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Red Meat Targets: Arrowleaf Clover in Mixed Pasture Sward

Abstract

Developed by the Tasmanian Institute of Agricultural Research, Arrotas arrowleaf clover was developed as a high production, speciality forage crop for Tasmania's cool temperate environment. The purpose of these trials was to evaluate Arrotas in terms of animal productivity and liveweight gain, as well as determining its suitability in a mixed sward. Due to the drought affecting irrigation capability, sowing of some of the trials was deferred until conditions were suitable. Extended dry conditions prevented the potential of Arrotas to be fully evaluated.

Over two years of evaluation, a pure sward of Arrotas produced good live weight gain on first cross terminal lambs, despite unfavourable weather and soil conditions. Greater liveweight gain would be expected under better conditions.

There was initial success introducing Arrotas into a mixed pasture sward. However, where Arrotas was introduced into both an established pasture and a new pasture, Arrotas populations dramatically declined in the second year. Most likely this is due to a combination of high hard seed content (96%), a dry season and competition by other dominant species. Long term persistence in mixed pastures requires on-going study.

The results of this project suggest that Arrotas is best suited as a high production, speciality forage crop.

Executive Summary

Arrotas was developed by the Tasmanian Institute of Agricultural Research as part of its grass and legume breeding and development program. The primary role of Arrotas is as a high production, speciality forage crop, similar to lucerne. The combination of a long taproot and later maturity compared with other legumes, means that Arrotas can provide feed in late summer when most grasses and legumes have either died or dried off.

Previous work at Hamilton in Victoria had shown the potential of a pure sward of Arrotas to provide feed through to late summer (Riffkin et al., 2001). However no animal production data had been generated under Tasmanian conditions. There is also a need to determine if Arrotas has a role in a mixed pasture sward.

Liveweight evaluations commenced in spring 2006 and finished in the summer of 2008. A 5 hectare paddock was sown with 10 kg/ha of Arrotas and divided into three strips for rotational grazing by 1st cross terminal lambs. In the 2006/2007 grazing period, lamb growth rates of 150 g/day were maintained until feed quality dropped off in late January. With improvements to the site (including improved irrigation and addition of dolomite), growth rates increased to 259 g/day in the 2007/2008 grazing period. This dropped to 184 g/day in January, but unlike 2006/2007, the Arrotas continued growth was grazed for a third time after this project finished.

The establishment of Arrotas into an established and a new pasture had mixed success. Establishment of Arrotas into an established cocksfoot pasture, commenced in 2005. While showing initial vigour, the population density has since declined. Hard seeds and dry conditions at early growth stages affected the density. Establishment into a new pasture had initial success in 2006, but again dry conditions and hard seeds resulted in a loss in Arrotas density in 2007. Further evaluation of population density under both establishment methods will continue. However it is clear that unless sufficient moisture is available at seedling emergence, Arrotas is not suited to a dryland pasture mix. However the liveweight results from an irrigated monoculture, suggest that Arrotas could have potential in an irrigated intensive system (eg. dairy).

The biggest impact of Arrotas will be in finishing systems, as a high quality source of protein during the summer period.

Contents

1 Background

1.1 Arrotas Arrowleaf Clover

The purpose of these trials was to evaluate the new arrowleaf clover cultivar Arrotas (Trifolium vesiculosum Savi) in terms of animal productivity and live weight gain, as well as determining its suitability for sowing in a mixed sward.

Arrotas was developed by the Tasmanian Institute of Agricultural Research as part of its grass and legume breeding and development program. The primary role of Arrotas is as a high production, speciality forage crop, similar to lucerne.

The Victorian Department of Primary Industries, has assesses Arrotas for feed quality and animal production. Arrotas maintained significantly higher levels of dry matter digestibility and produced significantly higher dry matter yields later into the season than the three other legume species with which it was compared (Riffkin et al., 2001). Lambs grazing the arrowleaf clover grew at 254 g/day until late December and continued to grow at more than 100 g/day from late December until mid February (Holmes et al., 2005). Animal production data has not has not been generated under Tasmanian conditions nor has the cultivar been assessed with perennial pasture species commonly seen in Tasmanian pastures.

