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Chris Oldham
Greg Allen
Peter Moore
Bruce Mattinson

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Animal production from *tagasaste* growing in deep sands in a 450 mm winter rainfall zone

By Chris Oldham¹, Greg Allen² and Peter Moore³, Martindale Research Project, University of Western Australia, Nedlands and Bruce Mattinson, Integrated Tree Cropping Pty Ltd, Albany

In 1985, Martindale Pty Ltd, Sir James McCusker’s family company, signed a unique research contract with Professor David Lindsay of the University of Western Australia.

The *aim of the Martindale Research Project* was to study ways of increasing farm productivity in the sheep-wheat zone of south-western Australia. A primary focus was the high cost of grain or hay used to fill the autumn feed gap in grazing systems.

It was clear from the outset that *tagasaste* could be established from seed on deep infertile sand and would persist over summer without rain. These facts were irrefutable and evidenced by the 60,000 trees standing two to three metres high in paddock 20 at Newdale, Martindale’s farm at New Norcia, 130 km north of Perth.

However, it was not clear how or if *tagasaste* might be economically used to replace the grain and/or hay used to fill the autumn feed gap in grazing systems.

In all the tables the standard error of the mean (sem) is shown to give an idea of the variability of the character being measured. In general, if two means differ by more than three times the sem they are likely to be significantly different.

Research at Newdale

At Newdale, New Norcia, the *tagasaste* was established as single rows of trees about five metres apart, giving about two kilometres of *tagasaste* hedge or between 1000 and 2000 trees per hectare. The original stand of *tagasaste* was sown into an area of very deep white to yellow sand (greater than 15 m of sand) in May 1983.

In the system of direct grazing developed at Newdale, sheep are not conditioned to grazing *tagasaste* in any way. At Newdale, the stocking rate is estimated using a yield of 3000 sheep grazing days per hectare from 10 months of regrowth divided by the required number of grazing days. Once grazing has started the defoliation of the trees (see Photo 1) is observed regularly. When a clear grazing line has been established at about 1.2 m above ground (Photo 2) the hedges are cut at about 0.5 m (Photo 3).

So far bark-stripping has only been a minor problem, and only when cutting has been delayed too long. Sheep are removed as soon as the cut material has been eaten (Photo 4).

Initial cutting and grazing studies conducted from 1985 to 1987 gave yields of 3000 kg of edible dry matter or 3000 sheep grazing days per hectare per year respectively (Southern 1988; Oldham and Mattinson 1988). These yields were four times higher than the 700 sheep grazing days per hectare per year (two dry sheep equivalents (DSE)) obtained from annual pastures on the same paddock in previous years.

Young ewes or young store cattle grazed on *tagasaste* for 31 weeks (from 22 October 1986 to 27 May 1987) grew slowly. The ewes gained about 60 g/head/day and the cattle 150 g/head/day compared with flockmates or herdmates that slowly lost weight grazing dry pasture with a supplement of lupin grain in autumn.

The growth rates of sheep and cattle grazing *tagasaste* are much less than the estimates suggested by the chemical analysis of the edible leaf and stem. This suggests that there are other factors in *tagasaste*, for example tannins, that may be lowering its nutritive value when grazed directly from the trees. However, young ewes grew significantly more wool while grazing *tagasaste* than did their flockmates on supplemented dry pasture (Table 1).

South-western Australia has a Mediterranean type climate with predominantly winter rainfall and annual pastures. In most grazing systems, farmers budget for a nominal three months feed gap from late summer to early winter.

Before the early 1991 crash in the wool market, farmers running a self-replacing flock of Merino ewes, budgeted to feed about $2 of grain to weaners and about $3 of grain to ewes to maintain their condition and wool quality during autumn.
LEFT: Photo 1. Ewe weaners grazing 9.5 months regrowth of tagasaste at Newdale.

BELOW: Photo 2. The weaners have clearly marked a grazing line 1.2 m high in the tagasaste. Bushes are now ready for cutting.

Photo 3. Contractors are using machines like this Kimberley Seeds sawblade mower, which can cut tagasaste branches up to 60 mm thick. Annual growth for cutting is usually about 25 mm thick.

