

The sheep dairy industry in New Zealand: a review

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Introduction

In early 2014, there were five sheep dairy operations in New Zealand, ranging in size from one small flock of 70 ewes to what we believe to be the largest sheep dairy operator in the world, Blue River Dairy (BRD), with over 20,000 ewes. Two of the five producers are survivors of the industry's early commercial start-up phase in the late 1990s, following the importation of East Friesian sheep in 1992 (Allison 1995; 1996). All the producers are involved in some way in producing cheese or supplying makers of artisan cheese. But the commissioning of Blue River's powder plant in 2013, and the expected supply of sheep milk in 2015 to the dryer unit belonging to Food Innovation Waikato, points to a significant shift in the industry in the last few years.

The success of Blue River Dairy, and the growth of the Hamilton-based dairy-goat cooperative, encouraged Government's commercial-research-funding agency, Ministry of Business, Innovation and Employment, to support a bid by the Crown Research Institute, AgResearch, and three of the existing dairy operators, for \$5.5 million in funding to support the nascent industry. Further evidence of institutional interest was evidenced by the 2014 Nuffield Scholarship Awarded to Lucy Griffiths who travelled to the US, China, Israel and Europe to study sheep dairying (Griffiths 2015), and by three papers presented to this society (King 2014; McMillan 2014a & b). Elsewhere, interest was largely expressed in 'backroom conversations' and rumours.

Landcorp Farming Ltd (Landcorp) had privately been considering the case for investing in sheep dairying for some years under its previous CEO. Its new CEO, Steve Carden, confirmed plans in December 2014 to convert one of its Wairakei Pastoral conversions to sheep milking. Recently it made public plans to convert two more of these farms to sheep dairying. Assuming all three will milk around the same number of animals then Landcorp's joint-venture company 'Spring Sheep Dairy' may well be milking 10,000 sheep on the central plateau site by 2020.

On the back of these developments and interest, we believed that the fledgling industry was on the verge of further development and so, with the help of Linda Samuelsson, the AgResearch leader for its Sheep Dairying Project, went ahead with plans to organise a conference.

This paper introduces the current dairy operators, and then describes presentations made at the Ewe Milk Products and Sheep Dairy Conference held at FoodHQ in February

2015. We identify key points from the conference sessions and draw out key conclusions reached. The conference has also been briefly reviewed by Buckley (2015). We also outline important developments that have occurred since the conference.

Existing dairy sheep operations

Blue River Dairies

Blue River Dairies commenced in 2004 with about 2500 ewes, grew markedly and now has several flocks with an average size of 2800 ewes (McMillan et al. 2014b). In 2004 the current owner, Keith Neylon, purchased the assets of the original Blue River Dairy cooperative of five farmers who originally produced milk only for feta cheese production. The flock is described as East Friesian (EF) cross and, whilst exact numbers are not available, McMillan et al. (2014b) presented data on this flock based upon milk yields of 26,603 ewes. Production is over 300 litres per ewe in 160 days (McMillan et al. 2014a). Cheeses are still produced locally but most milk has been exported as powder to Indonesia and China. BRD is understood to have suffered difficulties in the China trade when access for BRD infant formula to the Chinese markets ceased (following the Fonterra/AgResearch botulism scare). In part, as a response to this, BRD sold its Invercargill processing plant and its brand to Chinese interests in January 2015. The purchaser, Blue River Nutrition HK, will continue to process milk from Antara Ag farms, the renamed farming-side of Keith Neylon's business. Antara aims to concentrate on expanding farming and milk-production operations (McCarthy 2015).

Kingsmeade

"Kingsmeade" owned by Miles and Janet King at Masterton has been operating since 1996 (King et al. 2013). About 160 EF ewes grazing on 11 ha (with very limited supplementation) produce around 150 litres of milk after lambs are weaned, enabling the production of 8.5 tonnes of artisan cheese, which is manufactured on site and sold mainly in their retail outlet on the nearby state highway. Using selection based upon temperament, health and lactation length, Kingsmeade has developed arguably the top pure-bred EF dairy flock in New Zealand. The business has remained viable because of excellent animal husbandry, attention to detail in the factory, and because it had remained small and is vertically integrated from sheep to market, enabling close control by Miles and Janet.

Improvements in cheese manufacturing and marketing are ongoing and herd testing along with participation in a small sire-proving scheme is expected to improve production.

