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THE DOHNE MERINO IN SOUTH AFRICA

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SUMMARY

The Positioning of the Dohne Merino Breed in the South African small stock industry is quantified. Changes in breeding policy, resulting genetic change and environmental trends are presented. Possible global collaboration is stipulated.

INTRODUCTION

The Dohne Merino breed was developed at Dohne Research Station, Eastern Cape, South Africa with the initial purpose to breed wool bred sheep adapted to the harsh sourveld high rainfall conditions. The base population developed into a dual purpose breed for which an official breed society was established on 16 May, 1966. The breed gained international recognition with the establishment of the Australian Dohne Merino Society in 1999. The corner stone of the breed remains profitable production by means of relatively large flocks under commercially viable conditions. Breed improvement is based on scrutinizing large numbers of animals by means of objectively estimated breeding values supplemented by visual appraisal. The purpose of this paper is to outline the position of the breed in the South African small stock industry, to overview the current genetic improvement strategy and to mention possible international development in the near future.

The South African small stock industry-core statistics. Sheep numbers in South Africa declined from 30 million sheep in 1990 to 21 million in 2015. Concurrently wool bred sheep numbers declined by 7 million. The number of rams sold on official sales was used to estimate the market share of the Dohne Merino breed in the broader South African Merino sheep industry as 40.6 percent.

The Dohne Merino Breed Society increased to a total of 33,547 ewes in 2014. Despite a constant membership of 90 breeders, the expansion in population size in a declining industry is of some significance. The South African Dohne Merino Breed society is managed by a council consisting of 9 councilors. Membership is divided into 6 regions each with its own local management structure to promote the breed locally and to liaise with council.

Breeding objectives. *The South African economic climate.* Income generated from mutton production in absolute terms, increased dramatically from 1990 (R4.79, price per kg) to 2015 (R51.42, price per kg). Socio-economic factors dictated a decrease in mutton consumption of 30.6 percent from 1990 to 1996 where after consumption gradually increased to 93.6 percent of the level for 1990. Mutton imports are utilised when necessary to stabilize the local market at an average rate of 16.6 percent of total consumption.

The decline in wool production since 1990 (41.2 mil. kg. greasy wool), resulted from the decline in the total South African small stock population. During the same period, the average greasy wool price for merino sheep (including Dohne Merinos) increased from R6.98 to R68.63 (Table 1).

The trends in wool and mutton price indicate a long term change of 8 percent in ratio between the two prices in favour of mutton. Another significant change was the decline in the price premium (5 year rolling average used to calculate an economic weighting factor only) for fine wool by R2.00 per kg. clean wool.

Table 1: **Production and price of mutton and wool in South Africa**

Year	Mutton production (1,000 tons)	Mutton Imports (1,000 tons)	Mutton price (R/kg)	Greasy wool production (Million tons)	Greasy wool price (R/kg)
1990	206.0	17.3	4.79	74.6	6.98
1995	143.0	38.1	8.26	45.2	10.01
2000	159.0	55.1	14.62	33.5	15.52
2005	176.0	43.0	23.37	31.8	19.36
2010	155.0	8.1	40.48	31.5	43.58
2015	193.0	10.2	51.42	33.4	68.63

South African Dohne Merino policy. Economic changes necessitated the following breeding policy changes:

1 Selection for increased 12 months Body weight (initially an indirect selection criterion) was replaced by selection for growth rate, evaluated by weaning weight direct and maternal breeding values, at the end of 2013. Apart from economic considerations, 100 day measurement coincides with lamb marketing as (1) Slaughter lambs (2) lambs for feedlots or (3) veld prepared lambs marketed at a later stage. Snyman (unpublished) provided proof of 100 day measurement being accurate to estimate maternal ability of Dohne Merino ewes. The objective with this change was to promote early maturity and to retain fitness of the breed.

2 The relative importance of fibre diameter in the selection index decreased from 40.0 percent to 19.9 percent. At the same time, the amount of wool produced per head was maintained at a constant level.