Table 1. The mean (± sem) clean fleece weight (CFW) and mean (± sem) fibre diameter (FD) of young ewes grazed on tagasaste or dry pasture over summer/autumn

<table>
<thead>
<tr>
<th></th>
<th>No. of ewes</th>
<th>CFW (kg)</th>
<th>FD (micron)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tagasaste (31 weeks)</td>
<td>27</td>
<td>3.0 (0.08)</td>
<td>21.3 (0.22)</td>
</tr>
<tr>
<td>Pasture</td>
<td>30</td>
<td>2.2 (0.05)</td>
<td>20.5 (0.21)</td>
</tr>
</tbody>
</table>

Table 2. The real return on investment and target returns on investment from tagasaste grazed by weaners in autumn (seven days per week) in place of grain feeding (adapted from Oldham and Mattinson 1988, using market values existing in October 1988)

<table>
<thead>
<tr>
<th></th>
<th>Return on investment</th>
<th>Sheep grazing days</th>
<th>Reduction in sheep grazing days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newdale</td>
<td>23%</td>
<td>3400</td>
<td>0</td>
</tr>
<tr>
<td>Target</td>
<td>20%</td>
<td>3060</td>
<td>340</td>
</tr>
<tr>
<td></td>
<td>15%</td>
<td>2550</td>
<td>890</td>
</tr>
<tr>
<td></td>
<td>10%</td>
<td>2170</td>
<td>1230</td>
</tr>
</tbody>
</table>

Photo 4. Tagasaste bushes have been cut back to 0.5 m and weaner sheep are grazing the cut tops.

When the initial sheep production information from tagasaste was run through a computer model**, designed to combine all resources to maximize income from Newdale, the model selected an optimum solution that included tagasaste grown on deep sand to replace hand feeding in autumn.

On a ‘typical’ sheep and wheat farm in this State, about 10 per cent of the arable area under mature stands of tagasaste, yielding 3000 sheep grazing days per hectare, would be enough to replace the grain fed in autumn.

**Adapted by Bruce Mattinson from the original MIDAS model, a Model of an Integrated Dry Land Agricultural System; David Morrison and Ross Kingwell, Department of Agriculture, Western Australia.

Tagasaste (Chamaecytisus palmensis), known to many in Australia as tree lucerne, is an enigma. Its potential as a fodder tree for animal production has been vigorously promoted by a series of champions, each operating in relative isolation and each dying with their dream of an agricultural revolution based around tagasaste unfulfilled.

Tagasaste is a hardy leguminous shrub or tree that grows three to five metres high. All parts of the stem and branches are enveloped in leaves. Its very leafy character is one of the marked features of this shrub, selected about 150 years ago from the barren volcanic hills on Palma, one of the Canary Islands, located in the Atlantic Ocean, just off the coast of North Africa.

The first champion was Dr Victor Perez, a medical practitioner based in Orotava, Teneriffe. Dr Perez published several extension and scientific papers extolling the many virtues of tagasaste, the first in 1863, and when he failed to attract interest from the Spanish he sent seed to the English via the Royal Botanical Gardens, Kew.

In 1879, Kew distributed samples of seed to the Colonial Governments in Australia, India, New Zealand and South Africa with the following covering letter.

"SIR,
I am sending you through the Colonial Office, a packet of seed of tagasaste. This is a shrub, a native of the Canaries, the leafy branches of which are said to be a useful fodder. It requires a light, dry soil and is rather intolerant of frost in winter. The plants should be placed 6 to 10 feet apart, may be cut 2 or 3 times a year and will last 10 to 20 years. The seeds are very slow in germinating."
(Royal Kew Gardens 1891.)

In 1925, Western Australia's own local champion, Dr Laurie Snook, was introduced to tagasaste as a student at the Narrogin School of Agriculture where it was being grown as shelter and fodder for lambing ewes. In 1947, Dr Snook planted tagasaste on deep sand at Nedlands and began a lifetime of measurement and observation which culminated in the publication in 1986 of his book entitled simply 'Tagasaste'.

have been the most vocal in drawing the attributes of tagasaste to the attention of both farmers and scientists.

A dogma has developed regarding the best techniques for establishment and annual management. However, for all the combined enthusiasm of the various champions over the years there is little objective information on most aspects of the commercial use of tagasaste.

