

Feasibility and economics of retaining steer weaners through winter for sale as yearlings.

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Summary

- The profitability of retaining steer weaners through a second spring, either on pasture or winter forage crop, was compared to a system of selling at weaning, based on the GrassGro model site at Bungarby.
- Retaining steers on pasture increased farm profit in all but the driest years, with an average increase in farm gross margin of 20%. Running these steers on an oats crop over winter at 2.5 steers/ha increased farm profit by an additional 38 percentage points. The benefit of the oats crop was a 32 kg/head increase in sale weight, but more importantly a decrease in area needed to run the steers, allowing greater cow numbers to be run.
- The key outputs of the three 1000ha systems are tabled below.

System	Average Steer Sale Weight	Total Enterprise Gross Margin	Gross Margin Increase v Weaner Production	Total Live weight Sold	Number of Calves weaned
Weaners – sell in weaner sales 1 st April.	261 kg	\$166/ha	N/A	110 tonnes	386
Pasture based Yearling system	442 kg	\$199/ha	+ 20%	116 tonnes	310
Oats based Yearling system (Winter Forage)	474 kg	\$262/ha	+ 58%	142 tonnes	356

- The winter forage system required around 7% of the cattle enterprise area to be sown to fodder crop. Perennial pastures with high winter growth potential may be an alternative, and is an area for further MFS work. However, the summer fallow period for the oats crop does increase the reliability of winter growth relative to perennial systems.
- The use of winter forage crops gave the greatest advantage when grain prices were high (due to reduction in grain feeding), and also in years when cattle prices were low because there tends to be a greater premium (in c/kg) for weaner cattle in periods of high cattle price.
- In the worst 10% of seasons, weight gain of retained steers is low. In these driest seasons, producers may decide to sell steers as weaners. March/April rainfall total gives a reasonable indication of likely steer weight gain on fodder crop over winter.
- Providing pastures are capable of reasonable weight gains, retaining steers increases profitability and flexibility for Monaro producers. Further work is needed to measure dry matter production, digestibility, and steer weight gains on various winter pasture options, as the area of fodder crop required to keep all steers will be an impediment for some farms.

Introduction

Monaro cattle enterprises have traditionally operated on the premise that weaner steers and surplus heifers are sold at 6-9 months of age before their first winter. This practice is intended to reduce the total stock numbers over winter in order to maintain the highest possible numbers of cows so as to maximise the number of calves for sale. Recent increases in the price of beef cattle has caused producers to question whether the impact of reduced cow numbers might be more than offset by the increased return from steer progeny retained through the winter and spring and sold as yearlings.

A number of Monaro Farming Systems members have already taken this approach in recent years with good economic outcomes in these relatively good seasons. The question is whether the strategy of retaining progeny to yearling age will be profitable across the full range of seasons and to what degree the trade off in cow numbers offsets this increase in the sale value of steers.

It was decided to explore the options for retaining weaner cattle through winter using the GrassGro DSS which has already been regularly used in other MFS projects. In this case a breeding cow enterprise has been overlaid onto a farm system that is a mix of fertilised and unfertilised native pasture along with improved pastures on a basalt soil at Bungarby.

Two options for retaining steers for sale as yearlings were tested and compared to the baseline practice of selling all steer and surplus heifer progeny in their first autumn. The retained steers were either grazed as a leader mob on the existing pasture base and fed to maintain condition if required or they were moved to a cereal crop from the middle of May until the end of September in order to maintain growth.

Modelling structures allowed an assessment of the required reduction in cow numbers resulting from each strategy

and allowed a calculation of the net economic benefit of adopting a retain and finish strategy for cattle on the Monaro.

Method

The GrassGro decision support tool was used to compare retaining steers to yearling age with the baseline practice of selling store weaners in autumn. All cow breeding farm systems were historical, running from 1960 – 2015 inclusive using weather data from the SILO data drill for the Bungarby Locality(36°39'S,149°00'E). However a tactical simulation was used to characterise a grazing Oat crop and the forage available to steers and the outputs characterised and used as a feed supplement in the historical simulations. Oats being an annual crop (re-sown each year) cannot be simulated in a GrassGro historical run necessitating this alternate approach. Detailed initial parameters of soil, pastures and animals can be seen in **Appendix 1**.

Soils and Pastures

The model farm is 1000ha entirely on basalt soils located at Bungarby. There are three basic pasture types comprising of 250ha (5 x 50ha paddocks) of improved phalaris pasture with sub-clover and annual grasses (PHL), 350ha (5x70ha paddocks) of fertilised native pasture dominated by *Poa* spp and *Austrostipa* spp with annual legumes (H-NAT) as well as 400ha (3x133ha paddocks) of unfertilised native pasture with the same species mix (L-NAT). Fertilised and unfertilised paddocks use soil fertility scalars of 0.85 and 0.75 respectively. Sustainable stocking rates were defined as the maximum possible while maintaining average ground cover of pasture above a minimum of 70% for 7 years out of 10.