Waituhi Kuratau Maori trust

Since 2005, the Waituhi Kuratau Maori trust (WKT) has been milking EF-cross ewes at Kuratau near Turangi. In November 2013, Edwards (2013) reported that WKT had a nucleus of 4500 milking ewes and exported 90% of product to Australia, the remainder used for local yoghurt production. WKT formed Kuratau Yoghurt in partnership with Kate and Damien (James) Clairmont, owners of Waiheke Island Cheese Company. Kuratau Yoghurt started operations in 2013, producing the Hipi (Maori for sheep) yoghurt brand. Details of the WKT operation were summarised by Edwards (2013). According to William Konui (CEO), WKT did not milk in the 2014-15 season, following difficulties in obtaining appropriate certification, but expects to return to full production in the new season. Peter Gatley (ex LIC geneticist) has been appointed general manager of WKT. Milk will go to Waikato Innovation's drier in Hamilton for export to China (Stuff 2015). WKT's plans include some collaboration with Spring Sheep Dairy, the Landcorp-SLC joint venture, over pre-processing milk storage (see below).

Andy and Kat Gunson

Andy and Kat Gunson milk 85 ewes at Waiwhare in Hawkes Bay producing about 200 litres per ewe that is sold to Origin Earth, which has a small factory at Havelock North. Origin Earth produces cheese, yoghurt and milk which are sold via the company's factory, Hawkes Bay Farmers Market, and to local restaurants and retailers. Details of the Gunson's production are given below.

Neudorf Dairy

Neudorf Dairy, owned by Brian and Sharon Beuke, produced cheeses and yoghurt at upper Moutere, near Nelson, since 2005. In 2014, the flock was sold to Landcorp and production has ceased.

Planned dairy sheep operations

Landcorp Farming Limited (Landcorp) announced in December 2014 their intention to milk sheep at their St Kilda sheep dairy unit near Taupo and have been buying sheep with dairy potential throughout New Zealand. In early June, they announced the appointment as sheep dairy farm manager, of John Rylie who is President of the British Sheep Dairy Association and who was keynote speaker at the Milk Products and Sheep Dairy Conference. Until recently, John had been the manager of "Orchid Meadow Farm" in Dorset England, a sheep dairy farm milking 1,500 ewes lambing throughout the year. The Landcorp farm will contract to supply the joint-venture company, "Spring Sheep Dairy" (Scoop 2015).

Guy and Sue Trafford own a 10-hectare block at Charing Cross, near Darfield, and another small leased block. They will begin milking operations in spring 2015.

Sandra and Dave Rae purchased 16 EF ewes from Waipu and intend to milk them on their property at Waikanae;

the milk may go to Kingsmeade. Keith Fergusson was one of the early buyers of EF from Silverstream (Allison 1995; 1996). He still has access to some of the sheep and hopes to milk at Matakahe. Several other people have indicated to us their intention or interest in beginning sheep dairy operations.

Ewe milk products and sheep dairy conference

In February 2015, the authors organised a two-day conference held at FoodHD in Palmerston North. The conference was organised in several themed workshops and a central "exploratorium" which offered participants the chance to observe sheep milking and simple cheese making and to taste products produced from sheep milk. Plenary speakers were Lucy Griffiths and John Rylie. The workshops are summarised below. Some speakers submitted abstracts which are published at the end of this volume of the proceedings, and recordings of the conference can be accessed at http://www.massey.ac.nz/massey/learning/colleges/college-business/school-of-management/research/sheep-dairy-new-zealand/sheep-dairy-new-zealand_home.cfm.

The conference was opened by Miles and Janet King, who told us of their experiences setting up their business, from developing the husbandry methods, to obtaining compliance for cheese making, with entertaining anecdotes. A particularly instructive story was that of ewe "Yellow 70", their ewe which produced 35 lambs and 288 kg of cheese in 12 years, earning over \$15,700 for Kingsmeade.

First Plenary Session: Lucy Griffiths (Nuffield Scholar)

Lucy spoke of the immense potential of the New Zealand sheep dairy industry, potentially a billion dollar industry in 10 years time. Lucy reported on her overseas visits to France, USA, Switzerland, Italy and Israel.

In France, Roquefort largely controls the industry; 1700 suppliers work together to produce the iconic cheese which retails for \$140/kg in NZ. Lucy asked how NZ might produce a global premium brand that will stand the test of time. She visited a farm where the Lacaune breed produced 330 litres in a 210-day lactation, were fed lucerne and white clover, housed throughout winter, and at night only for the rest of the year.