However, many farms in Western Australia have more than 10 per cent of their arable area made up of poorly productive deep sands. In this case, the model selected to grow more tagasaste, up to a limit of about 30 per cent of the arable area, to be grazed by young sheep throughout summer. The selection of this solution recognised that the sheep would not fatten but would grow a significant amount of extra wool. However, the decision to grow extra tagasaste was very sensitive to the quantity of extra wool grown and its mean fibre diameter.

The remainder of this article reports further information with respect to these two options, plus some further data on cattle grazing tagasaste in summer or winter and spring.

Sheep: the 10 per cent option

In 1988 and 1989, studies of sheep grazing tagasaste confirmed our original estimate of about 3000 sheep grazing days per hectare for 10 months of regrowth of tagasaste.
In April 1988, 288 weaners, with an average liveweight of 30 kg, took 47 days to completely graze four hectares of tagasaste. This represented a yield of 3400 sheep grazing days per hectare.

In April 1989, a two-hectare plot of tagasaste, in the same area of tagasaste that was used in 1988, maintained 40 weaners per hectare at about 35 kg liveweight for 100 days. This represented a yield of 4000 sheep grazing days per hectare.

When we used a yield of 3400 sheep grazing days per hectare, the estimated real return on the investment in tagasaste was 23 per cent (Table 2). If the yield was reduced to about 2000 sheep grazing days per hectare the estimated return was still a respectable 10 per cent.

'Rationed grazing' of tagasaste, that is grazing the plantation less than seven days per week, can greatly increase this yield.

Recent studies by Jim Rowe and others at the Western Australian Department of Agriculture have shown conclusively that feeding grain supplements to sheep in autumn, once a week or once a fortnight, maintained their liveweight and wool quality as well as did daily feeding of flockmates. In all treatments, sheep ate the grain at about a kilogram/head/day. The rationed groups experienced a feast for a day or two once a week or once a fortnight with no detrimental effects.

The same philosophy was tested in two years of experiments of sheep grazing tagasaste at Newdale.

In 1988, we compared production from groups of 15 ewe weaners grazing either dry pasture or tagasaste for seven days, three days or one day per week. When grazing, all groups grazed together in either the tagasaste or the dry pasture paddock. The experiment ran for 20 weeks, beginning in mid January. Between January and May, weaners grazing tagasaste for seven days per week lost 2 kg while those grazing dry pasture lost 5 kg.

Weaners grazing tagasaste for three days or one day per week lost about 3.5 kg (Figure 1).

However, the weaners grazing tagasaste for seven days per week grew significantly more wool without an apparent increase in mean fibre diameter (Table 3).

Encouraged by this result we conducted a much larger experiment in April 1989.

Weaners were allocated at random to the following treatments for a minimum of 78 days:

- 210 weaners per hectare, one day per week in tagasaste.
- 90 weaners per hectare, three days per week in tagasaste.
- 30 weaners per hectare, seven days per week in tagasaste.
- 5 weaners per hectare in a heavily grazed oat stubble seven days per week (control).

Each plot of tagasaste was about half a hectare and there were three replicates of each treatment. When not in the tagasaste plots the weaners in the 'ration-grazing' treatments grazed together on separate subdivisions of the same oat stubble and at the same stocking rate as the control group.

At shearing in August, there was no difference between the four groups in yield of clean fleece or its quality (Table 4).
Table 3. The mean (± sem) clean fleece weight (CFW) and mean (± sem) fibre diameter (FD) of young ewes grazed on tagasaste for seven, three or one day(s) per week or dry pasture over summer and autumn

<table>
<thead>
<tr>
<th>Group</th>
<th>No. of ewes</th>
<th>CFW (kg)</th>
<th>FD (micron)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry pasture only</td>
<td>15</td>
<td>1.7 (0.06)</td>
<td>19.7 (0.34)</td>
</tr>
<tr>
<td>Tagasaste for:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 day per week</td>
<td>15</td>
<td>1.8 (0.06)</td>
<td>19.9 (0.26)</td>
</tr>
<tr>
<td>3 days per week</td>
<td>15</td>
<td>1.8 (0.07)</td>
<td>19.2 (0.31)</td>
</tr>
<tr>
<td>7 days per week</td>
<td>15</td>
<td>2.0 (0.06)</td>
<td>19.9 (0.34)</td>
</tr>
</tbody>
</table>