Note: The Arrotas arrowleaf cultivar is protected under the Plant Breeders Rights Act 1994.

2 Project Objectives

1. To provide information on the potential animal production from a pure sward of Arrotas arrowleaf clover grown under Tasmanian conditions.

2. To investigate whether Arrotas arrowleaf clover will establish and persist in a mixed sward under two sowing conditions;
    - Sown in initial pasture mix
    - Sown into a pre-existing improved pasture base

3. To determine the competitiveness and persistence of Arrotas with cocksfoot and tall fescue companion grasses.

3 Methodology

3.1 Methodology – Animal Production Evaluation

3.1.1 2006/2007 Grazing Period

Arrotas was sown on the 9th June 2006 at 10 kg/ha with Super plus molybdenum at 250 kg/ha. The paddock was separated into three sections for strip grazing by weaners. This paddock was irrigated from November 2006 and received 500mm in irrigation.

Strip grazing by 430 weaners commenced on the 12th of December, after being introduced to Arrotas on the mixed pasture sward. This was done to acclimatise the rumen microbes to the Arrotas dry matter and overcome any scouring that may have impeded initial live-weight gain. The lambs were 1st cross terminals from a range of sires (Romney and Poll Dorset) with Merino ewes (medium to fine wool). The target liveweight for the lambs was 43kg.

The weaners were weighed on and off the pure sward, using portable yards and the Tru-test weighing system. The pure Arrotas paddock was the ‘on’ paddock, while a mixed pasture sward, containing Arrotas in the mix was used as the ‘off’ paddock.

Irrigation was applied via travelling irrigation to each of the strips at during emergence and post grazing. After the grazing period had finished, the area was sprayed off and heavily grazed with ewes.

3.1.2 2007/2008 Grazing Period

A second application of Arrotas was sown in August 2007 at 10 kg/ha with Super Mo at 250 kg/ha, to ensure a good population density was maintained. Prior to sowing an application of dolomite had been applied to alleviate the effects of manganese toxicity to the clover. This toxicity problem was identified in 2006 by plant tissue testing.

Strip grazing by 245 weaners commenced on the 12th of December 2007. The lambs were 1st cross lambs from a range of sires (Romney and Poll Dorset) with Merino ewes (medium to fine wool). A smaller number of weaners were used to allow for a quicker rotation and to begin with a smaller distribution of weights. The target liveweight for the lambs were 43kg.

Irrigation was applied via travelling irrigation to each of the strips at during emergence and post grazing. In addition, the strips were topped or mulched after grazing to reduce the annual grass population and additional P and K applied.

3.2 Methodology – Establishment and persistence in a mixed sward

3.2.1 Establishing Arrotas in a new mixed pasture

Arrotas was sown in a paddock at the Cressy Research and Demonstration Station, on the 10th of June 2006, at 5 kg/ha with 250 kg/ha Super Mo in a grass and legume mix. The mix contained either; 2 kg/ha Porto Cocksfoot or 8 kg/ha Demeter Tall Fescue, and 1 kg/ha Palestine Strawberry Clover, 5 kg/ha Denmark Sub Clover, 2 kg/ha Astred Red Clover and 2 kg/ha Bolta Balansa

The tall fescue/clover mix was sown into low lying areas and the cocksfoot/clover mix into the higher sandy ridges. The paddock was irrigated after sowing, up until January 2007 for a total of 406mm. After the final grazing the area was irrigated again, to ensure good clover seed set.

The paddock was unirrigated in the 2007/2008 season until February 2008.

3.2.2 Introducing Arrotas into an established pasture

Arrotas was sown at Cressy Research and Demonstration Station, by broadcasting seed in June 2005 at 10 kg/ha with 250 kg/ha of super with moybdenum, onto an established Porto cocksfoot pasture. The paddock was grazed down after the seed was applied and kept short to allow the Arrotas to establish. Plant frequency counts were taken from 2005 to 2007 in the spring. The paddock was grazed as required to promote the growth of Arrotas and control excess cocksfoot growth.