Livestock Enterprise

The enterprise tested is a self-replacing breeding herd of Angus cows joined in November for a calving beginning the second week of August. Replacement heifers are retained and joined at 15

months of age at the same time as the main herd. The genotype is Angus with a body weight in average condition of 550kg.

Supplementary Feeding

Livestock feeding is generally confined to maintenance feeding based on condition score thresholds. As a default level all stock classes are fed to maintain the lowest condition animals above CS 2. In addition breeding cows are fed sufficient to maintain their condition score if they fall to or below CS 3 during late pregnancy and early lactation. This is done to ensure cows are in sufficiently good condition to rejoin. Additional production feeding of weaner heifers may also occur from June onward if their growth rate is insufficient to meet desirable joining weights (280kg) by the end of October. Since grain is usually the cheapest source of energy the feed used is Barley at an ME value of 13.7 MJ/kgDM.

Grazing Management

The inclusion of many paddocks in the systems brings the requirement for a grazing management plan to ensure that paddocks are utilised in accordance with their carrying capacity. To this end GrassGro allows for two types of grazing rotation which can be altered sequentially throughout the year.

- 1) Pastures can be grazed on a time based rotation with animals visiting paddocks for a defined number of days in a fixed order.
- 2) Pastures grazed on a flexible rotation where animal movement and paddock choice is determined by the goal of maximising livestock performance. Stock movement rules are based firstly on a minimum time spent in any one paddock and then movement to the best available paddock according to where their weight gain can be maximised.

In all simulations reported the pattern of grazing was a rotation of all available

paddocks with approximately 8 weeks rest between grazing. Once calves have been weaned any weaners retained in the system enter the rotation as a leader herd so getting first pick of all paddocks.

Steer Selling Strategies

Young stock sales in GrassGro can be managed in three ways.

- 1) Stock can be sold on a fixed date;
- 2) Stock can be sold at a target weight any time before a fixed final date for sale;
- 3) Stock can be sold at a target weight between fixed start and final dates. Sale may also be triggered if a target weight gain is not met. This option allows animals to be sold earlier in poor seasons before they slip too much but also allows them to be retained to the heaviest desirable weight in good seasons.

Option 1 is used in the baseline scenario and calves are sold on the 1st of April regardless of their live weight or the remaining pasture available.

In systems where steers are kept to finish at heavier weights **option 3** is utilised. The steers are retained until the end of December and then only sold if the 21 day running average for growth rate falls below 0.6kg/hd. All steers are sold by 1st of April (20 months) regardless of weight or pasture conditions.

Costs and Prices

Enterprise costs were sourced from the most current NSW DPI gross margin budgets and aggregated into the relevant inputs for GrassGro. These inputs are summarised in **Table 1**.

Cattle prices were determined from data for three major NSW selling centres (Dubbo, CTLX Carcoar, and Wagga published on line by Meat and Livestock Australia. This data was analysed for the 3 yrs to the 13th of June 2017. Table 2 shows the percentile prices calculated and used as in the GrassGro analysis.

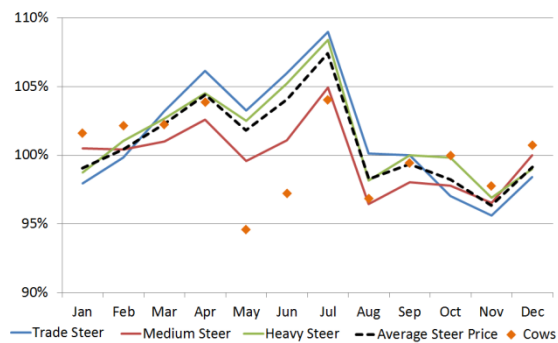
Table 1. Costs used in the analysis.

Animal Husbandry	
Cows	\$8.25/hd
Young Steers and Heifers	\$5.25/hd
Livestock Purchases and Sales	
Bulls	\$6000
Fixed Sale Costs	\$28.60
Commissions	4%
Pasture and feed costs	
Pasture maintenance	\$42/ha
Grain Supplements	\$250/t
Cereal Crop	\$220/ha

Table 2 Cattle Price percentiles (c/kg Live Weight) used in the sensitivity analysis.

Steers	10 th	25 th	Med	75 th	90 th
<280kg	197	250	324	374	403
280 – 330kg	192	239	317	354	377
>330kg	198	244	320	348	366
Heifers	195	217	286	326	360
Cows	142	175	212	229	244

Figure 1. Monthly deviation of cattle price over the period from the mean 2010 – 2015.