It is generally accepted that the use of a selection index is the most effective method to pursue any breeding objective. In the case of South African Dohne Merinos within flock selection index averages serve as a benchmark to identify stud animals. This moderate minimum standard provides more than sufficient opportunities for individual breeders to pursue divergent within flock objectives. At this stage, insufficient proof of significant genotype by environmental interactions, hold back a final decision on the implementation of different selection indexes for different farming conditions and systems.

Genetic response. Genetic response and environmental change for the four measured traits in the Dohne merino selection Index is presented in Figure 1.

Limited response in maternal weaning weight is envisaged on account of low heritability. However maternal weaning weight was included in the selection index to improve on the non-significant trend in this trait (Figure 1). No significant change in environment (management) could be detected for both weaning weight and 12 months body weight.

Recently clean fleece weight increased very slightly (< than 100 gm. in 15 years) as possibly the result of a correlated response to selection for growth traits and less emphasis on fibre diameter. The reason being that South African breeders maintain a low wool production potential percentage (WPP%) in order to improve reproduction and retain hardiness and adaptability attributes of the breed.

Figure 1: Genetic and environmental trends in production traits of South African Dohne Merinos.

A point of concern to breeders is the further possible decline in the genetic change of fibre diameter. Increasing reproduction and growth as well as the effect of "current gains" may explain this concern. The genetic outcome of the recent reduction in selection pressure on fibre diameter is awaited before more drastic decision making will be considered.

Future challenges: A South African perspective. The South African Dohne Merino model over the past 50 years resulted in a highly successful well established breed. The system is however in need of adjustments (Minutes Dohne Merino Council Meeting, 2016) to provide for the following aspects vital to survival and expansion of the breed:

1 Locally and internationally, genomic improvement and measurement of additional traits including resistance to parasites, carcass measurements and visual scores on a routine basis, pose a serious challenge to infrastructure and financing. The development of more advanced systems will have to be carefully balanced against the additional work load and possible returns

for individual breeders. The reality of breeders resorting back to less effective genetic improvement systems at lower cost will have to be seriously addressed by not only South African breeders but the seed stock industry at large.

2 Marketing strategies have to be more focused on the role of the Dohne Merino in cross breeding systems. Additionally the useful attributes of the breed to increase commercial output from hardy indigenous sheep breeds deserve more prominence.

3 Current veterinarian protocols jeopardise effective exchange of genetic material on an international basis. Improved understanding of the global animal health status of production regions may assist to alleviate this problem.

4 Common ground should be found on an international basis to expand and adapt current within country improvement systems for the purpose of international comparisons. Global expansion of the breed should be based on internationally agreed guidelines to ensure the continued existence of the true dual-purpose character and easy care attributes of the breed.

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THE DOHNE IN AUSTRALIA

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SUMMARY

The Dohne (Merino) has provided Australian and overseas sheep producers access to sheep that are highly profitable, have and will continue to improve their productivity (Figure 1), and rams that can be selected easily and accurately relative to a breeder's objective.