The paddock was then left to go to seed and strip-grazed by cattle from March 2006 through to June 2006. This paddock had 10 kg/ha of Arrotas sown again in June 2006 to maintain population density. This also allowed for the fact that in the second year after sowing a high population is not likely due to the very high level of hard seed produced by Arrotas arrowleaf clover.

4 Results and Discussion

4.1 Results and Discussion – Animal Production Evaluation

4.1.1 Results and Discussion – 2006/2007 Grazing Period

Liveweights

The lambs to graze the Arrotas were weighed on to the pure sward at an average of 25kg and reached on average of 30kg within 4 weeks (149 g per head/day growth rate). There was a large range of genetic variation within the flock, which resulted in a wide distribution in weights.

This initial growth coincided with an average pasture mass of the pure sward of 3500 kg/DM/ha and the following Feedtest analysis (Table 1);

Table 1: Feedtest Results

FeedTest	Dec-06	Mar-07
Dry Matter (%)	14.4	31.5
Crude Protein (% of DM)	19.3	9.1
NDF (% of DM)	32.8	50.5
Digestibility (DMD)	73.3	54
Metabolisable Energy (MJ/kg DM)	11	7.7

Recovery of the pure sward was quite slow, largely because of the manganese toxicity. At the start of the second rotation in March 2007, the sward had an average pasture mass of 2600 kg/DM/ha. The Feedtest results for the sward showed a reduction in nutritive value (Table 1). This is expected as the clover was starting to set seed.

As expected, growth rates slowed down once energy and protein levels in the feed decreased (Figure 1). At the end of February, the average weight was 34.4 kg, with 2 hectares of Arrotas feed remaining. Final weights will be recorded in mid March.