The overall yield of tagasaste was 2672 ±421 sheep grazing days per hectare, from 10 months of regrowth. This yield did not differ between treatments, for example the yield from 30 weaners grazing tagasaste seven days per week for 89 days was the same as that from 210 weaners one day per week for 13 weeks. However, the relatively large standard error of 421 sheep grazing days demonstrates that the yield from tagasaste does vary between plots across a plantation, even when the plots had about the same number of trees per hectare. In this case, yield ranged from 2000 to 4000 sheep grazing days per hectare.

Even if we adopt a standard yield as low as 2500 sheep grazing days per hectare, the concept of 'ration grazing' dramatically increases the profitability of tagasaste grown on deep sand to replace grain feeding in autumn, relative to the analysis shown in Table 2.

In theory, a yield of 2500 sheep grazing days per hectare of tagasaste equals 30 weaners per hectare for 83 days, seven days per week. However, it might equally mean seven flocks x 30 weaners per hectare, with each flock grazing the same plot of tagasaste one day per week for 83 days, that is, a maintenance supplement for 210 weaners per hectare for 83 days.

The logistics of moving flocks in and out of tagasaste becomes daunting. However, the limiting factor rapidly becomes the area of readily accessible dry pasture on good stable gravel country on which to run the sheep when they are not grazing tagasaste. This is particularly so when all the deep sand on the property is concentrated in one area as it is on Newdale.

Returns from tagasaste at Newdale, 1990

At Newdale, 7000 weaners and 150 store steers (a total of 8900 DSE) grazed 380 ha of mixed aged tagasaste and surrounding pasture on gravel (1220 ha) for 120 days during autumn and winter. Flocks were ration grazed in tagasaste from pasture, week about. The alternative would have involved hand feeding at about $4 per DSE.

The grazing of tagasaste and surrounding gravel resulted in a total saving of about $36,000 or a nett return of about $50/ha after allowing $45/ha for interest, fertilizer and cutting.

Sheep: the 30 per cent option

Ewe weaners grazing tagasaste throughout the summers of 1987 to 1989 consistently grew more clean wool than flockmates grazing dry pastures or oat stubbles. However, the effect on other wool characteristics is extremely variable.

An analysis of wool produced from groups of ewe weaners at Newdale is shown in Table 5. The wool production of those sheep grazing tagasaste is shown as the difference from flockmates grazing dry pasture or an oat stubble. Flocks grazed in tagasaste seven days per week from November to May in 1987, 1988 and 1989. The 1987 summer was very dry with a 'classic' break in late April. There was significant early summer rain in 1988, and in 1989, heavy rains in January produced a sustained green pick in the oat stubble.

The variability about the micron, length and strength of the extra wool grown by weaners grazed on tagasaste over summer is impossible to explain, given current knowledge about the physiology of wool growth and factors controlling the nutritive value of tagasaste. However, it may be associated with the variable amount and timing of summer rain and its influence on the feed available in the inter-row and/or its influence on the nutritive value of the tagasaste.

The model's selection of the 30 per cent option for Newdale was very sensitive to the amount of extra wool grown and its mean fibre diameter. The theoretical influences of increasing clean fleece weight by 500 g and increased mean fibre diameter by 0.5 or 1.0 micron, on the return from weaners grazing tagasaste from senescence of the annual pastures to the break of the new season, are shown in Table 6. The analysis used prices taken from the Australian Wool Corporation's weekly market summary dated 16 February 1990.
In 1987 and 1988, the extra dollars from wool produced by weaners, grazing extra tagasaste, at 15 DSE per hectare for the summer, would have returned about $15/ha nett more than flockmates run traditionally (15 x $4 = $60 - $45/ha for interest, fertilizer and cutting). This is about 25 per cent of the return from using tagasaste to replace grain feeding in autumn.

