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A comparison of hay conservation systems

By E. E. Rowley,
Agricultural Adviser,
Merredin

The high cost and shortage of farm labour in the Esperance District is posing serious problems for farmers using traditional hay conservation systems. Author Ted Rowley, then an adviser with the Esperance District Office of the Department of Agriculture surveyed a number of farms to study the economics of various alternatives. This article is a summary of his report presented to a 1976 Fodder Conservation Workshop.

Fodder conservation has always been a job that demands a high labour input—but high labour and other costs are now forcing farmers to seek fodder conservation systems other than the traditional baling and hand hauling ones.

The alternatives must have lower costs and labour requirements, but must also maintain the quality of conserved fodder. They should allow the harvesting and handling/storage of larger quantities of fodder in a shorter time than do traditional systems.

Traditional baling
Traditional baling systems are still the most commonly used in the Esperance district but costs have become a serious problem, especially for large farms requiring more than 200 tonnes of hay a year. The major labour cost is associated with the hand hauling, storing and feeding operations.

Cost differences between the self-propelled and power take off baling systems result mostly from capital cost difference between balers (Table 1), as there is little difference in baling capacities.

Stacking wagons
Loose hay stacking wagons are becoming increasingly popular and a
junction with stack wagons is similar to that used with traditional balers. The 5-tonne stack wagon considered here (Table 1) is actually a stacker and mover in one (McKee Stacker and Mover), while the 1- and 3-tonne stack wagons are used with 1- and 3-tonne stack movers (Hesston, 1- and 3-tonne stackhands and movers).

Labour requirements and hence labour costs (Figure 2) decrease for stack wagons as their size increases because of relative working capacities (Table 1). The total cost per tonne (Table 2) of hay made by the three stack wagons reflect their capital costs (Table 1) at the 100 and 400 tonne annual production levels, but there is little cost difference at the 800 tonne production level.

Feeding losses and nutritive values are also important but Esperance district farmers estimate that wastage from different sized stacks is similar and within the range of 5 to 15 per cent. of dry matter (20 per cent. moisture content).

Wastage depends on the type and site of the feeding system, stack condition, and the type and quality of hay. It can be minimised by producing a dense, well shaped stack, and by closely controlling the amount of hay available to livestock at any one time. Where control is poor, on poorly drained sites, farmers' estimates suggest that trampling losses can reach as high as 45 per cent.

Successful stacks (or bales) can be made from a wide variety of forages including vetches, lucerne, cereals, fodders such as Sudan grass and pasture. However, for satisfactory storage and feed quality, stemmed and pasture hay needs conditioning to assist field drying and improve stackability. The moisture content of windrowed hay for stacking should be the same as (or slightly higher than) that for baling.

Most problems with stacks arise from stacking at too low a moisture content. Although extra compression may compensate to some extent for this, such stacks are light, unstable and prone to wind erosion.

To form a stable stack cereal forages such as oats and barley should be stacked in the morning or late afternoon. In spite of this, cereal stacks often lack sufficient cohesion to remain together after unloading and it may be necessary to prevent blowing by methods such as spraying the roof of the stack with a mixture of water and molasses (ratio 3:1). As most stacks have a tendency to fall apart if lifted and moved immediately after stacking it is advisable to allow a 48-hour settling period.

**Fodder rolls**

The commonest roll baler is the Econ fodder roller, which produces rolls weighing about 110 kg. Bales of about 900 kg are produced by bigger balers such as the New Holland, International and Gelh, although bale weight obviously depends on bale dimensions and the type of material rolled into the bales.

Roll balers can generally be categorised according to whether they roll the windrow up on the ground, or pick up the windrow and roll it between a series of belts in the machine. Belt types may also wrap string around each bale to make it more stable.

The gentle action of roll balers when handling crops like lucerne reduces the loss of leaf material and hence maintains hay protein content.

The same preparation and windrow moisture content is required for roll baling as for loose hay stacking. Feeding out is also similar and roll
Loose hay stacking wagons lift the windrow and produce a compressed stack for paddock storage and or transport.

Besides reducing labour requirements roll balers have a gentle action which reduces leaf loss and maintains protein content of conserved materials.

bales can be left in the paddock to be fed out by truck, tractor or a system of temporary fencing.

The feeding precautions are essentially the same as for loose hay stacks. Feeding losses are minimised by forcing stock to clean up the rolls within seven days, feeding on a well drained and sloping site, and, if possible, from some sort of bin (such as part of a water tank). Whether the bales are fed singly on site by controlled fencing, or by hauling to a feeding site, farmers estimate feed losses to be about 10 per cent. of dry matter (20 per cent. moisture content).