Lucy reported that the USA has over 100 sheep dairies (most in Wisconsin), some with over 1000 ewes, but most are small artisan companies and sell milk and dairy products at premium prices over goats milk (retail US\$10.99/l).

In Switzerland, the farmer Lucy visited had Lacaune ewes which produced 400-450 l per lactation, weaning lambs at five weeks of age. The farm-gate milk price of NZ\$3.74/l was the highest she saw in her travels. Lambs were sold as milk-fed lambs at 4 kg carcass weight for NZ\$14.50/kg. Sheep were indoors during the day and out at night in summer, and housed all winter. Lucy mentioned the growing popularity of dairy products such as sheep yoghurt as a sports food. AVH, sheep-and-goat-product traders in Netherlands, has been bought by large dairy group Emmi

(Switzerland) due to growth in artisan cheeses and lactose intolerance. “How many other large dairy groups are eyeing up sheep dairy?” she asked

Italy has the oldest sheep dairies and great variety in products; the most famous sheep cheese is Pecorino. Merino ewes producing 3-400 ml per day graze herbs in mountain pastures. City dwellers may “adopt” a ewe and get products and discounted accommodation on farm.

Lucy described the UK dairy industry as “emerging”. The farm she studied milked 550 Friesland ewes with 250 replacements. The average MY was 650 litres in 300 days. They were fed a high-energy TMR at 3.5-4 kg/d.

Israel was summarised as “efficient”. As a new industry it was not hamstrung by a history of management such as lambing practices, but rather sought best practice. Timing of decisions is absolutely critical to achieve lambing three times in two years. The Assaf breed (a cross between East Friesian and the Awassi) produces on average 670 l/ewe. All animals are housed and fed TMR according to their stage of production, each with EID; milk meters are used with an EFMilk milk-monitoring system. All milk is used for making feta. The profit was \$169 per sheep.

Lucy’s business plan is available; in summary the aim is to produce the highest-quality sheep dairy products and obtain top prices. Health, tradition and fashion drive demand for milk dairy products. BRD has experienced a 50% increase in milk power price in last three year (BRD sale news). Lucy listed several opportunities for the NZ industry emphasising the opportunity to produce on a large scale and the potential for UHT milk production (over 65% on China’s milk is UHT). Furthermore, there is a potential for fresh sheep milk export to China; Oravida now airfreights fresh cow’s milk into China. But Lucy said “don’t ignore the west; the USA is the biggest consumer of sheep cheese in world”. On the production side, marginal land and small units can be viable. In summary, Lucy said that currently we milk about 25,000 ewes on seven farms averaging 200 l/ewe sold at the farm gate for \$2/l. In 10 years we could be milking 900,000 ewes producing a billion dollars.

Consumers, markets and products workshop:

Joannie Williams is co-owner of Origin earth at Te Mata (Havelock North) producing and selling liquid milk and cheese from sheep milk and marketing mainly through Hawke Bay farmers’ markets. She said that the farmers and many Maori were among those that they engaged with, who struggled with opportunity to try drinking sheep’s milk and its products.

Abby Thompson (Riddett Institute), who is involved in product development, clarified the situation regarding intolerance to dairy products, stating that lactose is the same in all species. Justine Neylon added that milk fat globules are much smaller in sheep’s milk and so easier to digest.

Justine Neylon (Blue River Dairy) briefly summarised the products made by BRD. The company started as a cheese business making only feta and exporting to New York. However, they could not compete on the international

market. Bulk powder was not competitive so they needed a value-added product such as infant formula for the market in China and cheese for the strong market in NZ and Australia. Ice cream is a by-product of infant formula and butter is also likely to be a future product. She pointed out that “Yang” is the name for both sheep and goats in China.

James Clairmont (Waiheke Island Cheese) said they milked sheep because it was too dry for cows, and goats were not allowed in the Hauraki Gulf. He believes that success depends upon a “good story, good cheese maker and good marketing”. In the past he had joined with WKT and set up Hipi milk and yoghurt. He described dealing with supermarkets and advised that it took 12 months to reach a suitable agreement with Progressive and that with Foodstuffs, a relationship with the owner was needed. He also mentioned the importance of education of the consumer, distance to the market, terms of trade with the supermarket, the age of the product, competition with Fonterra for shelf space and ability to respond rapidly to the market with batches to order.