In 1989, the discount associated with the extra increase in micron would have caused a significant loss from those extra hectares established to tagasaste to grow extra wool. However, this simplistic analysis of the economics of planting more than 10 per cent of the arable area of a farm to tagasaste does not account for the potential of the farmer to increase the overall stocking rate per hectare. Theoretically, this is possible if the extra productivity of deep sands established to tagasaste for use in summer can be matched by an increased stocking rate on gravels in winter and spring.

A combination of some deferred grazing in early winter and the 'ration grazing' approach being studied by Peter Doyle from the Department of Agriculture’s Albany office, and Jon Young, a farmer of Kojonup, strongly suggests that may be possible.

A major part of the Martindale Research Project's current programme involves a large experiment on Dunmar Research Station at Badgingarra. The experiment involves about 800 ha of tagasaste and 4000 sheep on five experimental farming units. Each farm has 65 per cent of its arable area as deep sand and runs a self replacing flock of Merino ewes. On each farm a different proportion of its deep sand is established to tagasaste, up to a maximum of 65 per cent.

**Cattle: what do we know and what are the options?**

If cattle are forced to use all of the tagasaste in a paddock by grazing in summer and autumn, it is our experience that they leave the paddock at or near the same liveweight as when they entered it.

However, if cattle are moved regularly to fresh paddocks of tagasaste and therefore allowed to ‘take off the cream’, it appears that sustained gains in liveweight of about 500 to 600 g/head/day are possible. Thus, in theory, cattle may be grown over summer on tagasaste if they graze fresh tagasaste paddocks before sheep.

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**Table 4. The mean clean fleece weight (CFW), fibre diameter (FD), staple length and staple strength for ewe weaners ration grazed on tagasaste for 78 days in the autumn of 1989**

<table>
<thead>
<tr>
<th>Treatment group</th>
<th>CFW (kg)</th>
<th>FD (micron)</th>
<th>Length (mm)</th>
<th>Strength (n/ktex)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tagasaste 1) 1 day per week (N=25)</td>
<td>1.9</td>
<td>20.2</td>
<td>85</td>
<td>52</td>
</tr>
<tr>
<td>2) 3 days per week (N=24)</td>
<td>2.1</td>
<td>20.6</td>
<td>90</td>
<td>47</td>
</tr>
<tr>
<td>3) 7 days per days (N=25)</td>
<td>2.1</td>
<td>20.1</td>
<td>89</td>
<td>50</td>
</tr>
<tr>
<td>Oat stubble 4) 7 days per week (N=26)</td>
<td>2.2</td>
<td>20.5</td>
<td>86</td>
<td>42</td>
</tr>
</tbody>
</table>

N = number of ewes in each treatment group

**Table 5. The mean clean fleece weight (CFW), fibre diameter (FD), staple length and staple strength for the control weaners and showing the difference from these estimates for flockmates grazing tagasaste**

<table>
<thead>
<tr>
<th>Year</th>
<th>Control</th>
<th>Tagasaste</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>CFW (kg)</td>
<td>2.1</td>
</tr>
<tr>
<td>FD (micron)</td>
<td>20.5</td>
<td>20.6</td>
</tr>
<tr>
<td>Length (mm)</td>
<td>85.5</td>
<td>85.8</td>
</tr>
<tr>
<td>Strength (n/ktex)</td>
<td>25.0</td>
<td>29.7</td>
</tr>
<tr>
<td>Micron</td>
<td>0.8</td>
<td>0.4</td>
</tr>
<tr>
<td>Length</td>
<td>2.7</td>
<td>7.9</td>
</tr>
<tr>
<td>Strength</td>
<td>4.5</td>
<td>-7.3</td>
</tr>
</tbody>
</table>

* In 1988, the weaners were shorn prem in the middle of June

**Table 6. The theoretical influences of increasing clean fleece weight and/or increasing mean fibre diameter on the return from weaners grazing tagasaste**