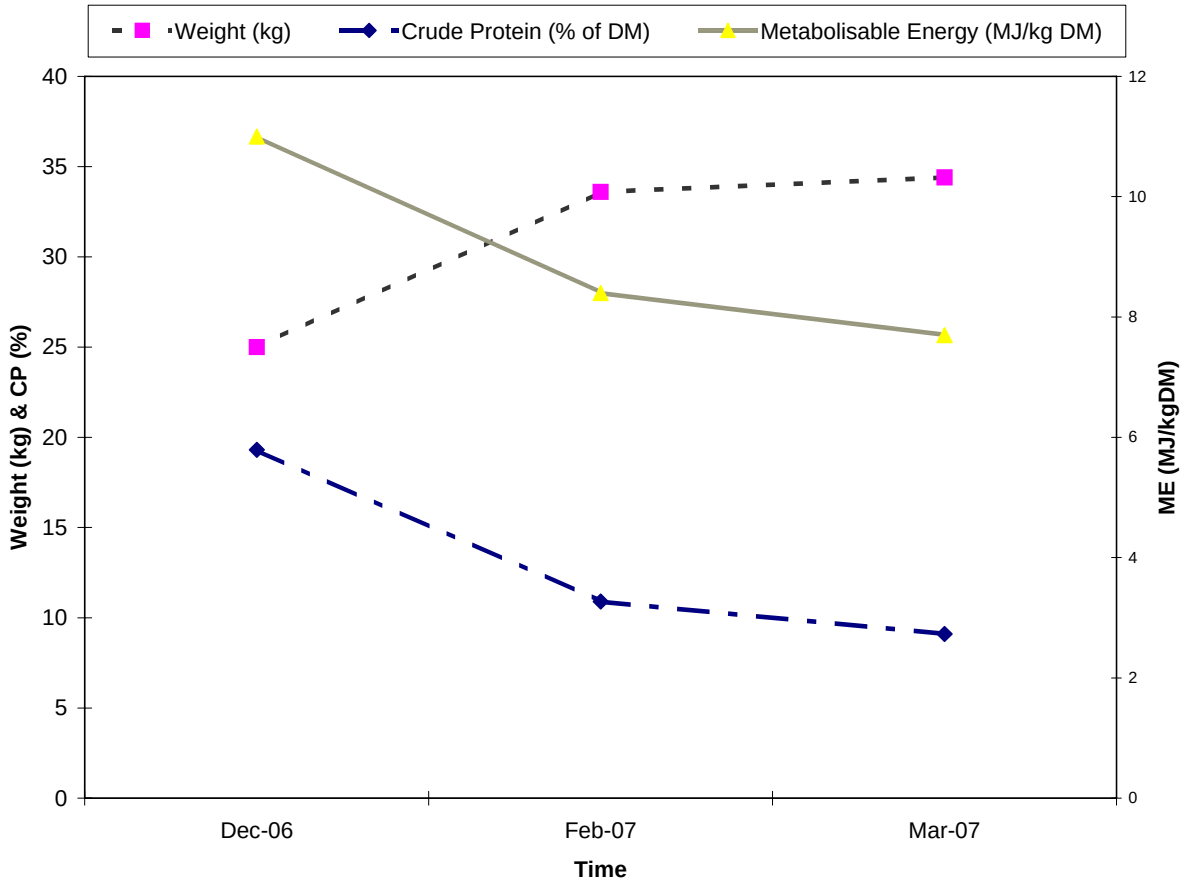


Figure 1: Effect of changes of Arrotas Feed Quality on growth rate

Pasture Health

No insect or fungal damage was detected on the Arrotas sward. However a yellowing and stunting of growth was found at various levels of severity across the paddock. Plant tissue and soil tests were collected for analysis and manganese toxicity was confirmed. The manganese level was 2540 mg/kg in plant tissue and 140 mg/kg (DTPA) in the soil. With further live-weight analysis to be conducted in 2007, lime and dolomite will be added to allow the Arrotas to perform to its full potential. It is estimated that there was at least a 20 - 30% reduction in pasture mass due to the stunting.

Annual grass weeds, sorrel and thistles were the main weeds in the pure sward. This will be eliminated after the pure sward has been allowed to set seed and grazed bare.

Animal Health

Faecal egg counts remained very low throughout the grazing period and no drenching was required. A comparative group of 1st cross lambs had high nematodirus counts and had to be drenched in February.

Arrowleaf clover contains moderate levels of an identified compound that appears to behave in a similar way to condensed tannins, which studies have shown can reduce the level of parasite infection. This could help explain the low worm counts experienced by the Arrotas mob. In addition, arrowleaf clovers are non-bloating.

4.1.2 Results and Discussion – 2007/2008 Grazing Period

Liveweights

The lambs were weighed on to the pure sward at an average of 29kg and reaching on average of 35kg within 3 weeks (259 g per head/day growth rate). The lambs were moved off the site to a dry pasture and lost on average 3kg in the next 3 weeks.

This initial growth coincided with an average pasture mass of the pure sward of 4430 kg/DM/ha and the following Feedtest results (Table 2).

Table 2: Feedtest Results

FeedTest	Dec-07
Dry Matter (%)	92.3
Crude Protein (% of DM)	18.7
NDF (% of DM)	40.1
Digestibility (DMD)	68.3
Metabolisable Energy (MJ/kg DM)	10.1

The lambs were weighed on to the pure sward for the second rotation on at an average of 34kg and reached an average of 39kg in 4 weeks (184 g per head/day growth rate). Pasture dry matter at the start of the second rotation was 2700 kg/DM/ha. 45 lambs were removed from the flock having reached the target weight of 43kg.

A third rotation will be undertaken, because the majority of Arrotas remaining vegetative. Unfortunately grazing had not started when this report was completed, but final liveweights will be recorded.

Stocking rates

The stocking rate in the 2007/2008 grazing period was 45 lambs/hectare compared with 86 lambs/hectare in the 2006/2007 grazing period.

Animal Health

Faecal egg counts remained low until the lambs were removed onto dry pasture on the 7th January 2008. The lambs had to be drenched before any further paddock movement due to a high nematodirus count.