Andrew Ivory (Waituhi Kuratau Trust) said that the problems mentioned by James Clairmont (above) are why WKT is not producing for retail markets for the NZ market. WKT has 6000 ewes on the station with 4500 committed to milking. WKT started making cheese but had too much milk for the NZ market. Their primary market has been export to Australia where it was used to make high-quality cheeses, yoghurt and ice cream. Andrew reported concern about the image of housed sheep (to avoid walking long distance from pasture to milking). Lucy commented that in the UK, the image projected was that ewes were housed “in a hotel, cosy and warm” at night, but free-range during the day.

Brian Beuke (Neudorf Dairy) started farming dairy sheep at the same time as Miles King. He supplied a small cheese maker in Motueka. He reported that they made two major business mistakes. First, the price was too cheap, and second, they did not specialise - one can’t be expert at making ten different cheeses. Yoghurt was very successful but the challenge was to get people to taste it. Distance to market was a problem (they used a courier). For a small cheese maker, being able to sell surplus milk or buy in milk when needed would be great.

Scottie Chapman (SLC) explained that SLC is an investment and strategic-marketing company. He previously worked for Zespri International. He is currently researching the industry to find out why people buy our products. Is it luxury (high-fat ice cream etc.) or is it nutrition? He added that science knowledge is needed regarding the role of things such as calcium. We must narrow down our focus and know exactly the insight for the end consumer. How can we keep demand above supply for the next 20 years? He emphasised that we must avoid the commodity market, sell the right products in the right markets, and create the right brand that is scalable.

Comment on workshop

There is general agreement that the industry should produce premium products for discerning markets rather than low-priced commodities susceptible to price fluctuations. In New Zealand, many people are not aware of sheep-milk products and some are reluctant to sample them.

Second Plenary: John Ryrie (Chairman British Sheep Dairy Association)

John began by reminding us that sheep milking developed in places with little water and that the advantage of sheep remained. He warned that cottage industries don't get a lot of respect – when they fade away the negative/failure is remembered. He said that in Britain, sheep milk suppliers are price makers not price takers. Without advertising, there has been a 25% increase in yoghurt and 14% increase in raw-milk sales year on year.

In 2000, the farm he managed was milking 200 Dorset ewes. The owners wanted it to be organic, but there was not enough milk to justify costs, so he crossed the flock with Friesland. No selection was done as demand for milk was so high. Customers wanted milk all year round but they can't use CIDRs, so they just put a lot of ewes and a ram together. Due to photoperiod, the biggest lambing period is just before Christmas. Customers say the milk gives good cheese yield and long shelf life.

Ewes are shorn before lambing (week 14) and 150 ewes are kept in a group pen, then when they lamb, they are moved to individual pens for two days, after which lambs are removed for artificial rearing. Explaining the early removal of lambs, John stated that there is no bond between the lamb and its mother at two days of age. Lambs bleat for food but stop bleating when fed. If lambs are removed at three weeks of age, they can't get them onto the milk machine so the lambs are dependent on dry feed. Lambs are fed on milk machines *ad lib*. Lambs can't be fed on ewes as the milk is too valuable. Furthermore, if ewes are producing 4-5 l/d the lambs don't remove enough, so ewe milk yield declines.

After one week, pellets and TMR (clover silage and cereals with some protein, the same as given to milking ewes) are introduced. Lambs stay in the lamb rearing pens for 30-35 days; mortality is high after that if they continue to drink *ad lib*. milk because they get "twisted guts". John advised that after weaning, water should continue to be fed through the milk machine teats otherwise water intake is inadequate. The 9% death rate in their rearing system is lower than the national average. They initially castrated lambs with a ring at two days of age but now ring at three weeks with local anaesthetic. No rings are used on Friesland because they naturally have a short "rat" tail, no dags and no fly problems. Lambs are weaned outside onto high-clover pastured and killed at 45 kg.

At milking, they wet wipe to clean udders, and milk twice daily in 24-aside parlours with 440 sheep per labour unit. Feeding in the parlour to induce sheep to enter, increased throughput 20%. Udders are bumped – but not

in late lactation. Shifts are timed to suit key people because "they need a life". Ewes that have lambed recently are milked three times daily (10% increase in MY). In summer, those are kept inside during the day. The proportion of Dorset is being reduced; the Friesland has a 10-11 month lactation. Milk meters are only installed on one side (don't buy cheap meters). They are planning genome mapping to increase MY since, as an organic unit, they can't feed protected-protein or protected-fat diets.