Median price was used for the detailed analysis and other percentiles were included to determine the sensitivity of the enterprises to changes in price while at the same time varying grain price between Low (\$150/t), Medium (\$250/t) and High (\$350/t).

Seasonal price variance was also analysed but due to the confounding influence of rapidly rising prices in 2015-16 these

calculations were done for the period from July 2010 to June 2015. Figure 1 shows steer prices were higher in Autumn/Winter than in Spring/Summer and a similar trend exists for Cow prices.

The monthly deviations shown for average steer price and for the cow price were used to adjust the prices according to the time of sale.

Farm Systems Tested

Base

The baseline farm system (BASE) sells weaner steers and surplus heifer weaners on the 1st of April each year. For the entire year the herd grazes the entire farm in a rotation with animals moved every 5 days so allowing a spell of approximately 2 months between each grazing. As this system does not wean steers there is no ability to instigate a grazing system to favour the young growing stock with greater access to improved pasture. Replacement heifers are retained and weaned on the 1st of April and enter the rotation as a leader mob which lengthens the total graze time of each paddock to 10 days and shortens the spell between grazing by 5 days.

Yearling

Rather than selling as weaners steers are retained on the baseline pastures through to at least the following summer to sell between the end of December and the 1st of April depending on seasonal conditions. Supplementary feeding of females remains as described above and since steers are retained they are also fed for maintenance if required.

Both steers and replacement heifers follow the same grazing rotation in a leader mob grazing paddocks immediately before the cow herd. Retaining steers through winter compromises their growth rate but also means a trade off in cow numbers due to the extra grazing pressure. Cow numbers are rebalanced to ensure the same ground cover target is being achieved.

Winter Forage

This system retains steers to yearling age with use of grazing oats to maintain growth over winter.

Grazing oats provides better winter forage for steer weaners and will minimise the land area required to run them so helping to maximise the sustainable cow numbers. Also the steers will continue to grow at higher rates helping to more reliably reach heavier weights at sale.

Simulating grazing oats

GrassGro does not have a standard parameter set for winter cereals and also does not support a sowing event each year of a simulation. To work around these limitations the production of forage and steer performance over the winter period was modelled in a separate tactical simulation using a modified annual ryegrass parameter set (parameters for growth temperature lowered to ensure winter growth rates were in the range expected for grazing oats). The tactical simulations were commenced on the 1st of March (sowing date) and the growth stage set as senescent and the seed pool set to 100kg of ripe soft (germinable) seed.

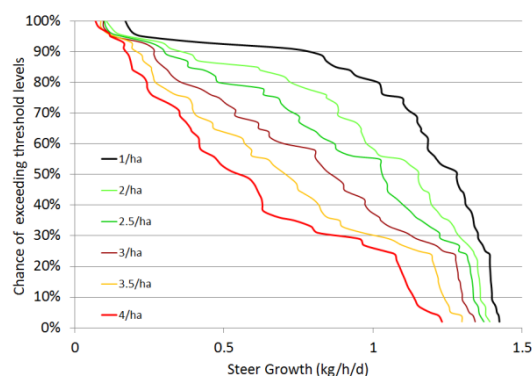
Soil moisture at the start of the simulation was determined from a separate tactical simulation for the base soil type but with the pasture characterised as senescent annual grass with no seed pool. This simulates the impact of a summer chemical fallow on soil moisture retention at the time of sowing. The spin up ran from the 1st of November (first spray out date) to simulate the likely range of soil moisture at the 1st of March sowing date resulting from poor, medium and good summer seasons.

The stocking rate was selected based on the balance between performance per head and total weight gain per ha and the probability of supplements being required (risk of poor seasons). 2.5 steers per ha was selected as the sustainable balance point. In certain seasons far higher

numbers could be carried but the area of crop sown must be decided in the previous spring so the area to be sown must be based on the balance of possible seasonal outcomes.

At higher stocking densities the growth of steers while on the oat crop has a high chance of falling below critical levels (Figure 2). At 3/ha average growth rate exceeds 1kg/h/d in just over a third of all seasons while at 2.5/ha the chance of averaging 1kg/h/d increases to 55%. Importantly at a stock density of 3/ha, steer growth is below 0.6kg/h/d in a third of all seasons reducing the chance of them meeting the MSA grading standards compared to steers stocked at 2.5/ha. Overall a density of 2.5/ha appears to be the best balance between stocking rate and animals performance.

Figure 2. Impact of stocking density on average growth rate of steers grazing oats from 15th of May to 30 September.



A historical simulation selling steers as yearlings was then formulated with the impact of grazing oats mimicked by feeding the steers a green oat supplement in a “feedlot” for the period from the 15th of May to the 30th of September. The supplement quality was determined from the tactical simulation of the oats based on the average diet quality consumed by the steers and is shown in table 2.