Due to the great foresight by the Australian Dohne Breeders Association (ADBA) steering committee, a huge amount of training and promotion, ongoing development of the breeding system, as well as the very effective application by breeders and service providers the Dohne has thrived in Australia with approximately 20% of Australian commercial breeding ewes likely to be Dohne or their crosses with Merino. Flexibility of the breeding (including marketing) system has maintained cost effective genetic gain however, large challenges and opportunities continue and cooperation between all involved, a cornerstone of the Dohne, must be maintained. Change is an imperative, it is not an option.
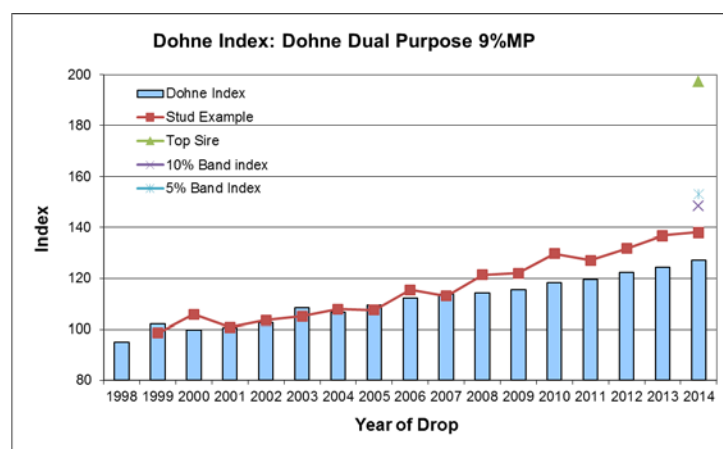
Figure 1. ADBA genetic progress relative to a commercial production index.

INTRODUCTION

In the late 1990s, Merino commercial sheep producers in Australia were experiencing a significant change in the market place to one that provided them with less return for wool relative to meat. Fortuitously for Australian sheep breeders the Republic of South Africa (RSA) had been experiencing the same market forces for more than a decade and a group of RSA commercially driven Merino breeders had responded to this market by breeding a type of Merino known as the Dohne Merino that had a production balance to match this market.

Australian breeders recognized the opportunity that the Dohne Merino (Dohnes as they would be known in Australia) provided them to meet the changing market and in 1998 they began

to import pure bred Dohne embryos. Cameron McMaster's book *'Birth of a breed. The Dohne Merino Story'* (McMaster, 2015) outlines the Australian discovery, importation and development of the Dohne, in particular Chapters 25 and 33. Cameron's *'Birth of a breed'* is a comprehensive history of the first 75 years of the Dohne after beginning of their development in 1939. The authors of this paper would like to sincerely acknowledge the many sections of the book that have been incorporated into the paper and highly recommend the book to obtain both the detail and just as importantly the story of the people who were the driving force behind the Dohne.

Due to limits on length, this paper will largely not name individuals, however the authors would like to stress that, like in South Africa, it has been the people associated with the development of the Dohne in Australia who should feel a great sense of pride in the breed's achievements. In particular, these achievements include;

- All Dohne ram buyers have the best and easiest to use independent selection information.
- Genetic productivity is continuously and rapidly improving – the 2014 drop was 30 index points more commercially productive than in the first Australian drop (Figure 1).
- A breeding system is in place to allow genetic gain to continue and at an increasing rate.
- The Dohne has had a significant influence on approximately 20% of Australian breeding ewes.

The Australian Dohne Breeders Association (ADBA). The history of Dohne sheep in Australia is very closely defined by the Dohne breed association, known as the Australian Dohne Breeders' Association (ADBA) and its ram breeding members. The ADBA has worked very effectively to promote the breed and provide service to both its ram breeding members and commercial producers.

Passionate breeders with a long term vision, not entrepreneurs, were responsible for introducing the Dohne from the RSA. In 1999, the year after the first Dohne genetics were imported, these breeders quickly formed and maintained the ADBA because they had a long term vision and understood that a single and united group of breeders could achieve so much more. A good number of these breeders had a strong understanding of the conduct of a breed association therefore the passion very quickly and effectively translated into productive action. In addition, the breeders who formed the ADBA were blessed with the support of the South African Dohne Merino Breed Society (DMBS) that provided valuable direction.

Another critical factor was the establishment and maintenance of a comprehensive across- flock performance evaluation system by the ADBA. The system was very influential in uniting breeders as it allowed new and smaller breeders the opportunity to demonstrate the true breeding value of their sheep and gave them a valuable and unique service to market to their clients.