Pneumonia and orf (called scabby mouth in NZ) are the main health problems. Orf on ewe's teats is a nightmare. They use a homeopathic remedy which is effective (added to the water) for orf, pneumonia, and cryptosporidium.

Other brief advice included: "Don't undersell yourselves; you are on the threshold of huge potential. There is room for everyone in the market; for hygiene standards can't extrapolate data from the cow industry; you should get six lactations per ewe easily; sheep are housed overseas – don't do it in NZ".

Processing and regulation workshop

Alaa El-Din Bekhit (Otago University scientist) (abstracts #1 & #2) studies biological functions of sheep milk using proteomic methods, and has a database of 669 proteins in whey; 229 proteins are shared with cows, so two-thirds differ. Gene ontology is used to study protein function. Sheep whey proteins are mostly involved in immune response and cellular development (cows' whey proteins are associated with metabolism and cellular growth). The mineral content of sheep milk (c.f. cow) has higher amounts of Ca P and Mn. The buffering capacity is higher in sheep's' milk which may explain some of the messages we hear about peoples' greater tolerance of sheep milk.

Wayne Young (AgResearch)(abstract #3) is a member of the 'food, nutrition and human health' team studying functionally of milk and its effect on health. He explained that allergy to milk is primarily an immune response to one or more milk proteins, which in cows' milk are most commonly beta-lactoglobulin and alpha S1 casein. However, sheep milk contains different forms of these proteins, which may be why sheep milk is preferable to sheep for some consumers.

Shane Kells (Food Waikato)(abstract #4) told us that Food Waikato established a new spray drier in 2012. Open access can offer the use of the drier and expertise in the methods and training. They can wet mix and add value to sheep milk. They could thermalise (65 degrees for 15 seconds, not pasteurise) every second day, and hold liquid over and dry a batch once per week to make it effective. The evaporator runs at 3800l/h. Minimum volume is 10,000 litres or enough for four hours.

Richard Archer (Massey University) pointed out that since farms will develop long distances from processors, liquid milk may not be able to be economically and frequently transported. Milk can be frozen to make cheese & yoghurt but it won't last for six months and can't be used for UHT. In large volumes of milk, the water is frozen out

first and salts and casein concentrate in the middle. The casein molecules touch each other and don't let go, so the casein precipitates when the milk is thawed. Richard outlined the problems of freezing milk and mentioned his research into freezing it in small quantities, and that further research will follow.

Kevin Gilbert (Thermoflo) Design and build small- to medium-scale processing plants which produce pasteurized (72 degrees for 15 seconds), extended-life (132 degrees) or UHT (142 degrees) milk.

Comment on workshop

New Zealand has scientists and food technologists who are already intimately involved in the sheep dairy industry, or who are capable of contributing at minimal notice, if funding is available.

Farm operations and management workshop

Ken Geenty (retired sheep dairy researcher; consultant) (abstract #5) presented results from a series of sheep-milking experiments at the Templeton Research Station in the late 1970s. Variance in MY between and within breeds was very high. Ewes suckling lambs produced more milk than milked ewes, and those milked without oxytocin produced even less (Geenty 1980). Production data from ewes weaned at four, six and eight weeks were presented along with the effects of frequency of milking and udder stimulation (both resulted in 20% increase) (Geenty & Davison 1982). Herbage allowance should be at least 5 kgDM/ewe/day for a milking ewe to reach her potential production.

Linda Samuelsson (scientist AgResearch) (abstract #6) outlined the research program at AgResearch. Studies include milk composition, the value of milk for human health, storage and processing of milk, ways to increase milk yield, increased lifetime of milk, healthier early weaned lambs, and to endorse the sustainability of sheep dairy production.

David Stevens (scientist AgResearch) (abstract #7) discussed lamb-rearing systems, emphasising reducing cost, enhancing early rumen development, and the effect of early life nutrition on lifetime performance. He discussed the role of housing relative to cost and the use of human food by-products for sheep, how to provide nutritional targets in variable climatic conditions (what supplements and when) and how they alter the milk profile.

