRODUCTION

The operation of golf course facilities depends on the use of specialised machinery and in particular mowers, to produce surfaces that are suitable for the game of golf. Mowing is the most frequently undertaken operation and the use of mowers raises issues of noise and air pollution and energy use.

Some form of mowing is undertaken every day, providing that conditions permit the operation of mowers (e.g. wet weather can stop mowing operations). As a consequence, mowing and the associated labour costs can make up a significant proportion of the annual maintenance budget.

10.2 MOWING

Mowing regularly with the correct equipment that is well maintained is one of the key components in providing high quality turf surfaces. Turf areas that are infrequently mown or cut with poorly maintained equipment present unsightly, scalped and non-uniform surfaces that inhibit the game from being played at its best.

10.2.1 Costs associated with mowing

Minter Research (undated) was commissioned by Ciba Australia to determine the costs associated with mowing golf course fairways and roughs. The research was undertaken using a telephone survey of 25 golf courses in each of Queensland, NSW and Victoria. This survey was undertaken due to a lack of definitive costings on mowing and how mowing costs compare to the use of a growth retardant.

The cost of mowing was determined by examining all the inputs including:

- type and size of golf course
- frequency of mowing
- man hours taken to mow
- average wage rates
- cost of clippings disposal

- number and model of fairway and rough mowers
- replacement cost of mowers
- life expectancy of mowers
- total maintenance costs for mowers
- fuel costs
- insurance costs
- management measures to mitigate for noise

There is a wide range of variables that affect the cost, including wages, mowing time and equipment. There are also different costs according to the climate in different areas. The variables identified that have most impact are:

- mowing frequencies
- seasons, (i.e. the length of each growing (mowing) season in each area)
- man hours to mow, (i.e. the time taken by staff to mow one hectare of fairway or rough)
- the other main costs were maintenance and depreciation.

Fairway mowing was considered to be a lower cost operation compared to mowing roughs because it is relatively simple due to the lack of obstacles. On the other hand, rough mowing requires more maneuvering due to trees and other non-cut areas.

Two mowing seasons were identified with the peak mowing season being summer, with secondary being spring and autumn. There was little difference in regard to the variety of turf being mowed.

The mowing costs for New South Wales are detailed as follows:

Monthly mowing frequency — fairways

Peak	12/month
Secondary autumn	6/month
Secondary spring	6/month

Monthly mowing frequency — rough

Peak	6/month
Secondary autumn	3/month
Secondary spring	3/month

Hours required to mow fairways and roughs

	Fairways	**Roughs**
Peak	0.64 hrs/ha	2.22 hrs/ha
Secondary	0.64 hrs/ha	1.78 hrs/ha

Table 10.1: Cost per hectare per month — Peak

	Fairways	**Roughs**
Direct Costs		
Wages Labour Burden Clippings Disposal Maintenance	$83.25 $24.98 $0.00 $43.94	$208.13 $62.44 $0.00 $43.94
Sub Total	**$152.17**	**$314.51**
Equipment		
Depreciation Insurance	$28.44 $0.57	$28.44 $0.57
Sub Total	**$29.01**	**$29.01**
TOTAL	**$181.18**	**$343.52**

Table 10.2: Cost per hectare per month — Secondary

	Fairways	**Roughs**
Direct Costs		
Wages Labour Burden Clippings Disposal Maintenance	$41.63 $12.49 $0.00 $43.94	$104.06 $31.22 $0.00 $43.94
Sub Total	**$98.06**	**$179.23**
Equipment		
Depreciation Insurance	$28.44 $0.57	$28.44 $0.57
Sub Total	**$29.01**	**$29.01**
TOTAL	**$127.07**	**$208.24**

Table 10.3: Cost per cut per hectare — Peak

	Fairways	**Roughs**
Direct Costs		
Wages Labour Burden Clippings Disposal Maintenance	$6.94 $2.08 $0.00 $3.66	$17.34 $5.20 $0.00 $3.66
Sub Total	**$12.68**	**$26.21**
Equipment		
Depreciation Insurance	$2.37 $0.05	$2.37 $0.05
Sub Total	**$2.42**	**$2.42**
TOTAL	**$15.10**	**$28.63**

Table 10.4: Cost per cut per hectare — Secondary

	Fairways	Roughs
Direct Costs		
Wages Labour Burden Clippings Disposal Maintenance	\$6.94 \$2.08 \$0.00 \$7.32	\$17.34 \$5.20 \$0.00 \$7.32
Sub Total	**\$16.34**	**\$29.87**
Equipment		
Depreciation Insurance	\$4.74 \$0.09	\$4.74 \$0.09
Sub Total	**\$4.84**	**\$4.84**
TOTAL	**\$21.18**	**\$34.71**

10.2.2 Cost effective alternatives to mowing

Mowing is a critical and large part of golf course operations and is an area that offers good opportunities to increase eco-efficiency. Decreasing the amount of mowing will provide clear environmental (as well as economic) benefits. These include a reduction in the use of resources (eg fuel), decreased maintenance and upkeep requirements, a decrease in the number of times machinery needs cleaning, a decrease in the amount of green waste generated etc. The following are some practical steps to reduce mowing.