In November 1999, a steering committee to assist the Dohne's development in Australia was formed and had its first meeting. The committee's major aim was to develop a progressive breed association that had a broad industry representation and a co-operative approach to breed development, education and promotion. The committee also had as a priority to continue the DMBS breeding objective and breeding system. It was however decided at that meeting to take a significant leap forward and base the Australian breeding system on across-flock breeding values – Estimated Breeding Values (EBVs) as they were known at the time. The ADBA bylaws included comprehensive requirements for compulsory recording of full pedigree and performance for all registered sheep. It was a requirement that the Dohne EBV performance and the inspection grade of all registered sheep would be public and it was compulsory for them to be reported at the point of sale. In October 2000, the steering committee conducted the inaugural meeting of the ADBA Limited at Katanning in Western Australia where the constitution and bylaws it proposed became the Associations base.

In the first year after the establishment of the ADBA two manuals were produced, the Dohne Ram Breeders' Manual and the Flock Breeders' Manual. The first editions of the

two manuals were released within a little over 12 months during the 2002 series of workshops. Ram breeders worked cooperatively to conduct ongoing workshops to develop ram breeders understanding and skills and promote the Dohne to commercial breeders.

   Growth of the ADBA and as a result commercial flocks. Membership of the ADBA grew rapidly, with 35 registered Dohne ram breeders (studs) by the second Annual General Meeting. By April 2002, the number of studs had risen to 51, with members in all mainland states in Australia. Numbers continued to rise rapidly and by June 2004 there were 100 studs with a corresponding rise in the number of pure bred stud Dohne sheep being bred (Figure 2) and sold by these flocks. In 2005, there were 152 stud members and in 2015 this had consolidated to 81 studs.

   As well as pure registered Dohne sheep (introduced to Australia via embryos) Dohne sheep could be bred up from registered Dohne rams mated to Dohne like Merino ewes, a strategy known as a Foundation Flock and later in 2013 and additional system known as a Nucleus Flock.
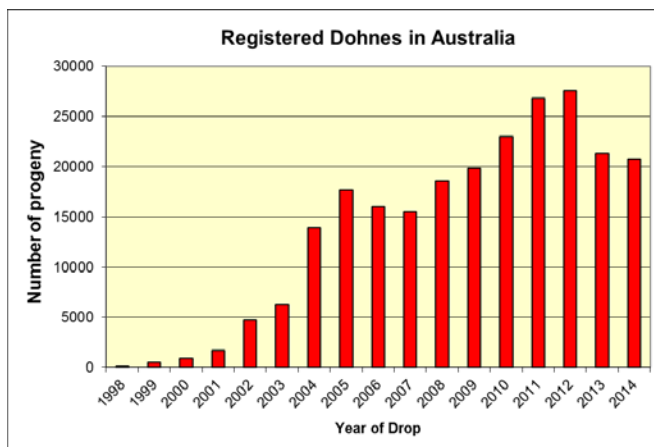
Figure 2. Number of sheep bred in registered ADBA ram breeding (stud) flocks.

   The development of ram breeding flocks. In the period from 1998 to 2002 Dohne development centred on the establishment of studs that had the capacity to meet the demand for genetic material for newly emerging studs, as well as commercial flock rams. EBVs and index values allowed ram breeders to assess the performance and genetic progress of their flock and other studs in Australia and ADBA studs overseas, and to breed and purchase the most relevant sheep. During that time the number of pure bred sheep were increasing at a rapid rate with many studs continually undertaking embryo transfer programs to meet buyer demand.

   Sale prices and clearances in the early sales were a good indication of the interest shown by both new studs establishing flocks and commercial flock breeders taking the remainder of the catalogue at prices far in excess of normal wool sheep ram prices. While these phenomenal prices were not maintained over the following years, they served as a strong incentive for Dohne breeders to increase the supply of rams. As the supply grew to meet the demand, prices eased to a more realistic level. The speed and professionalism with which the ADBA was established put the Dohne on a solid base.