Sue McCoard (Scientist AgResearch) (abstract #8) summarised research on early weaning systems including weaning at four weeks of age and use of artificial feeding, development of the gut, metabolism and immune system. Studies involved feeding high amounts of milk and low amounts of TMR and fibre-based supplement. Weaning at four weeks of age was successful. David Stevens described a larger-scale trial at BRD using machine feeders (abstract #5).

Guy Trafford (Lincoln University scientist and budding sheep dairy farmer) described computer modelling of lamb-rearing systems to compare profitability. A sharemilking system in which lambs were kept on the ewe

for six weeks and ewes were milked once per day was much more profitable due to lower lamb-rearing costs, compared to systems in which lambs are removed from the mother early and artificially fed. In real lamb-rearing experience the problem of bloat was solved by using cold milk and improved hygiene. Acidosis in grain-fed lambs was solved by *ad lib.* use of baking soda.

Chris Smith (scientist AgResearch) (abstract #9) spoke about effluent management on intensive sheep dairy farms. There is no published information about the environmental impact of sheep dairy. Compared to dairy and beef cows, dairy sheep farms have a different pattern of nutrient movement and different effluent disposal problems. They plan to model the sheep dairy system using "Overseer" based upon dairy goats, and to design a low-N sheep system and benchmark it against other industries. Effluent disposal systems such as pod sprinkling are being investigated. Nutrition of the ewes can greatly affect the content of the effluent. The high-input farming system at BRD is being compared with the low-input system at Kingsmeade.

Andy and Kat Gunson (sheep dairy owners) (abstract #10) operate a five-hectare milking platform and 14-ha leased runoff for winter grazing (mostly swedes). Lambs (average birth weight 4.3 kg) are reared on the ewes and weaned at about six weeks. They have significant problems with worm burden so lambs don't go in the milking flock of EF crossbreds. Lambs are sold "store" as soon as possible (first spring sale) to get them out of the system. They run two separate flocks, the first flock lambing beginning 7th July (over 26 days) and the second lambing in November. Lambs are removed and milking the first flock starts 7th September. True lambing percentage (ewes tupped/lambs weaned) is 45% in the first flock (many two toothers) and 105% in second flock (many hoggets). Changes in milk composition of some ewes influence the production of cheese and yoghurt significantly, so they are dried off early. About half to the first flock are milked for the full season.

Milk yield and composition is monitored – when changes in composition in late lactation of the first flock affect cheese manufacture, milkers are brought in from the second flock. When production falls below 1 l/d in summer, and if feed is not available, milking stops. Increasing production in the second flock is a high priority for the future. Milk composition is about 18% total solid on average, but rises rapidly in November. Total production was 15,400 l of milk with 2659 kg total solids, worth about \$30,000 at a pay-out of \$11.60 kg. The top 50% of ewes milked for 192 days, produced 109 litres (plus a lamb growing at 4-500 g/day). Milk revenue was \$416/ewe, milk solids production was 532 kg/ha and 37/kg/ewe.

Nick Lyttle (Mineral Systems Limited; Abstract #11) discussed the nutritional basis of animal disease and poor production. His business uses pasture and soil analyses to try to provide appropriate nutrition for dairy animals. Nutrition can limit the ability of animals to reach genetic potential. Fertilizer program and supplementation are important to health and production.

Ian MacDonald (dairy sheep breeder; Xcell) (abstract #12) outlined the cost of milking equipment as barrier to entry to the sheep dairy industry. He showed a video of a prototype mobile sheep-milking plant that he has developed.

Sam Peterson (Scientist Massey; abstract #13) presented data showing results of experiments studying sheep lactation. Spring-lambing ewes gave birth to lambs about 0.5 kg heavier and produced 40% more milk in the first week of lactation than those lambing in autumn (Peterson et al. 1990). Seasonal differences had little effect on whole-lactation milk yields of Romney ewes but affected the production of EF (Peterson et al. 2005; 2006b). Management factors such drenching, moving ewes onto crops, and time of shearing have large effects on milk yield (MY). Ewes bearing triplets produce little or no more milk than those bearing twins, and twin lambs grow faster than triplets (Peterson et al. 2006a).