Table 2 Nutritive value of green oat “supplement” used in the historical simulation

DM%	DMD%	CP%	RDP%
28	79	16	90

GrazFeed was then used separately to determine the feeding rate required to achieve the 25th, 50th and 75th percentile steer growth rates achieved in the tactical simulation of the oat crop (Table 3). These feeding rates were used to mimic the impact of a range of seasonal conditions on the supply of grazing oats.

Table 3 Feeding rates required to achieve the expected range of steer growth rates

Percentile	Growth Rate	Feeding rate
25 th	0.68 kg/h/d	21.6 kg/h/d
50 th	1.03kg/h/d	26 kg/g/d
75 th	1.29kg/h/d	29 kg/h/d

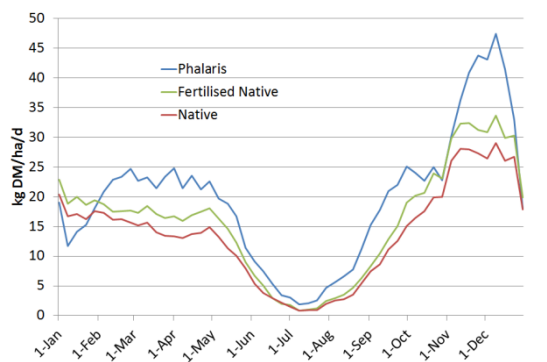
A multi run analysis using feeding rate as one factor and stocking rate as another was used firstly to determine the sustainable cow stocking rate and then outputs from the remaining three simulations (three rates of feeding green oats) was used to create a distribution of expected animal performance and economic output from the complete system.

Results

Pasture Production

The growth curves for the three base pasture types are shown in Figure 3.

Figure 3. Long term average pasture growth for three pasture types at Bungarby.

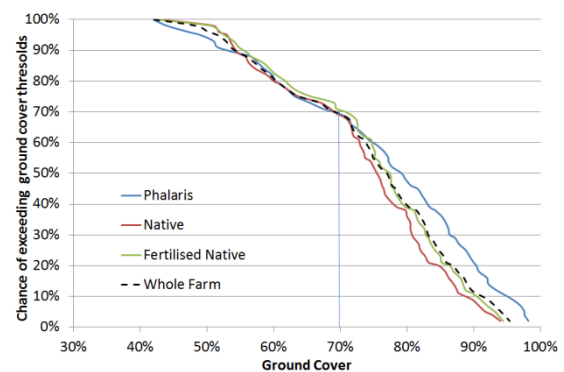


All three pastures follow similar growth patterns however the Phalaris based pasture is generally more productive producing on average 45% greater biomass than the native pasture and 25% more biomass than the fertilised native pasture.

The improved pasture recommences growth about a month earlier in spring.

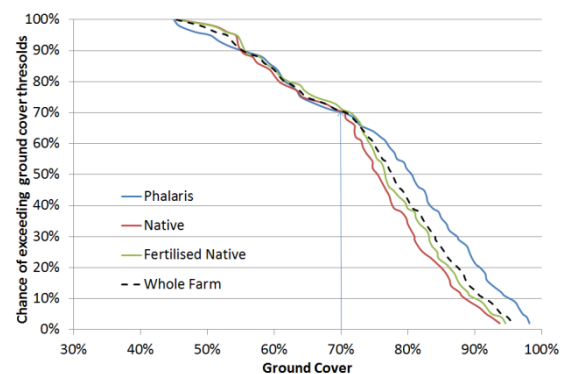
Stocking rates on the baseline system have been set to ensure a minimum of 70% ground cover is achieved in at least 70% of years. Figure 4 shows the probability of ground cover exceeding any given level for each pasture type grazed at a whole farm stocking rate of 0.5 cows/ha.

Figure 4. Probability of ground cover of the base system exceeding threshold levels.



At this stocking rate the average farm minimum ground cover is maintained around 70% in 70% of years for a long term pasture utilisation rate of 28%. The annualized stocking rate derived from GrassGro was 6.4 DSE/ha

Figure 5. Probability of ground cover in the Yearling system exceeding threshold levels.



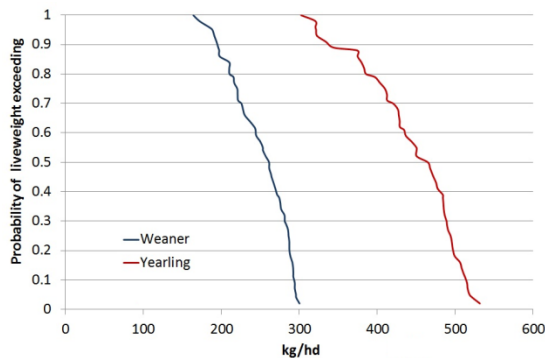
When steers are retained to yearling age the cow carrying capacity is reduced by 20% to 0.4 cows/ha when a similar ground cover profile is achieved (Figure 5). For the yearling enterprise the long term average stocking rate was 6.3 dse/ha and the overall pasture utilisation was the same as for the base system. In both systems the

risk of low ground cover is relatively uniform throughout the year.

