PROJECT SUMMARY

RURAL INDUSTRIES
Research & Development Corporation

Optimising genetics, reproduction and nutrition of dairy sheep and goats

Introduction

The Australian dairy sheep industry currently has six well-established businesses, all of which are vertically integrated, processing all of their milk in their own factories. Of these, the products of one are nationally distributed and the products of three others are well established. The farm gate value from these dairies is probably about $4 million per year and probably growing at about 10 per cent per year.

The Australian goat dairy industry has a number of nationally distributed brands that are available in independent retailers, food services and, over the past few years, supermarkets. These brands are derived from milk produced from two substantial dairies in Victoria. There are also well-established brands in all the other states, each reliant on one or several family farms to supply their milk. The industry has a factory-door turnover of at least $30 million per year, and this is estimated to be growing at around 20 per cent per year. Australian dairies are now exporting cheese to the USA and have received genuine enquiry for powdered milk from China.

This project was aimed at devising strategies suitable for increasing the efficiency of milk production in Australian dairy sheep and goats.

Background

Dairy sheep and goat industries in Europe are several orders of magnitude larger than in Australia, and thus provide a substantial body of scientific and industrial experience for the small Australian industry to utilise. A 2007 tour of sheep and goat dairies in France and Spain highlighted some critical differences between their situations and that of ours in Australia. The most significant were:

- **Year-round milk production is of more importance in Australia:** European industries are based on seasonal milking that inevitably reduces prices. Consequently the Australian industries' competitive advantage is to produce fresh product with short shelf life for the domestic market. This necessitates year-round production in the face of annual cycles of photoperiod that induce changes in both animal reproduction and milk production. Year-round milking also makes it possible to vary the interval between lactations.
- **Both sheep and goats milked in France and Spain are genetically superior to those milked in Australia:** Sheep dairying in Greece, Spain and France is carried out with millions of sheep, derived from government-supported breeding programs that have led to breeds such as Lacunae, Chios and Assaf that routinely yield over 300 litres of milk. In contrast, East Friesland cross ewes milked at Meredith Dairy yield on average about 200 litres of milk per lactation.
- **Concentrates form a more substantial portion of the ration than forage in Europe:** European goats are housed and fed concentrates from weaning to puberty which leads to rapid growth rates while lactating goats are fed a mix of hay and concentrates. Feeding practices in Australia have generally included pasture feeding from weaning to puberty with concentrates added later.

These observations, together with findings from previous research using dairy animals, suggest a number of management strategies that, trialled successfully and evaluated rigorously, could be used in the Australian dairy sheep and goat industry.

Aims/objectives

The project aimed to establish technologies that would enable sheep and dairy goat farmers to cost-effectively produce year-round supplies of milk. Specific objectives included:

1. Determine how to manipulate photoperiod to increase milk production in sheep and goats
2. Determine optimum growth curves and optimum age and weight at first joining in dairy lambs and kids
3. Determine the optimum lactation length in goats
4. Determine the yield penalty from suckling lambs for several weeks before weaning
5. Evaluate the genetic merit of the Awassi breed
6. Determine how to maximise the intake of energy as whole grain and conserved grass (hay and silage), while minimising the incidence of acidosis in goats.

Methods used

Three methods of escalating effort were made to achieve each objective:

1. A comprehensive review of the scientific literature was first undertaken to determine which objectives could be met through published knowledge obtained using controlled experimentation in other countries, or in other species. Insights obtained in this way were corroborated by changing management practices at Meredith Dairy, Meredith, Victoria, to reflect them, and observing whether the desired change in milk production, animal health, or productivity was obtained.
2. When a gap in the literature was discovered, retrospective studies of the lactation records, and live-weight records of Meredith Dairy were conducted. The sheep and goats at Meredith Dairy have eartags used for radio frequency identification (RFID), which allows milk volume to be recorded at every milking for every animal, and live weight to be obtained at all stages of the production cycle (for example, weaning, joining, or kidding).
3. Some objectives could only be met by conducting controlled experiments, which were also undertaken at Meredith Dairy; for example to establish the effect of increased photoperiod on milk production.

Results and key findings

The results and key findings for experiments into **optimising reproduction** for increasing the efficiency of milk production include:

- Extended photoperiod influenced milk production throughout lactation, but the main benefits were in late lactation where both milk volume and yield of milk protein were increased. This was determined by randomly allocating goats in either early (5 to 20 days in milk) or late (190 to 210 days in milk) to either a normal photoperiod or a long day photoperiod (16 hours light, 8 hours dark) for 8 weeks (see Fig. 1).