   While the number of Dohne stud flocks had fallen previously it was not until the 2013 and 2014 drops that the number of stud sheep bred fell from its peak in the 2012 drop. This easing in numbers is understandable when it is taken into account that sheep numbers in Australia had been on a rapid downward trend ever since the time of importation of the first Dohnes. At that time (1997-98) the AWI, MLA Wool Production Forecasting Committee, estimated there were

120.1 million sheep in Australia. The Committee estimate that in 2014-15 this number had plummeted to 71.6 million sheep – a drop of 40%. While the number of rams required across the sheep industry has dropped by a similar proportion, the Dohne ram supply continued to increase due to demand.

The Dohne point of difference. For commercial sheep producers the increase in the value and stability of the price of meat relative to wool has been the major driver behind the uptake of Dohne sheep with their considered high lamb growth rates and reproductive performance. Low breech wrinkle, polled, self replacing, hardy and easy care all had a very positive influence.

While all these commercial influences remain very firmly in the market place many Merino studs have focused their breeding objectives (often with assistance from Dohne sires) on these traits and are now offering good performance in these areas. One only has to observe the change to polled Merinos in the last ten years to see that for Dohnes this attribute has changed from a major point of difference to being just like the great majority of Merino studs who now offer poll rams.

While lacking the apparel wool attributes of the Merino, self replacing Composite flocks have also dramatically increased in numbers over the last 10 years limiting another point of difference for breeders who wanted to breed a self replacing prime lamb dam.

The development of commercial flocks – 20% of Australian breeding ewes. Commercial Dohne flocks were established as soon as rams were available from the initial stud drops. Despite commercial production not being from purebred Dohne flocks the results were impressive. The higher reproduction performance of pure bred flocks was not yet being fully expressed. From 2002 onward, when greater numbers of flock rams became available, there was a rapid increase in commercial Dohnes, bred in most cases by using Dohne rams over Merino ewes. This extended to breeding-up to purebred Dohne flocks in order to capture all the breed's commercial advantages.

During training workshops and associated activities, Cameron McMaster observed the evidence from abattoirs, such as Q-lamb in WA and Southern Meats in NSW, clearly demonstrating that even F1 Dohne prime lambs fully met the requirements of the Australian export lamb market. This meant an assured lamb market could be achieved and confirmed the Dohne dual purpose advantage. The fact that this could be achieved in self-replacing Merino flocks, while at the same time maintaining high quality Merino wool, was seen as a major benefit in a sheep industry that was being paid for both meat and wool. Cameron's comments to breeders backed by his RSA case studies of profitability of Dohne flocks had a great deal of influence among commercial breeders.

The success of the Dohne in Australia should be judged by their contribution to commercial sheep production. To assist in understanding the influence of the Dohne we can look at the results of the tri-annual wool and sheep meat survey (AWI, MLA. 2014) conducted jointly by the Australian Wool Innovation and Meat & Livestock Australia. The most recent survey (June 2014) found approximately 20% of Australian commercial breeding ewes are likely to be Dohne or their crosses with Merino. This is a truly remarkable impact from a zero base in 2000 to only 15 years later having an influence on close to 20% of the Australian commercial breeding flock.

Ram breeder working together at a regional level. At the establishment of the ADBA there were two regions, the Western Australian region and the Eastern States region that originally included the states of Queensland, New South Wales, Victoria, South Australia and Tasmania. The first Dohne sheep were introduced into Australia by two Western Australian (WA) breeders – Alex Leach and Geoff Beeck. Effectively from that time on WA breeders have been industry leaders. This has not only been at the national level but also at a regional level. WA has continued to lead the way in working together at a regional level to develop and promote the Dohne breed. The WA region was established in July 2001. The establishment of a WA committee led to the first public auction sale of Dohne rams in Australia.

After the initial introduction of Dohnes into the Eastern States in late 1999, the establishment of registered studs progressed very quickly in New South Wales (NSW). Dohne ram breeding began in South Australia (SA) shortly after the establishment of the early studs in WA and NSW, however, more slowly in Victoria, with no registered studs listed until 2003. That same year the first Dohne stud was registered in Tasmania.