Production.

As expected the sale weight of steers increased significantly by retaining them throughout the winter and the following spring. In most cases the steers were sold on the 1st of January as growth rate had fallen below the target of 0.6kg/hd/d. Figure 6 shows the median sale weight of *Weaners* was 261kg while the *Yearling* steers achieved a median sale weight of 465kg, an increase of 78%.

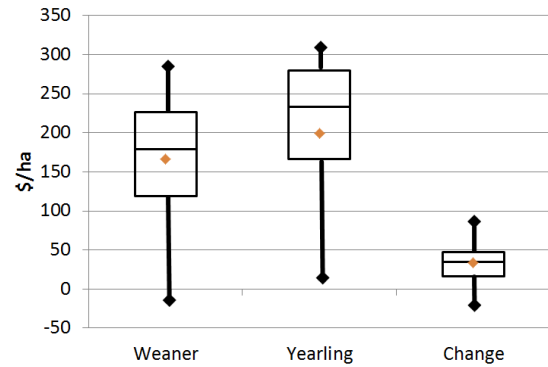
Figure 6. Probability of steer sale wt per head exceeding threshold levels



This increase in weight of steers is partially offset by reduced numbers of cows, surplus heifers and steers for sale each year due to the 20% lower cow stocking rate. The median total weight of steers sold from the *Weaner* enterprise was 50kg/ha while from the *Yearling* enterprise it was 69kg/ha an increase of just 38%

Overall, the Gross Margin of the Yearling enterprise at an average of \$199/ha is 20% higher than for the weaner enterprise but this difference is highly variable between years. Figure 7 shows that the change in Gross Margin (Profit) averages just \$34/ha and in a few years is actually a loss while being more than \$90/ha in the best years. The biggest returns occur in years when weaning weights were light but seasonal conditions allowed large weight gains between weaning and sale as yearlings.

Figure 7. Economic return from retaining steers to yearling age.



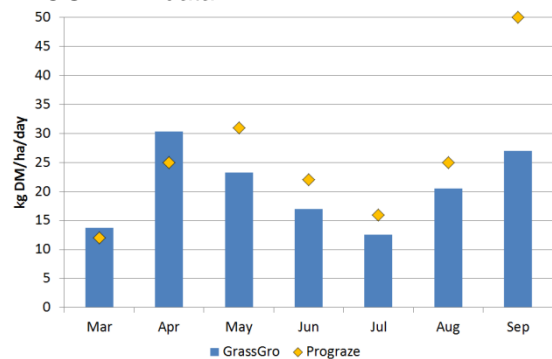
The middle boxes represent the middle 50% of years surrounding the median, while the whiskers identify the highest and lowest value. The orange diamond is the average.

Winter Forage

Production

The Oats (modified annual grass) parameter set was run in a tactical simulation over the years 1960 to 2015. The average monthly growth rate achieved from a 1st of March sowing into good soil moisture is shown in Figure 8. Compared with the generic growth curve for Oats on the southern tablelands (PROGRAZE manual), monthly growth rates from GrassGro are slightly lower through winter due to the generally colder and dryer winter conditions experienced on the Monaro. September growth is also quite low by comparison but early September growth is still being reduced by relatively cold temperatures and dryer conditions in many years.

Figure 8. Monthly average growth rate of grazing oats from GrassGro compared with PROGRAZE data



In the tactical simulation weaned steers are inducted onto the oats on the 15th of May at a weight of 280 kg and grazed at 2.5/ha.

In the worst 10% of seasons steers gain just 20-40kg of live weight over the full grazing period (Figure 9). The model predicts that there is also considerable maintenance feeding required during these years. It should be concluded from this that despite the sowing of oats, management should remain flexible and steers still sold as weaners if the seasonal conditions cannot support sufficient steer growth over the winter.

Figure 9. Steer live weight on 1st October after grazing Oats since 15th May.