4.1.3 Discussion – Animal Production Evaluation

Over the two grazing periods, the number of lambs grazing the Arrotas was reduced from 430 to 240 lambs (86 lambs/ha to 48 lambs/ha). In the 2006/2007 period, initial growth rate was good, but dropped off sharply in March 2007 due to very dry conditions and a reduction in feed quality. The reduction in feed quality was largely due to the majority of Arrotas going to seed and drying off due to the dry conditions (despite irrigation). In the 2007/2008 grazing period, growth rates improved and have been maintained during January and February (Figure 2).

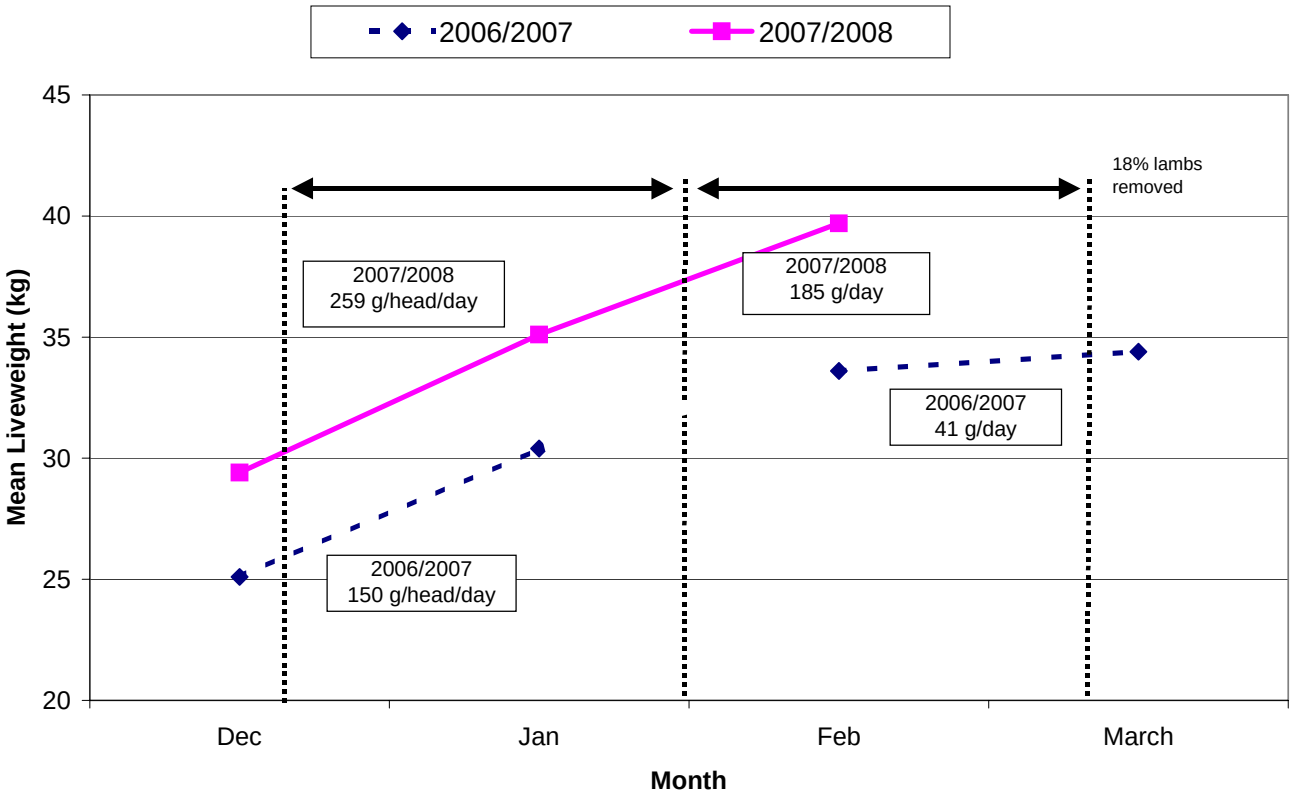


Figure 2: Comparison of mean liveweights on pure Arrotas over 2 year grazing period (2006/07 – 2007/08).