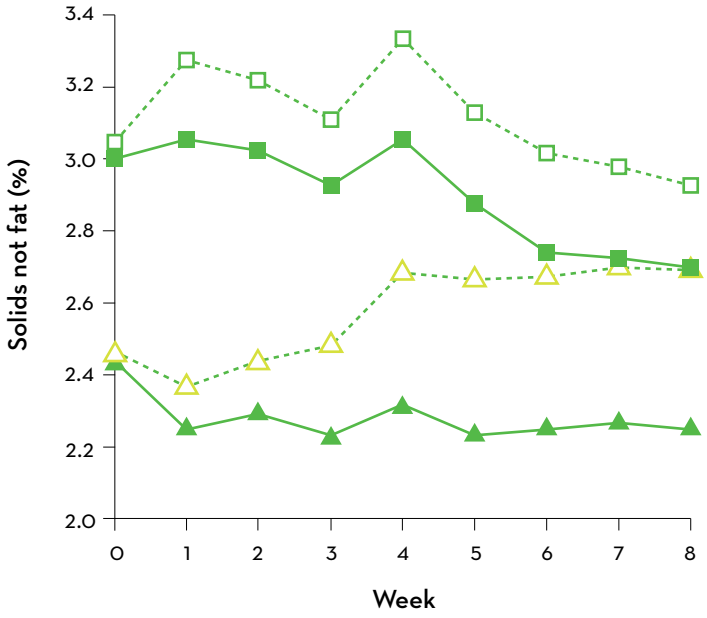

Fig.1 Relationships between milk relative to baseline (week 0), for does receiving natural lighting in early (■) or late (▲) lactation and does exposed to LDPP in early (□) or late (△) lactation. The standard error of the difference for the interaction between treatment, stage of lactation and week is displayed on the data for the does receiving natural lighting during early lactation. The P-values for effects of photperiod (P), stage of lactation (S), week of treatment (W), P x S, P x W, S x W and P x S x W were <0.001, <0.001, 0.47, <0.001 and <0.001.

- While artificial lighting in late lactation is a cost-effective means of increasing milk production, lighting should not commence until late April, and joining should be completed within 8 weeks of lighting commencing. When a plasma progesterone concentration of greater than 1.5 pmol per litre was used as evidence of ovulation, the results show that under natural photoperiod, ovulatory activity was largely maintained until August, whereas under extended photoperiod ovulatory activity significantly declined by July. Exposure to males slightly alleviated this inhibitory effect of light.
- Joining goats at 7 months of age is more profitable than joining at 10 months of age. This is because a penalty of 0.25 litres per day of milk (the difference in milk production in the first 60 days of lactation for goats completing pregnancy and entering the dairy as 7-month old (1.75 litres per day) or 10-month old goats (2.01 litres per day) equates to only 75 litres in a 300-day lactation. Goats joined at 7 months of age had produced an average of about 150 litres of milk by the time those joined at 10 months of age would have kidded.
- A database built from information collected at Meredith Dairy including age at which a ewe lamb reaches 45 kg (i.e. 60 per cent of mature live weight), weight at lambing and 200-day milk production at first and subsequent lactations was investigated to determine optimum age and weight at first joining in dairy lambs. Analyses indicated that 210 days and 45 kg are below the threshold values that permit a maximum yield at first lactation, although correlations found indicate that only about 10 per cent of yield is explained by variation in age and weight, whereas 25 per cent of variation is due to fixed causes (which importantly, include genotype).
- Satisfactory pregnancy rates for goats can be achieved with a single mating following the use of a controlled intravaginal releasing device (CIDR) and pregnant mare serum gonadotrophin (PMSG). In comparing the time of PMSG administration relative to CIDR withdrawal, it was found that the proportion of goats pregnant was significantly higher in goats treated with PMSG two days before CIDR withdrawal, and was not increased by the insertion of a second CIDR after mating (see Table 1). Further work is required aimed at increasing the proportion coming into oestrus and to clarify whether reducing feed intake after mating increases pregnancy rates.

Table 1. The proportion of does that kidded after a single mating at synchronised oestrus, at which PMSG was given 0 or 48 hours before CIDR withdrawal, and half the mated does received a second CIDR 14 days after mating.