Costs for roll bales (Table 2) have been calculated using paddock-corner storage and haulage by truck and tractor (front-end loader) to and from the storage site.

Losses at well drained storage sites can be further reduced by placing the rolls in rows to reduce wind damage, and with sufficient space between rolls to allow water run-off. Trials have indicated that small fodder rolls lose about half their dry matter during an open storage period of nine months—about the same as traditional bales—and it is suggested that where more than six months’ storage is anticipated some form of cover is necessary. Between three and six months’ open storage will cause losses of about 17 and 20 per cent. dry matter for small rolls and traditional bales respectively.

Large square bale system
The Howard Big Baler produces large square bales of about 450 kg and consisting of numerous small bales which have been compressed, in a cage, into a combined square bale. The large bale is held together with string but the process allows the smaller hay ‘lots’ to be easily removed and fed out. The technique is more suited to bin feeding than straight paddock feeding where animals tend to scatter the small units and cause considerable wastage.

Square balers are somewhat similar in operation to big roll balers, although more complicated mechanically. They require the same windrow preparation and moisture content as for fodder rolls and traditional bales, but the square bale lacks a well ‘thatched’ roof and is more weather susceptible than loose hay stacks or big rolled bales. Unless they are well compressed it appears that the ‘mini’ bales making up the square bale allow water to run down into the bale and cause spoilage.

An advantage is that the square shape allows vertical stacking up to three high, which can reduce weather damage and space requirements.

Comparing the conservation systems
Hay conservation systems can be compared economically by examining break-even annual tonnages, that is by comparing the minimum annual tonnage costs associated with a proposed conservation system, with equivalent costs for the same quantity of hay conserved by a traditional (P.T.O.) baling system. Alternatives are listed below:

<table>
<thead>
<tr>
<th>Hay conserved per year</th>
<th>0-99 tonnes</th>
<th>100-199 tonnes</th>
<th>200-299 tonnes</th>
<th>300+ tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>System with costs similar to traditional baling</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Big roll bale</td>
<td>1 tonne stack</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large square bale</td>
<td>3-tonne stack</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small roll bale</td>
<td>5-tonne stack</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* There is no tonnage at which small roll bale conservation costs more than traditional baling. Thus substantial savings could be made by using a small bale system rather than traditional (P.T.O.) baling at any production level.
At conservation levels greater than these breakeven figures, substantial savings can be made by using the system suggested rather than continuing with traditional baling. For example, at a 400 tonne production level the cost of traditional (P.T.O.) baling would be $8 028 compared with $7 280 using a 1-tonne stack system (a saving of $748 a year), or with $7 212 using a 5-tonne stack system (a saving of $816).

Table 2 and Figures 1 and 2 show costs associated with each system, and how these compare with each other. Initial capital costs of the balers for each system are reflected in the high cost structure at lower production levels, while at higher levels cost factors associated with repairs, maintenance and machine capacities become relatively more important. At high production levels the time taken for harvesting and storage also becomes important.

Table 1 shows the tonneage capacities per hour for different operations within each system but as labour costs are indirectly related to machine capacities the labour costs in Figures 1 and 2 reflect the total capacity of any system.

Capacity figures for baling operations are only half the story, as hauling and storing requirements tend to be more important. Smaller bale systems (small fodder rolls or traditional bales) have low capacities for later stages in conservation operations and hence conserved material usually suffers weather damage and quality loss while sitting in the paddock waiting to be hauled and stored. High labour costs associated with small bale systems are mainly caused by this high manpower requirement during haul-

Table 2—Costs of hay conservation systems
($ per tonne at 100, 400 and 800 tonne annual production levels)