While some of the Arrotas had flowered as of March 2008, the majority of plants remained vegetative despite only a week's difference in the grazing start date.

In terms of liveweight gain per hectare, there was very little difference between the two grazing periods (Figure 3)

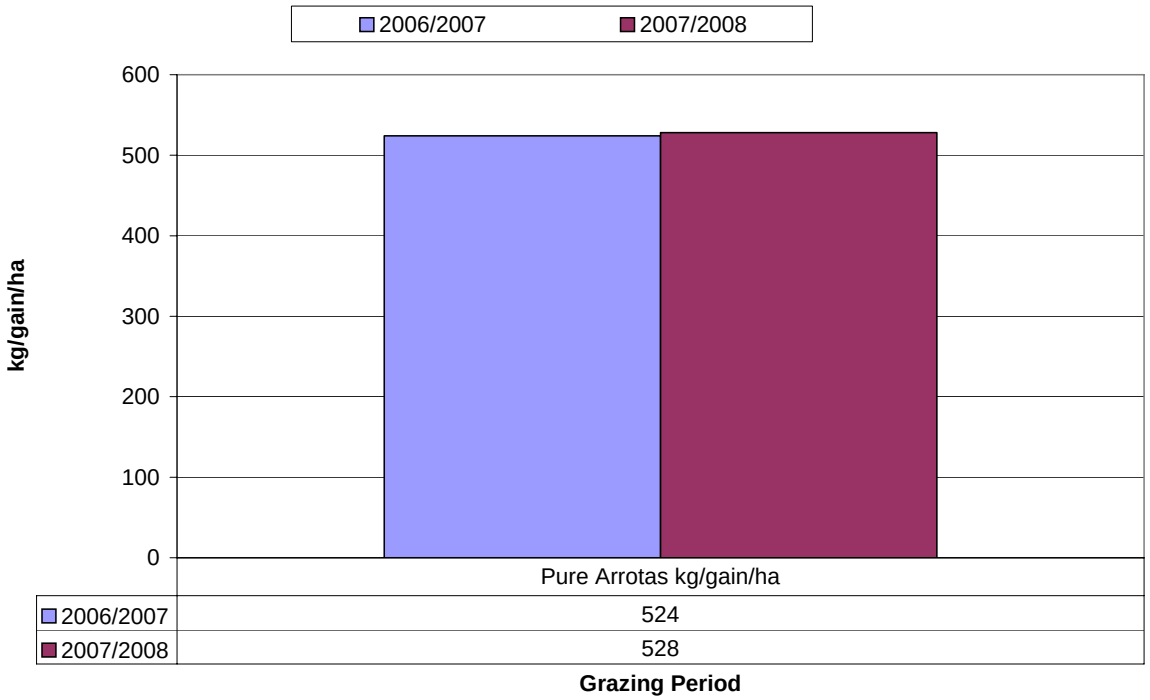
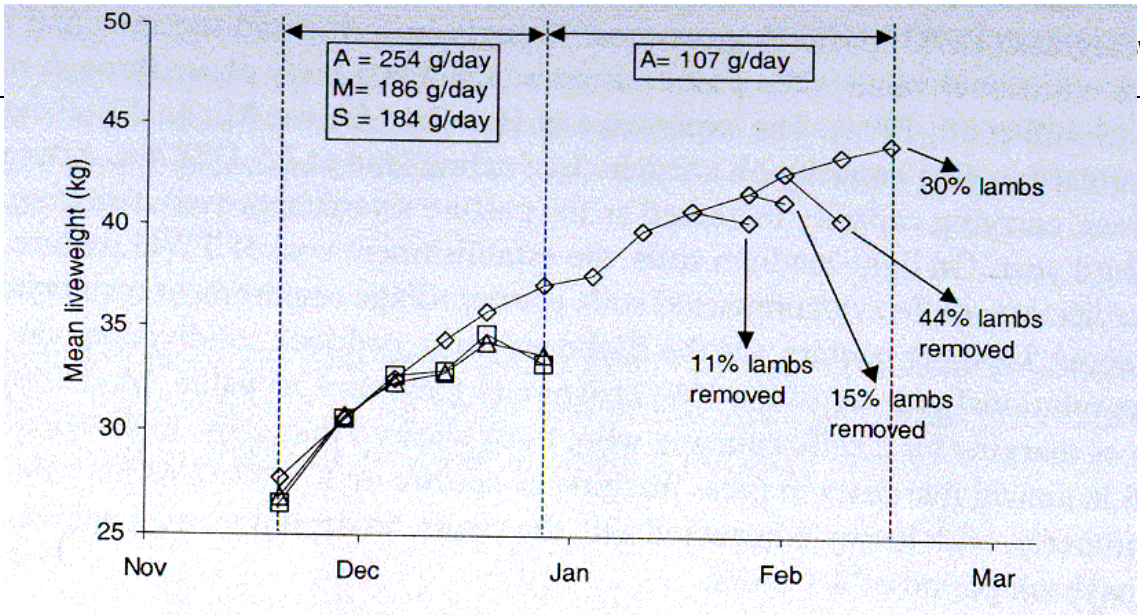