	Time of PMSG administration relative to CIDR withdrawal		Total
	minus 48 h	0 h	
No CIDR after mating	14/21	10/26	24/47
CIDR after mating	14/26	10/22	24/48
Total	28/47	20/48	48/95

- It is probable that the benefits of delaying joining of ewe lambs beyond 7 months age or 45 kg live weight will be more than offset by the losses of delaying the onset of both the first and subsequent lactations. However, more definitive evidence for this must await controlled experiments at which lambs are mated at pre-planned weights and ages in factorial experiments (which will be very expensive to carry out).
- Lambs in dairy ewes should be weaned within 48 hours of birth for optimum milk production. Milk production was reduced by about 25 per cent by suckling lambs for 3 to 4 weeks before milking ($P<0.01$) (see Table 2). The reduction in milk yield is a consequence of suckled ewes drying off faster and yielding less milk for a given number of days in milk.

Table 2. Mean 200-day milk yield from early weaned (lambs removed at 24 hours after birth) or suckled (lambs weaned at 3 to 4 weeks).

	n	Total milk yield per sheep (L)
Early weaned	117	173.36
Suckled	161	129.70

The results and key findings from investigations evaluating the Awassi breed for **optimising genetics** for increasing the efficiency of milk production include:

- Following a breeding program involving the use of frozen Awassi semen and later the purchase of almost-purebred Awassi rams, milk production from Awassi cross ewes and East Friesland cross ewes was compared. The Awassi cross did not significantly affect milk yield compared to the East Friesland crossbreds (see Table 3) *(overleaf)*.

Table 3. The 200-day yield of Awassi cross ewes (50 per cent Awassi, about 3/8 East Friesland) and East Friesland cross ewes (EF: about 5/8 East Friesland, self-replacing Meredith stock), at first and second lactation, where lambs were weaned at 24 hours after lambing, or 3 to 4 weeks after lambing.

Wean	Lactation	Breed	n	200-day yield (L)	SE
24 hours	1	Awassi	109	157	7
	2	Awassi	72	202	17
3 weeks	1	Awassi	18	140	37
	2	Awassi	39	156	21
24 hours	1	EF	1058	152	5
	2	EF	1169	205	5
3 weeks	1	EF	268	112	8
	2	EF	249	176	8

- The Awassi cross sheep had an extraordinary susceptibility to footrot. A strain that has been present at Meredith Dairy for many years, and is benign in the East Friesland cross ewes, was virulent in the Awassi cross ewes.
- The Awassi crossbreds also have a relatively flighty temperament and the lambs are remarkably difficult to train to drink from an automatic lamb rearing machine.
- The Awassi breed may increase milk production by an as yet to be fully defined amount, but substantial effort will be required to turn them into an easy-care breed.

The results and key findings for investigations into **optimising nutrition** for increasing the efficiency of milk production include:

- Neutral detergent fibre of 30 per cent of the ration will prevent sub-acute ruminal acidosis. Provided this parameter is fixed (along with the per cent of protein in the ration) carbohydrate source has little measurable effect on milk production. Experiments incorporated either cracked wheat, BioProtect-treated cracked wheat or cracked corn into the feeding ration of goats in late pregnancy and early lactation. It was found that there was no statistical difference between treatment groups for milk solids, milk fat and milk protein. Neither feed intake, nor milk production varied with treatment, meaning that wheat is suitable for feeding during the transition from pregnancy to lactation. This is satisfactory, insofar as wheat is usually the cheapest source of metabolisable energy in Australia (aside from pasture).
- One feeder space per two animals is adequate for dairy goats fed total mixed ration ad libitum. To determine if milk yield, weight gain and feed intake in fresh milking dairy goats are affected by altering pen space and feeding space, early lactation goats were placed into one of four treatments (normal (N: 1.5 square metre per goat) or high (H: 1 square metre per goat) stocking density; together with either one feeder space per goat (N: 30 cm per goat) or one feeder space per two goats (R: 15 cm per goat); see Fig. 2)). The goats remained in each treatment for a period of two weeks and then changed to a different treatment such that each goat experienced each treatment. The mean milk production for the first two treatment periods showed no significant difference between any of the four treatments. A preliminary analysis shows no difference in feed intake, milk composition or agonistic behaviour between the four treatments.
- The current recommendation of 1.5 square metres of floor space does not limit milk production in milking goats.