<table>
<thead>
<tr>
<th></th>
<th>Mower conditioner</th>
<th>Rake</th>
<th>Slasher</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(haybine)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>13-32</td>
<td>3-08</td>
<td>5-87</td>
</tr>
<tr>
<td>400</td>
<td>5-66</td>
<td>1-27</td>
<td>3-07</td>
</tr>
<tr>
<td>800</td>
<td>4-24</td>
<td>0-97</td>
<td>2-05</td>
</tr>
<tr>
<td>(includes haybine)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional baling</td>
<td>37-17</td>
<td>4-95</td>
<td>3-64</td>
</tr>
<tr>
<td>(P.T.O.)</td>
<td>17-68</td>
<td>3-92</td>
<td>3-92</td>
</tr>
<tr>
<td>1 tonne stack-wagon</td>
<td>22-93</td>
<td>3-16</td>
<td>3-60</td>
</tr>
<tr>
<td>3 tonne stack-wagon</td>
<td>32-55</td>
<td>5-60</td>
<td>5-60</td>
</tr>
<tr>
<td>5 tonne stack and mover</td>
<td>24-96</td>
<td>9-50</td>
<td>9-74</td>
</tr>
<tr>
<td>114 kg fodder rolls</td>
<td>8-46</td>
<td>3-72</td>
<td>3-77</td>
</tr>
<tr>
<td>450–680 kg fodder rolls</td>
<td>21-50</td>
<td>1-28</td>
<td>3-62</td>
</tr>
<tr>
<td>450 kg large square bale</td>
<td>21-99</td>
<td>1-28</td>
<td>3-62</td>
</tr>
</tbody>
</table>

Fig. 1.—Conservation costs for new vs traditional baling systems—$ per tonne.
ing, storage and feeding out. Labour costs for larger bales are considerably reduced because one or two high capacity machines do the hauling, storing and feeding operations.

Break-even tonnages can be found for any system compared with any other system. Comparing the 1-, 3- and 5-tonne stacking systems (Figure 2), the 1-tonne system can be seen to cost least up to the 370 tonne level, with the 5- and 3-tonne systems becoming less expensive at the 370 and 570 tonne levels respectively. Small cost per tonne differences between the 3- and 5-tonne stacking systems are mainly brought about by their different working capacities during baling, hauling, storing and feeding-out operations.

Big roll bales and the 3- and 5-tonne stacking systems break even with small roll bales at about the 390, 580 and 650 tonne annual production levels respectively. However the small bale systems have a moderately high labour requirement and the bales are difficult to store. Major factors affecting costs of small bale systems are the low capital costs of balers, and their extended working life resulting from relatively simple design and few working parts. Economically however, they best suit production levels of less than 390 tonnes per year.

Over 390 tonnes per year, the big roll bale system is least expensive. It is similar to the large square bale system, apart from cost differences due to capital costs of the two balers and their different labour requirements/costs. The large square baler has the added disadvantage of string ties around the bales, although of course these can also be found on some big roll bales. (Costs for the large square balers have also included a front-end-loader transporter attachment and counterweight.)

Large square bale systems have a similar cost and labour requirement per tonne to the 1-tonne stacking system, the slightly higher cost of the large square bale system resulting from the higher capital cost of its baler. The 3- and 5-tonne stack systems break even with the large square baling system at the 640 and 550 tonne production levels respectively.

Discussion
Apart from economic aspects of different conservation systems, their capacities and labour requirements are of prime importance.

In a short hay season any system chosen to harvest and store hay must have enough capacity to complete the operation without losing hay quantity or quality through weather damage. Larger bale systems have distinct weather-proofing advantages over small bale systems, and the small bales tend to be left in the paddock and suffer further damage, especially in a low-labour situation such as a one man farm.

Depending on labour availability, small bale systems are probably best restricted to operations requiring handling of less than 250 tonnes of hay a year, being cheaper than traditional bales but posing some hauling and storage difficulties.

Large bales and stacks are less susceptible to weather damage if left in the paddock and their capacities for hauling, storage and feeding out are considerably better than those for small bales. If stored carefully, loose hay stacks (1-, 3- and 5-tonne) preserve hay quality for at least one
season, and probably sufficient quality during a second season for most purposes.

Large square bales should also last through to the second season if stacked three high, but big round bales are difficult to stack vertically and do not have the same weather proofing as loose hay stacks. Although storage potential for big roll bales was not tested at Esperance it seems likely that they would sustain severe weather damage in open storage without some protective cover.

Silage and haylage were also considered in this comparison but results are not presented here because these materials appear to have little future under Esperance conditions. Although silage is often thought of as cheap fodder storage, comparison with hay systems showed it to be more costly per tonne than traditional baled hay at any production level, and using any silage storage technique. Haylage had a break-even tonnage with traditional bales at about the 760 tonne annual production level, and with loose hay stacking systems only at about the 870 to 880 tonne level.

It must be emphasised that no bale, roll, stack, pit or silo will improve the quality of material placed in it. At the very best, any conservation system can only maintain that quality which the maker puts into his system.

References

NOTE—Although some costs have changed since this article was written, alterations have not been sufficient to change the conclusions drawn from the original comparisons.

Labour and handling requirements make up much of the cost of traditional hay conservation systems. Recent equipment is helping reduce these costs on many large farms.