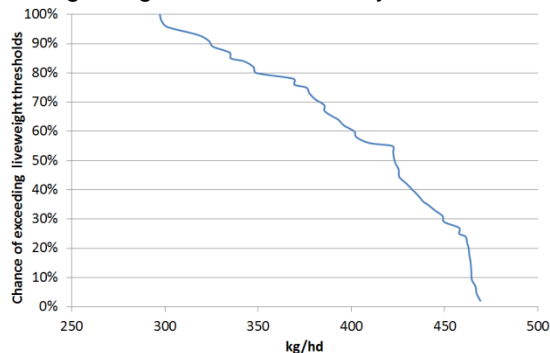
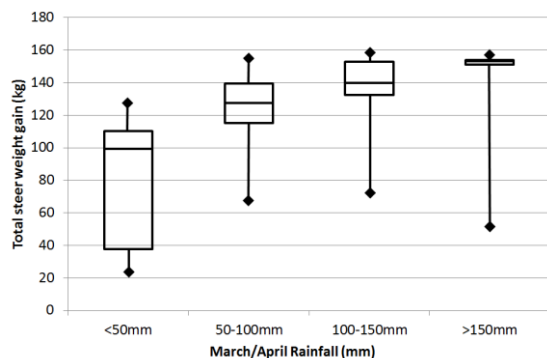


Figure 10 groups the total steer growth from May to September according to the total rainfall over the months of March and April. It can be seen that steer weight gain on the oats is forecast reasonably well by March-April rainfall and this could be used as a guide for tactical decisions to sell at least some steers as weaners rather than carrying them through.

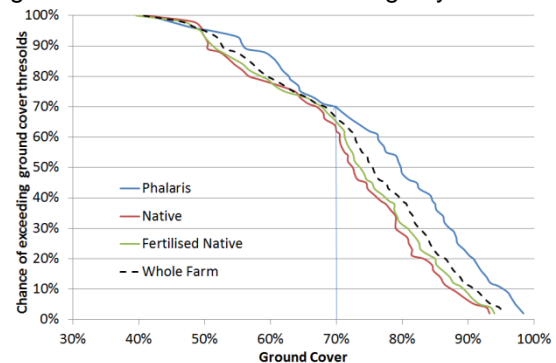
Figure 10. Total steer weight gain on oats grouped according to the March April Rainfall total.



Integration into a breeding enterprise

When oats is available for retained steers to graze over winter, the stocking rate of the remaining pasture area was able to be maintained at 0.5 cows per ha (as for the Weaner enterprise) without compromising ground cover(Figure 11). When averaged over the total farm area, the stocking rate for the winter forage system is 0.46 cows per ha, 15% higher than the *Yearling* system.

Figure 11. Probability of breaching 70% ground cover in the Winter Forage system.



Based on this background carrying capacity the area of crop required as percentage of the total land area can be solved using a simple simultaneous equation based on the following assumptions and definitions.

Farm Area = 1000ha

% Pasture area = Pa

% Crop area = Ca

Crop Stocking Rate = 2.5

BASE Stocking Rate = 0.5

Average Weaning Rate = 0.77

Steers as proportion of drop=0.5

Equation 1 $Ca = 100 - \%Pa$

Equation 2

$$2.5xCa = (0.5x0.5x0.77)xBa$$

$$\therefore 2.5xCa = 0.1925xBa$$

Solving for Ba

$$2.5x(1000 - Pa) = 0.1925xBa$$

$$2,500 - 2.5xPa = 0.1925xBa$$

$$2,500 = 0.1925xPa + 2.5xPa$$

$$2,500 = 2.6925xPa$$

$$Pa = \frac{2,500}{2.6925}$$

$$Pa = 92.8 \%$$

$$\therefore Ca = 7.2 \%$$

So approximately 7% of the farm area would need to be devoted to a grazing oat crop in order to retain all steers through the winter and meet desirable growth rate targets. On individual farms this may vary due to differences in actual baseline carrying capacities and weaning rates.

Figure 12. Chance of yearling steer sale weight exceeding any given level.

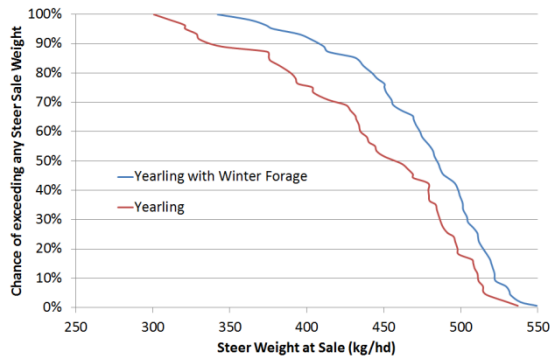
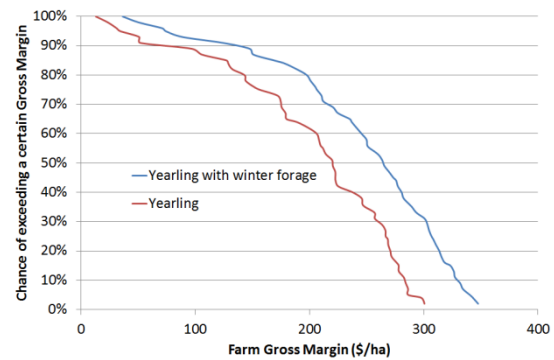


Figure 12 shows the effect on sale weight of grazing crops compared with retaining steers and feeding for maintenance as required. A winter forage crop increases the final sale weight more in the poorer years making final sale weight less variable. The impact is less in the better seasons (right hand side of the graph) since the difference in feed availability and quality between a permanent pasture and an annual fodder crop is less in those years.