<table>
<thead>
<tr>
<th>Micron</th>
<th>CFW</th>
<th>$/sheep Benefit from tagasaste ($/sheep)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>19.0</td>
<td>2.0</td>
</tr>
<tr>
<td>+ tagasaste</td>
<td>19.5</td>
<td>2.5</td>
</tr>
<tr>
<td>+ tagasaste</td>
<td>20.0</td>
<td>2.5</td>
</tr>
<tr>
<td>+ tagasaste</td>
<td>20.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Control</td>
<td>20.0</td>
<td>2.5</td>
</tr>
<tr>
<td>+ tagasaste</td>
<td>20.5</td>
<td>3.0</td>
</tr>
<tr>
<td>+ tagasaste</td>
<td>21.0</td>
<td>3.0</td>
</tr>
<tr>
<td>+ tagasaste</td>
<td>21.0</td>
<td>3.0</td>
</tr>
<tr>
<td>+ tagasaste</td>
<td>21.0</td>
<td>3.0</td>
</tr>
</tbody>
</table>

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Other research into fodder shrubs

About 90 per cent of the research conducted by the Martindale Research Project (MRP) addresses questions related to the use of tagasaste alone or in combination with other alternative species grown on deep sands.

Individual projects range from studies of the influence of fertilizer on growth, palatability and nutritive value, through management techniques to realize the full benefits of tagasaste, to a programme to select genotypes superior in nutritive value, or growth habit, or both.

In addition, other researchers in cooperation with the MRP have attracted funds from the Wool Research Trust Fund.

- Carolyn de Koning at the Moora office of the Department of Agriculture is studying the potential of a range of perennial species alone or in combination with tagasaste at Dunmar Research Station and at the Department's Badgingarra Research Station.
- Jim Fortune and Andrew Bailey at the University of Western Australia's School of Agriculture (Animal Science Group) are studying the role of tannins in determining the nutritive value of tagasaste at Newdale and in the laboratory at UWA.
- Until recently, John Hemsley at CSIRO was studying various aspects of the management and nutritive value of tagasaste at Bakers Hill and in the CSIRO laboratory at Floreat Park.
- Russell Speed and John Symonds from the Moora office of the Department of Agriculture are studying the hydrology of a site sown to tagasaste at Newdale.

Eighteen months ago, commercial contractors and farmers such as John Cook, Bob Wilson and Greg Hill have joined together with the scientists working on fodder shrubs (tagasaste, salt bush, acacias etc) to form the Australian Fodder Shrub Society to promote and share information about this new source of valuable grazing for livestock.

More information about the Australian Fodder Shrub Society is available from Chris Oldham at the University of Western Australia or Ted Lefroy at the Western Australian Department of Agriculture.

In addition, it appears that cattle prefer to graze the green feed between the rows of tagasaste in winter and spring. Under these conditions 15 month-old steers stocked at two per hectare and moved regularly to fresh paddocks consistently gained 900 g/head/day.

Conclusions

After five years of research and direct expenditure of more than $1.5 million, what do we know about tagasaste?

Autumn feed gap (10 per cent option)

- Tagasaste grown on deep sands is an economical robust alternative to feeding grain or hay to sheep and cattle.
- Yields are maximised by:
  (i) grazing once per year,
  (ii) making rapid use of tagasaste to maximize the period for regrowth (say 30 days grazing per year), and
  (iii) using ration grazing.

Grazing at other times of the year (greater than 10 per cent option)

Further research is needed into:

- management of tagasaste grazed other than in autumn, and
- the nutritive value of tagasaste, before firm recommendations can be made.

General

- Tagasaste will produce three to four times the amount of edible dry matter on deep sands compared with known annual pastures from the same rainfall and fertilizer.
- Tagasaste grown on deep sands should help to stabilize deep sands against wind erosion, and draw down and reduce the recharge to problem water-tables. However, measurement of these effects is difficult and has only just started.
- Bark stripping of tagasaste happens from time to time, it seems to be a feature of over grazing and delayed cutting and can happen at low or high stocking rates. It is proving more of a problem in the large experiment at Badgingarra and will need to be studied in more detail.
- Australian plague locusts also were a major problem in the summer of 1990-91. The locusts do not eat the leaves, but when locusts are flying in large numbers they chew through the leaf stems in passing. Their importance in the overall strategy will depend on the frequency and intensity of future plagues.

Acknowledgement

These studies could not have been carried out without the full cooperation of the staff of Martindale's farms, at all levels. The Martindale Research Project at the University of Western Australia is entirely funded by Martindale Pty Ltd.

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