10.2.2.1 Rough maintenance

The most obvious opportunity is to reduce the area that is mown. This is going to be restricted to the roughs, which represent a higher cost per mowing per hectare than fairways. Roughs are often a controversial area on the golf course because roughs that are poorly maintained or have grass which is too long, result in slow play, lost balls and frustrated golfers. It is therefore important for each golf course that a policy on roughs is established and for each golf hole, 'no-mow' areas are identified. On golf holes that have large areas of grassed, open space that is out of play, considerations should be given to re-vegetating with native plants that do not require mowing. Native Australian vegetation will provide additional benefits such as attracting or increasing native birds and other native fauna.

In a US study (Sims, 1998), the costs of maintaining roughs were analysed for the Selma G.C in Alabama. The issues in this case were:

- appearance (needed to be manicured)
- clippings
- pine cones and leaf litter
- weed control

The golf course has a budget of about \$500,000 with six full time personnel plus casuals. The grass type is predominantly Tifton 419 and common couchgrass. The labour and costs were calculated for the existing operations, including;

- mowing – 1,280 worker hours
- sweeping and blowing pine straw and leaves – 1,344 worker hours
- removing pinecones and debris – 624 working hours.

Pinecones, limbs, leaves etc. have to be disposed of without burning due to environmental restrictions.

In this situation the solution was to purchase a mulching mower (where traditionally a cylinder mower was used). The mulching mower mulched up leaves, pinecones and pine straw, there was reduced equipment maintenance, the process was quicker and the appearance improved. The cost comparisons are in Table 4.5.

Table 10.5: Cost comparisons of conventional rough maintenance compared to mulching

Practice	Time & expense of conventional methods	Time & expense of mulching	Savings with mulching	% Saving
Mowing roughs	1280 * $12, 288	1280 $12, 288		
Sweeping & blowing leaves & pinecones	1344 ** $12,902	672 $6, 451	672 $6, 451	50%
Pine cones & debris	624 *** $5, 990		624 $5, 990	100%
TOTAL	**3, 248 $31,180**	**1952 $18, 739**	**1296 $12, 441**	**40%**

* *Mowing hours did not decrease, however, width of mulching unit allowed 2 mowings/week*
** *Able to eliminate the equivalent of 2 workers, 3 days a week for 28 weeks*
*** *Able to eliminate the equivalent of 3 workers, 4 hours a day, one day a week for 52 weeks*

While the cost comparisons may not be directly comparable to New South Wales conditions, they do provide a good example of the process of determining current operating costs and how to compare alternative methods.

10.2.2.2 Growth regulators on fairways

Plant growth regulators (PGR) have been in use for many years, however, there has not been a wide adoption of their use because of:

- visual aesthetics (turf yellowing)
- growth suppression varies between plant species
- lack of turf recovery in high wear areas
- cost
  (Ohlson,1996)

There has been considerable research undertaken on determining the advantages of using PGRs and in particular the reduction in mowing and the associated costs. Johnson (1994) treated Tifway couchgrass with trinexapac- ethyl and found that vegetative growth was suppressed for 12 weeks and the number of mowings reduced by up to 70%.

Although chemical mowing is unlikely to replace mechanical mowing PGRs can reduce the mowing frequency. Johnson (1992) indicates a reduction in the number of required mowings and the associated labour, fuel and maintenance costs.

The market research undertaken by Minter Research compared the cost of using a PGR, trinexapac-ethyl (Primo®), with the costs of conventional mowing. Their research found that Primo® could reduce the growth rate of the turf by 50% for between 4 and 6 weeks. They have then assumed a maximum reduction in mowing of 50 percent.