On average the steers grazing oats over the winter have a 63kg advantage in live weight by the 30th of September but this diminishes to just 32kg/hd at the point of sale. So the steers retained on pasture grow less over the winter but they experience compensatory gain in spring and grow faster than the heavier and fatter steers coming off winter forage.

However, the seemingly small impact on sale weight is amplified in the gross margin through the larger herd size (Figure 13). The increase in gross margin is highest in above average years as the cost per kg of crop DM produced is lower while the total weight gain is higher.

Figure 13. Probability of Farm Gross Margin exceeding any given level.



On average the increase in gross margin from the winter forage crop is around \$63/ha across the whole farm coming from both increased steer sale weight and an increase in the whole farm stocking rate and hence numbers of stock for sale. Both these increases are attributable to the use of winter forage crops and represent a gross margin of \$875 for each hectare of Winter Forage grown.

Price Sensitivity

In light of the large changes in cattle price over the 2012 – 2016 price period used, it is important to explore the sensitivity of economic output to changes in both cattle price and the cost of feed supplements.

Table 4 shows the impact of changes in price of stock and grain supplements on the relative advantage of retaining steers to yearling age. The marginal gain (Profit) remains similar across the potential range in prices.

Table 4 Increase in Gross Margin (\$/ha) for the *Yearling* enterprise vs *Weaner* enterprise.

Grain Price	Price Percentiles				
	10 th	25 th	50 th	75 th	90 th
L	23	26	33	28	24
M	25	27	34	28	25
H	20	28	35	30	26

For the Winter Forage system the same price sensitivities were tested and the results shown in Table 5. While relatively insensitive to changes in cattle price the decision to utilise cereal crop to feed steers through winter was on average twice as profitable when grain prices were high as when they are low.

Table 5 Increase in Gross Margin (\$/ha) for the *Winter Forage* vs the *Yearling* enterprise.

Grain Price	Price Percentiles				
	10 th	25 th	50 th	75 th	90 th
L	53	50	40	34	26
M	75	72	63	57	49
H	97	95	85	79	71

The decision to both retain steers and grow winter forage to feed them gives a cumulative advantage of \$50 - \$150/ha and the advantage is proportionally greatest for the combination of lower cattle prices and high grain price.

Discussion

The recent good run of seasons on the Monaro has led to dramatically increased confidence in growing the cattle enterprise component of many farms. Recent prices have also increased interest in trying to do more with this enterprise than the historical norm of producing calves for the Autumn weaner sales.

In reality the modelling results suggest that the decision to retain steers and grow winter forage to carry them through is proportionately even better in years of low beef prices and high grain prices. While the impact of higher grain prices is logical a better economic response under lower cattle prices seems counter intuitive. Ultimately it is the premium paid for weaner steers relative to heavier steers that drives the difference. If this premium is low as it is for the lower price percentiles (Table 2) there is a greater advantage in retaining steers to heavier weights but overall the decision to retain steers to

finish at an older age is very robust regardless of cattle or grain price.

Importantly the use of a winter forage crop allowed reduced pressure on the remaining pasture area resulting in higher overall farm stocking rates than a system where steers are retained and supplementary fed for maintenance as required. It is the ability to maintain higher stock numbers rather than the steer weight gain that drives the majority of the economic advantage in growing winter forage.

Cereal crops are not the only option for increasing the quantity and quality of winter grazing. A number of MFS members are now using short term ryegrasses for this purpose saving the cost of re sowing every year and also potentially getting the benefit of grazing at other times of the year. However it should be noted that the cereal crop gains a significant advantage from stored soil moisture from the summer fallow. Short term perennial grasses will not gain this advantage in the system although their response to autumn rain may well be quicker and offset some of this advantage. Overall these pasture based alternatives to winter cereals should act similarly to maintain higher cow numbers when targeting Yearling steer production.

Including 7% of the farm area as crop does require an ongoing commitment to a program of pasture improvement if paddocks are cropped for two years before returning to pasture this would mean if improved pasture area was held to just 25% of the land area it would be up for replacement every 7 years.