William McMillan (retired scientist; private consultant) (abstract #14) spoke about the high milk production from sheep grazed in large flocks at BRD (McMillan 2014a). Ewes are milked from soon after lambing and reached peak production of about 3 l/d in the first week whilst hoggets produced 1.5 l/d peaking at day 35. Mean production over 160 days was 2 litres per day and 1.3 l/d for hoggets. Estimated cumulative MY over the whole lactation was ewes 355-375 l and hoggets 250 l if dried off at 0.3 l/d. Annual feed requirements were 750 kg DM and hoggets 600-650 kg DM. From the lactation curve, it is calculated that leaving the lamb on the ewe for a month cost a quarter of total MY, and for two months, half of total MY is lost, so development of cheaper early weaning system is imperative. He defined a high-performance ewe as one which produces four times her body weight in one lactation. He also reminded us of the existence Sheep Milking Technical Manual (Butcher et al. 1997).

Comment on workshop

The production data and payouts earned indicate that the sheep dairy farming is financially viable. It is clear that a major decision for any sheep dairy farmer is “what to do with the lambs” and that there are differing opinions regarding the best system for rearing lambs. William McMillan proposed that losing a quarter to a half of the milk by feeding it to lambs is prohibitive, but the modelling analysis by Guy Trafford’s honours student showed that the cheapest system was indeed “sharemilking” by leaving the lamb to suckle the ewe for a month or more. Unless definitive on-farm studies are done to resolve this, farmers will have to try various systems for themselves. It is likely that different systems will suit different farmers and be advantageous in different environments.

Sheep breeding workshop

Jock Allison (retired scientist; private consultant) (abstract #15) talked about the importations of the Awassi and the East Friesian in which he was instrumental (Allison 1996), and how they might be best utilised now. He

presented results from crossbred EF animals as hoggets and 2-tooths and emphasised that the EF and the Awassi must be used, as selection within populations of existing breeds will be slow, and to select those which can fit in with whatever management system we adopt, or adopt the management systems to better suit the very high producers.

William McMillan (abstract #16) reported on the promising early progress in improving the BRD flock using the methods described by Lopez-Villalobos (McMillan 2014b). Milk yield in excess of 200 litres have been achieved and, in future, progeny testing and additional traits (live weight, milk components, somatic cell count, and udder traits) will be included.

Nicolas Lopez-Villalobos (abstract #17) described methods for estimated breeding values for lactation yield of milk and lactation length (LL) of crossbred EF ewes lambing all year round, concluding that a selection index can be implemented to select ewes for high yields of milk and long lactation lengths. Breeding values for specific factors and production indices can also be produced.

John McEwen (Scientist AgResearch) (abstract #18) pointed out that, in a developed industry, about half of increased production comes from genetic improvement and that NZ has excellent sheep-recording systems. He discussed sources of good dairy genotypes in the Northern hemisphere. Genomic technologies, including SNP chips (which measure genetic variation), can be used to calculate breed composition and diversity. Dorset, EF and Lacaune were suggested as sources of high genetic diversity. Sheep in NZ can be searched to see what genes for milk are available without importation. The reported annual rate of improvement of 5.3 l/y in the Lacaune breed requires good selection systems and artificial insemination. He drew some of his information from ICAR (2014).

Ken Geenty (retired scientist, private consultant) provided similar data on the rate of improvement in the Lacaune and reiterated the importance of genetic selection. A main point was the great amount of genetic diversity in NZ breeds, such as the Dorset with more than 2.5 l per day difference between the highest and lowest producers. Selection within an existing breed is a good way to start, and breeders should consider indirect measures of MY such as udder size and shape. However, farmers should introduce specific dairy breeds when they become available and join a selection and breeding program.

Ian MacDonald (dairy sheep breeder; Xcell) milks sheep in order to select them for breeding. He described selection based upon two features – centre crease of the udder and teat placement. He uses a selection index with weighting of 6 for MY, 2 for lamb weaning weight at 30 d, and 1 for number of lambs born.

Comment on workshop

The animal breeders do not agree on the next step to be taken – which breeds to milk in the short term. Jock Allison says we should not milk “British breeds” but should start with at least half EF. He also supports the importation

of further EF bloodlines and new breeds, particularly the Lacaune. In stark contrast, Ken Geenty, believes that the very large variance within existing NZ sheep will provide the basis for rapid improvement through selection and breeding. He does acknowledge that ultimately using EF or Lacaune genes will be necessary. All agree that an effective breeding scheme is required. We believe that there is a danger in relying on further importations of high-producing dairy ewes. Although there have been marked improvements in MY in overseas' breeds, they have been selected in intensively farmed environments where they are often housed and fed TMR, a far cry from the pastoral system currently used in New Zealand. In the cow dairy industry, we have seen the dramatic effect of the importation of North American Holstein genes to the NZ dairy cow population. Although increased MY has been achieved, the volumes do not approach those of North America and the cost has been high in terms of reduced fertility, increased problems with metabolic conditions, increased need for costly feed supplements, and reduced productive lifetime. Traditional NZ sheep farmers have long held to the practice of selecting animals in the environment in which they are to be farmed; the sheep dairy industry would do well to continue that practice.