COMPARISON OF COSTS OF MOWING WITH THE USE OF PRIMO®

Fairways

- Monthly cost of mowing is $181.18/ha in peak season
- Cost of Primo® based on $189.00/litre (5L container)
- Application rate and costs
  - Kikuyu (800ml/ha): $151.20/ha
  - Common couch (400ml/ha): $75.60/ha
  - Hybrid Couch (300ml/ha): $56.70/ha
- Cost savings based on reducing mowing by 50%
  - 4 weeks growth reduction: $84.97/ha
  - 6 weeks growth reduction: $127.46/ha

Roughs

- Monthly cost of mowing is $343.52/ha
- Application rate and costs
  - Kikuyu (800ml/ha): $151.20/ha
  - Common Couch (500ml/ha): $94.50/ha
  - Hybrid Couch (500ml/ha): $94.50/ha
- Cost savings based on reducing mowing by 50%
  - 4 weeks growth reduction: $97.70/ha
  - 6 weeks growth reduction: $146.55/ha

10.2.2.3 No-mow areas

All golf courses have areas that are unlikely to come into play but still require maintenance in order to maintain the visual aesthetics. Depending on the style of the golf course and the vegetation/landscaping plan, there is usually scope to change the vegetation type in ‘non-play’ areas to a less maintenance intensive species. For example planting out areas to native grasses that may require slashing 1 to 2 times a year or to other native shrubs and trees.

CASE STUDY

At Gainsborough Greens the managed areas have been reduced by 15% through revegetation of grass areas.

The costs involved were:

• Purchase of a tree spade to move trees from heavily planted areas	$15,000
• Purchase of additional trees, labour and fertiliser	$ 5,000

The savings have been in not having to mow the planted areas:

- Time	6 hours/cut
- No. of cuts/month	2
- Cost (based on Minter Research of $16.03-$31.37/cut)	$384-$752
- Fertiliser	$500

The savings in dollar terms are relatively small, however, there has been an improvement in the visual aesthetics and 144 hours of labour that can be allocated to other tasks around the golf course.

To determine the potential for cost savings in mowing the golf course, an audit of the golf course layout and the time and costs associated with mowing the various areas needs to be conducted. A checklist can be used as part of the audit process.

Table 10.6: Golf Course Mowing Audit

	Fairway	Rough	Green	Out of play areas
1. Area (ha)				
2. Surface quality required				
3. Frequency of mowing (mowings/month)				
4. Time per mowing (hrs/mowing)				
5. Labour costs per mowing ($/mowing)				
6. Fuel cost per mowing ($/mowing)				
7.Equipment maintenance costs				
8.Depreciation on equipment				
9. Insurance				
10. Machinery tasks other than mowing e.g. - vacuuming & disposal of clippings - cleaning up of limbs, leaves, pine cones				
11. Potential for implementing other options (L, M, H)* - PGRs - Reduced cutting frequency - Change vegetation type - Change machinery type				

** L=low, M=medium, H=high*

10.3 MACHINERY NOISE

Many golf courses are within urban areas and are often constructed in conjunction with housing sub-divisions. Noise from operating machinery is an increasing concern as it affects the operation of the golf course.

Council authorised officers are likely to be the first point of contact for many enquiries or complaints about noise. It is good policy for golf superintendents to discuss such issues with their local council officer and seek ways to minimise such disturbance.

Councils may consider that machinery noise significantly impacts adjacent residential premises and may issue a Notice to the golf club to control the level of noise. Two forms of Notice are possible, a Prevention Notice and a Noise Control Notice.

The Prevention Notice is designed to control actions that result in noise and may require the production of an environmental management plan as a first step where it is initially unclear what management actions are required to reduce noise below what council consider undesirable. There are administrative costs payable by the golf club for the issue of this Notice plus compliance costs that are detailed in an associated Compliance Cost Notice. There may be additional costs in managing mowing activities in compliance with the notice as they may involve mowing sensitive areas at particular times which may have efficiency implications for the use of resources.

A Noise Control Notice seeks to control noise by stipulating a noise level not to be exceeded at a specified point, usually a residential property boundary and is used when the solution to the noise problem is simple. In issuing this Notice council needs to be clear that such a level is achievable and represents reasonable protection for residents. Again this Notice may have efficiency implications for the management of the mowing resource.

There is available an electric greens mower and this type of machine may provide an alternative to petrol and diesel powered mowers in some situations. At the Riverside Golf Club (South Australia), a Ransomes Eplex 2 electric mower is used for the express purpose of minimising noise disturbance on adjoining properties. The cutting reels of mowing equipment can also provide a high level of noise if not adjusted correctly or beeded in.