This might not be economically viable given the high cost of pasture sowing and the years taken to get into full production. This may mean farms need to implement a mix of the strategies analysed in this paper by choosing to sell some steers as weaners and retain others with a mix of a smaller area of grazing crops and use of supplements.

Alternatively the inclusion of sufficient crop area to carry all steers may mean if possible a shift to a higher proportion of improved pasture than our baseline model farm. This would increase the total Crop / Pasture rotation time keeping individual pasture paddocks undisturbed for longer periods.

Conclusion

On balance the modelling shows a decision to shift from Weaner to Yearling production should be economically sound, giving incremental gains in profit in most seasons and a low downside risk.

The inclusion of winter forage crops also improves the profit of the system further reducing the reliance on feed supplements and giving the highest returns when feed

grain prices are high. While the modelling of the crop biomass appears robust there appears to be a dearth of information on crop growth rates, especially on the Monaro, so in the longer term it would make sense for farmers to maintain good records of stock numbers and performance on these crops as well as estimates of biomass when mobs enter and exit crop paddocks so as to build a base of objective information from which real world growth rates can be derived.

Disclaimer: The information contained in this publication is based on knowledge and understanding at the time of writing (June 2017). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to independently check the accuracy and currency of the information.

Appendix 1. Base Simulation Inputs

1000ha with the following paddock structure.

Pasture Type	No of Paddocks	Paddock Size (ha)
Phalaris Improved	5	50
Native Fertilised	5	70
Native	4	100

Pastures

Pasture Type	Pasture Species			
Phalaris Improved	Phalaris	Tall Fescue	Annual Grass	Sub Clover
Native Fertilised	Poa Tussock	Corkscrew	Sub Clover	Medic
Native	Poa Tussock	Corkscrew	Sub Clover	Medic

Soil

Stony Basalt	Topsoil	Subsoil
Cumulative depth (mm)	300	1000
Field capacity (m ³ /m ³)	0.35	0.45
Wilting point (m ³ /m ³)	0.22	0.37
Bulk density (Mg/m ³)	1.16	1.20

Livestock

Livestock Genotype		
Breed	Angus	
Standard reference weight	550	kg
Death rate: adults	2.0	%/year
Death rate: weaners	2.0	%/year

Livestock Management

Stocking rate	0.5/ha	
Replacement rule	Self Replacing	1 Oct
	Cast for age	Sell stock aged 8 to 9 years on 1 April
First join at	1 years	
Mating date	1 Nov	
Conception at CS 3	99%	
Birth date	11 Aug	
Castration	yes	
Weaning date	1 Apr	
One bull per	50 Cows	
Keep Bulls for	5.0 years	

Maintenance Feeding rule	
Mature Females	Feed in paddock, applying the rules: If animal condition falls to 3.0 during 1 Jun to 31 Oct feed to maintain condition of average animals

	If animal condition falls to 2.0 during 1 Nov to 31 May feed to maintain condition of the thinnest animals										
Immature Females	Feed in paddock, applying the rules: If animal condition falls to 3.0 during 1 Jun to 31 Oct feed to maintain condition of average animals If animal condition falls to 2.0 during 1 Nov to 31 May feed to maintain condition of the thinnest animals										
Immature Males	Feed in paddock, applying the rule: If animal condition falls to 2.0 during 1 Jan to 31 Dec feed to maintain condition of the thinnest animals										
Weaners	Feed in paddock, applying the rule: If animal condition falls to 2.0 during 1 Jan to 31 Dec feed to maintain condition of the thinnest animals										
Supplement	<table border="1"> <thead> <tr> <th>Ingredient</th> <th>Barley</th> </tr> </thead> <tbody> <tr> <td>Dry matter content (%)</td> <td>89</td> </tr> <tr> <td>Dry matter digestibility (%)</td> <td>90</td> </tr> <tr> <td>ME:DM (MJ/kg)</td> <td>13.7</td> </tr> <tr> <td>Crude protein (%)</td> <td>12</td> </tr> </tbody> </table>	Ingredient	Barley	Dry matter content (%)	89	Dry matter digestibility (%)	90	ME:DM (MJ/kg)	13.7	Crude protein (%)	12
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Costs: Monaro 2017	
Description	70kg.ha single super + \$10/ha weeds
Cow Husbandry	\$8.00 /head
Calf Husbandry	\$5.75 /head
Rams Bulls	\$6000.00 /head
sales commission	4.00 %
sales cost	\$28.60 /head
Pasture cost	\$42.00 /ha
Barley	\$250.00 /t

Prices: Monaro Median 2016	
Description	3 year prices July 2014 to June 2017
Cow sales	212.0 c/kg
Steer Sales	< 280kg 324c/kg 280-330kg 317 c/kg >330kg 320 c/kg
Heifer Sales	Base price 286.0 c/kg