Industry structure workshop

Elena Garnevska (Agribusiness Massey) summarised aspects of cooperative structures.

Andrew MacPherson (General Manager Commercial Development Landcorp) described the company's search for something to transform NZ agriculture. They looked at many systems but they kept coming back to sheep milking; the take-home message is that he hasn't heard enough about producing high-value products. He said that we are indebted to Keith Neylon for his vision. For the future, we need a better genetic engine, and that Landcorp doesn't want to be part of a high-volume, low-value commodity production. The sheep dairy industry needs to attract the best graduates and needs to engage with Maoridom. For processing, Landcorp plans to work with Waikato Innovation, and for sales and marketing, a joint venture is planned with SLC group. Landcorp has worked with Abbey Thompson at Riddet to produce yoghurt, ice cream, and butter, and received advice on milk powder. He did not know if industry structure should involve a cooperative but does know that the industry must sell to high-value, discerning markets.

Brendan Claire (BNZ): told us that we have a blank cheque to design an industry structure; there are many possible systems but he believes it should be farmer-led. There is a shortage of capital and scale now, but access to capital should not be a problem.

Lucy Griffiths (Nuffield Scholar) made the final comments; she said we have people with all the skills necessary here in the meeting. Her experience in Britain showed that we need an annual conference and the equivalent of the British Sheep Dairy Association and the US Sheep Dairy Association. We should not limit our view to NZ – perhaps we should set up an elite global sheep dairy

network. Sheep dairy is transformative – but it will take skills and money. We have credibility in the industry now with large-scale players. Now we need premium products and markets.

In the final discussion Natalie Dang from China said that she was looking for sheep dairy product to buy.

Since the conference

A steering group has been formed to create an industry-good organisation and to consider the potential structure of the industry. On-line meetings have been held and a draft proposal has been written (http://www.massey.ac.nz/massey/fms/school_of_management/Sheep%20Dairy%20Body%20Proposal%20%28draft%29.pdf?E9BDFEF076890FCB039A24E54F1D7DB3).

Natalie Dang has formalised an agreement with Waituhi Kuratau Trust which has appointed Peter Gatley as its new general manager. Peter and Jake Chardon (ex CEO Holland Genetics) are also exploring further sheep-dairy farming options in the Taupo region. This farm will be stocked by EF ewes produced from embryos frozen since the original importation (Allison 1995;1996). It will also provide the home for a central flock for a breed improvement program run by Gatley and Chardon.

Suzanne Rowe (AgResearch) and Ken Geenty have announced a proposal for a sheep-dairy genetic-improvement scheme involving themselves and animal-breeding experts from AgResearch, Massey University, and Sheep Improvement Ltd.

Scottie Chapman (SLC), who specialises in implementing international sales strategies, has formed a joint-venture with Landcorp. The long-term goal of Spring Sheep Dairy is to export high-value, high-quality sheep-milk products to Asian consumers.

Conclusion

The vision and drive of Keith Neylon, William Konui, and Miles and Janet King, have established a small but strong base for the sheep dairy industry. The entry of Landcorp, and the new company fronted by Gatley and Chardon, into the industry confirms that there is a credible future for sheep dairying in NZ. However, the big companies will at some point likely be interested in talking to potential new producers about supply. Nevertheless, it will be up to individual farmers or groups of farmers with sufficient capital, to devise business plans that allow them to successfully enter the industry. Similarly, individuals or groups of farmers will need to decide on, and form, an industry-good organisation.

The scientific and technical community is well placed to assist the new industry if funded, and at least one commercial bank has strong interest in supporting the industry. The authors intend to continue to provide vehicles for information transfer via annual conferences, field days and email lists.

In our opinion, the sheep dairy industry is poised to expand and could build to become a billion dollar industry as indicated by Griffiths (2015). However, Geenty (1979) said pretty much the same thing.

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