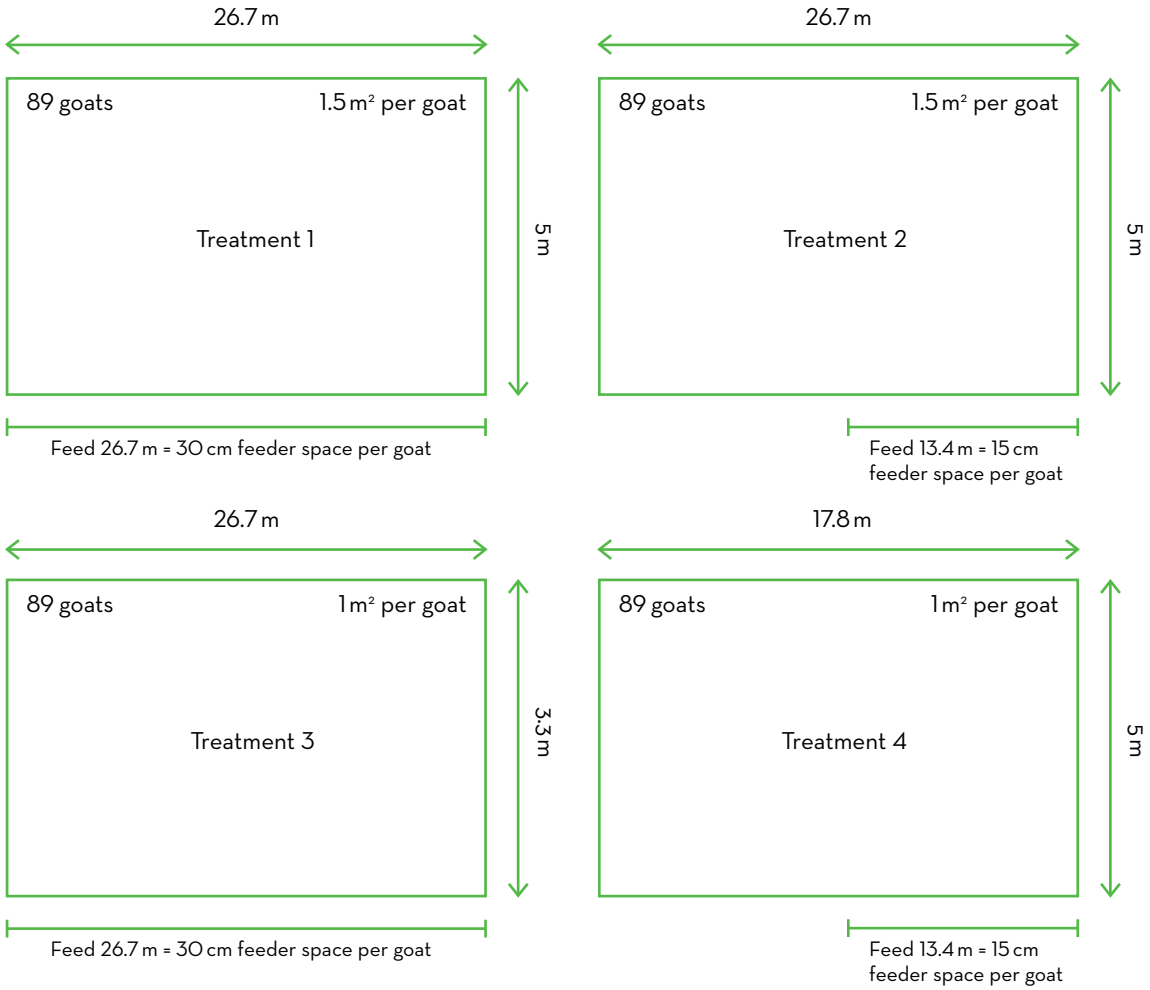

Fig. 2. Experimental design. Animals in four treatment groups: 1 – (N,N); 2 – (N,R); 3 – (H,N); and 4 – (H,R).

Implications

The findings can be immediately applied by sheep and goat dairy producers, and if applied, could increase their production and reduce their cost of production.

Meredith Dairy has approximately doubled its production of sheep and goat milk since this project was initiated, and increased employment by about 30 full time equivalent staff. Much of this is due to ongoing investment, but this investment has been made partly due to confidence engendered by running the above R&D program.

The full version of RIRDC Publication number 14/070 titled: *Optimising genetics, reproduction and nutrition of dairy sheep and goats*, by Alexander Cameron, can be obtained electronically from RIRDC's website: www.rirdc.gov.au

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