10.4 POLLUTION AND ENERGY ALTERNATIVES

General pollution issues related to noise, emissions, wash down areas and machinery maintenance facilities are requiring golf courses to upgrade facilities and machinery manufacturers to develop new ‘low pollution’ machinery.

In response to environmental issues such as leaks, emissions and noise, machinery companies are now investigating alternative energy sources. The TORO company have produced the following information detailing the alternatives that they are investigating.

Batteries: The energy needed by the machine is provided by a collection of batteries. The number of batteries is determined by the voltage that is desired. Typical voltages are either 36 or 48 volts.

Advantages	Disadvantages
• Zero emissions • No hydraulic leaks • Conventional technology (lead acid) • Similar to golf cars • Low maintenance required • Energy source generates no noise	• Heavy and bulky • Short run times -50 to 100 times less than gasoline (on a weight basis) • Long recharging time (typically overnight) • Advanced (non-lead acid) batteries are still developmental

CNG/LPG: The energy source for a conventional engine is either compressed natural gas or liquefied petroleum gas. Both CNG and LPG are a conventional hydrocarbon fuel, but they burn cleaner than gasoline.

Advantages	Disadvantages
• Lower emissions • Longer engine life • Less engine maintenance e.g. fewer oil changes • Fuel readily available (natural gas or propane) • Technology available today	• Tanks are bulky and heavy • More frequent refueling required • More difficult fueling procedure • New fuel storage infrastructure required • Additional cost in engine fuel system • Engine must be larger to produce the same horsepower

Fuel Cells: Fuel cells are electro-chemical devices that are similar to lead-acid batteries. They use different chemical reactions to generate electricity. The two reactions that are being aggressively worked on today are the hydrogen-oxygen reaction and the zinc-oxygen reaction.

Advantages	Disadvantages
• Zero emissions • Quiet • More energy per pound of weight than lead-acid batteries • Easily and quickly refueled	• Developmental (not yet available) • Safety questions • New infrastructure to deliver the fuel • More difficult fueling procedure • Slow to respond to varying loads • Currently expensive

Genset: The machine can be powered by an engine combined with a generator set. The engine supplies the energy which is converted to electrical energy by the generator. Electrical energy then powers the machine via electric motors.

Advantages	Disadvantages
• No hydraulic oil leaks • Easily re-fuelable • Loading on the engine is smooth • Easily controlled • Burns commonly available fuels (gasoline or diesel)	• Engine has emissions and noise similar to engine driven product • Electric drive system more costly than conventional drives

Hybrid: A hybrid combines the best features of two energy sources. For example, the primary energy source (a genset or a fuel cell) is sized to be capable of supplying the average power that is needed. Additional peak load requirements, such as climbing hills, are supplied by lead acid batteries. The primary energy source acts as a battery charger to charge the lead-acid batteries whenever the loads are below average.

Advantages	Disadvantages
• Engine runs at constant load and speed can he optimized to perform best under those conditions • When no load is demanded, no energy is consumed • Potential for low emissions and high efficiency • Long runtime between refueling • Easily refueled • Lighter than battery only • Engine powered version could be done with today's technology • No hydraulic fluids to leak • Stealth mode (battery only mode) possible	• More costly than engine only or battery only • Heavier than engine only • More bulky than engine only • Fuel cell version requires some technological development in fuel cells to be possible

While most of this work is still developmental it does provide a vision for the future.

10.5 MACHINERY MAINTENANCE

It is difficult to find any detailed information related to the eco-efficiency of machinery maintenance. However, the following points can be made (*Australian Turfgrass Maintenance*, 2001):

- Good maintenance reduces machinery downtime. Machinery downtime increases costs because employees who don't have use of the machine are being paid while not performing work.
- Well-maintained machines remain in service longer, reducing the cost-per-year figures for the individual type of machine.
- Well-maintained machines command a higher trade-in or sale price. This factor alone may compensate entirely for the increased costs imposed by increased maintenance schedules and investment in parts (more filters for more frequent oil changes.)
- Finally, there's the intangible factor that employees much prefer working with efficiently-running, well-maintained machines which do a better job. They may perceive greater respect from their employer as a result of giving them good equipment to use. They may also treat the machine with greater respect, and thus may be involved in fewer cases of damaging the machinery by indifference. This last one is difficult to quantify, but might be the most important factor of all, since human error and machinery abuse are so costly.
- Properly maintained machines will always pollute less.
- It is well known that properly sharpened mowers (whether reel or rotary) produce a more uniform cut while causing less stress to turf plants which in turn may require less fertiliser and fewer pesticides to maintain vigor.

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