Figure 3: Comparison of liveweight gain per hectare over 2 year grazing period (2006/07 – 2007/08)

The liveweights achieved compare favourably with those achieved by the Victorian Depart of Primary Industries at Hamilton in 2005 (Figure 4). In the 2007/2008 grazing period, growth rates from the Tasmanian trial were higher than recorded at the Hamilton trial. In the 2007/2008 season, the Tasmanian trial growth rate was 259 g/day compared with 254 g/day through the December to January period. During the January to February period, the Hamilton trial recorded 107 g/day on Arrotas, while the Tasmanian evaluation recorded 185 g/day.

While the Victorian trial was unirrigated, rainfall was 700mm and lower stocking rates were used (12 to 36 lambs/ha compared with 48 to 86 lambs/ha in Tasmanian trial. Lambs in the Victorian trial were rotated onto new Arrotas pasture, whereas the lambs in the Tasmanian trial were rotating onto poorer pasture while the Arrotas recovered.

Figure 4: Mean lamb liveweight for the arrowleaf (◊, A), mixed (□,M) and subclover (Δ,S) treatments and lamb growth rates from late November to late December and late December to mid February (Department of Primary Industries, Victoria, 2005).



Further work to investigate an ideal stocking rate at which lambs could rotate constantly onto at least 1000 kg/DM/ha of Arrotas would be useful.

4.2 Results and Discussion - Establishment and persistence in a mixed sward

4.2.1 Results - Establishing Arrotas in a new mixed pasture

Sown in 2006, there was extremely poor germination of the cocksfoot, due to the age of the seed. Of the clovers, balansa, red and strawberry clover did particularly well, with initial strong growth through the spring. Clover composition in the paddock ranged from 25 to 50%. Irrigation commenced at the start of summer 2006. Irrigation was applied to the paddock in the 2006/2007 grazing period, due to its role in the liveweight trial.

In summer, the growth of Arrotas overtook the other clover species, some of which were going to seed, while other species such as sub clover were out-competed and in any case had matured much earlier. While other clover species were going to seed, Arrotas was still providing green feed, well into February 2007.

A Feedtest analysis was obtained in early December 2006, which compared this pasture mix to the Arrotas pure sward (Table 3). While both pastures were of good quality, the pure Arrotas pasture had a higher level of crude protein, which would have added liveweight gain.

Table 3: Comparison of Feedtest result with a pure sward of Arrotas (December 2006)

Test	Pure Arrotas Sward	Mixed Pasture (with Arrotas)
Dry Matter (%)	14.4	20.9
Crude Protein (% of DM)	19.3	15.2
NDF (% of DM)	32.8	38.1
Digestibility (DMD)	73.3	69.7
Metabolisable Energy (MJ/kg DM)	11	10.4

This paddock was also separated into three sections and was the 'off' paddock for the weaners being evaluated on the pure sward of Arrotas.

From autumn 2007 to autumn 2008, no Arrotas seedlings or plants have been identified in the pasture mix. Red clover became the dominant species, with only a few balansa and strawberry clovers present. Irrigation was not applied until summer 2008. No Arrotas seedlings emerged. Whether this was a combination of hard seed and dry conditions at emergence will be discovered in spring 2008 when plant composition will be evaluated.

4.2.2 Results - Introducing Arrotas[A] into an established pasture

Sown in June 2005, the Arrotas emerged well, with the aid of irrigation after sowing. Lambs grazed the paddock in spring, before the paddock was shut up to allow the Arrotas to go to seed. In late summer, cattle strip grazed the paddock.

After a second sowing of Arrotas in 2006, conditions were poor with very little rainfall. Despite a good initial germination of seed, plant densities were reduced by spring (Table 4). By the summer of 2006, no seed heeds were visible and the majority of Arrotas plants had died prematurely due to the very dry weather conditions.

Table 4: Density of Arrotas in cocksfoot pasture

Year	Plants / m^2
2005	68
2006	28
2007	19

In 2007, similar reduced plant densities were recorded. However, slightly better conditions aided the remaining plants, most of which have set seed. Plant counts in spring will continue to observe the change in population over time.

4.2.3 Discussion – Establishment and persistence in a mixed sward

The decrease in plant counts over the last three years would be largely due to a lack of seedbed moisture in the autumn to spring period as well as the hard seed level of Arrotas (96% hard seed). It takes a number of years for the seed coat to be broken down, hence why a second application is recommended where sown as a monoculture.

Under a monoculture, for liveweight production, most Arrotas crops would be irrigated. While more drought tolerant than other species, its seedlings are not tolerant to dry conditions. Utilised in an irrigated, intensive finishing system (eg dairy pastures), with other suitable clover and grass species, Arrotas would have a role in a mixed sward. Its growth characteristic help to lengthen the availability of good quality feed well into late summer. In a mixed dry-land pasture mix, where dry periods are an issue, there are other more drought tolerant legume species (eg. perennial legumes such as red clover) that could be utilised instead or Arrotas.

5 Success in Achieving Objectives

Despite unfavourable weather and manganese toxicity, the objectives of the liveweight evaluation were met. There is further potential for improvement in liveweight gains using smaller mob sizes and evaluating in different soil types and regions of Tasmania. There is also an opportunity to compare Arrotas with other specialist forages (eg. rape, turnips), short term irrigated ryegrass and irrigated lucerne in finishing systems. In addition, the suitability of Arrotas in a cropping rotation in terms of its potential in nitrogen fixation should be investigated further.

Dry conditions prevented a thorough evaluation of Arrotas establishment in an established and a new pasture. Trials that were to evaluate the competitiveness of Arrotas with a range of grass and legume species were omitted due to a lack of irrigation. However it is evident that Arrotas is not suited to a dryland pasture mix unless there is sufficient seedbed moisture at seedling emergence.

6 Impact on Meat and Livestock Industry – now & in five years time

The biggest impact of Arrotas will be its role in finishing systems as a high quality source of protein during the summer period. Unlike many other legumes, it is bloat safe and contains similar to condensed tannin compounds that are thought to play a role in reducing parasite infection. Unlike forage crops, there are no toxicity issues such as acidosis. An additional role for this plant is that it can be conserved either as high quality hay or silage.

This work suggests that with a better understanding of the grazing management required under Tasmanian conditions, Arrotas could be integral to the red meat industry, particularly for finishing prime lambs or young cattle.

7 Conclusions and Recommendations

Liveweight gains with Arrotas arrowleaf clover were exceptional for a summer grazing period. Further work on optimal stocking rates and its potential in other areas of the state is needed.

Arrotas is not suited to a dryland pasture mix unless there is sufficient available moisture at seedling emergence. It may have a role in irrigated, intensive systems (dairy, red meat), but further work is required to examine and define which grass and legume cultivar combinations are best suited for this purpose.

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