There have been many challenges and successes since the introduction of the Dohne to Australia that have been positively progressed by a cooperative approach. For examples:

Training for Assessors, ram breeders and commercial flock producers. Particularly in the first five years of Dohnes coming into Australia there was a great deal of assistance from South African breeders and the DMBS. This came primarily as assistance to source and transfer genetics to Australia. However, there was a great deal of additional assistance. This assistance was provided in many ways to individual breeders and the ADBA. Training workshops were a standout.

Henri Londt and Cameron McMaster made an immense contribution to training workshops for Assessors, ram breeders and commercial flock producers. Henri, Manager of the DMBS at the time, was invited in 1999 and again in 2000 two conduct the first two official training courses under the auspices of the developing ADBA. As a result of the training received during that trip, Bevan Taylor and Alan Clarke were appointed the first Dohne Assessors in Australia. Following an invitation by the ADBA Cameron McMaster presented a series of training workshops across Australia in April-May 2002. Cameron held several workshop series between 2002 and 2007.

It was a requirement of all registered ram breeders to attend and successfully complete a Ram Breeder Workshop. This requirement was to ensure ram breeders understood the commercial focus of the Dohne and how to conduct the required pedigree and performance evaluation, both for measured and visual traits, and in both theory and practice. However, the workshops were equally important in developing cooperation and camaraderie between breeders, and between breeders and associated service providers.

Commercial Breeder Workshops focused more on the commercial productivity of the Dohne; the Dohne type; the quality assurance system; selection using EBVs and indexes; and Dohne sheep displays. Professional training material was provided to all those who attended – overhead presentation slides and evaluations, and a hard copy manual, either a Ram Breeders' Manual or alternatively a Commercial Breeders' Manual.

A very important part of the workshops was to impart the Dohne Breed standards by means of practical demonstrations and repeated hands-on classing exercises. Cameron stressed the need for correct "type" to achieve optimum results. ADBA assessors (now called classers) and ADBA ram breeders were major contributors to plan, provide sheep, host and assist presentation.

Branding of wool from Dohne sheep. One of the biggest individual challenges that the cooperative approach faced was the decision by the Australian Wool Exchange (AWEX) in 2006 during a periodic review to make it a requirement for wool from Dohne sheep to be branded as Dohne and not as Merino. An immense amount of time and resources was given over to overcoming that decision by showing Dohne wool was equal quality to other Merino wool. By the time of the next review of the Code of Practice in 2012, wool from Australian Dohne sheep could again be branded the same as all other Merino wool. While this result was very gratifying it required a huge amount of resources that would have been used to advance many other pressing and productive matters that would have improved Dohne sheep and the sheep industry in general.

The Road Show. Following on from a meeting with state presidents in 2014, the ADBA Council embarked on the Road Show to talk face to face with as many of its stud members as possible via a minimum of one meeting in each mainland state. Major topics were establishing a Breed Development Officer, centralised funding, national promotion, and the NSW Government decision to close Advanced Breeding Services. Advanced Breeding Services had managed the Dohne pedigree and performance database and estimated breeding value analysis and reporting since Dohnes were introduced into Australia and members needed to be alerted to the changes that would be coming. The success of the Road Show in developing communications and understanding in such an efficient and effective way means it is likely there will be regular Road Shows in the future.

ADBA Life Members. Many, many breeders and service providers have made an outstanding contribution to the Dohne in Australia. A cooperative effort across all these people has been the reason why the Australia and subsequently the world have benefited from of the great foresight and development of the Dohne in the RSA. While there have been many huge contributions four have been exceptional and have been recognised with ADBA Life Memberships. Firstly Sally Coddington and David Kain both exceptional ADBA presidents as well as giving so much more. In addition, service providers Cameron McMaster and Rob Martin receive their awards in 2015 for their outstanding contributions above and beyond the service they were engaged to carry out.

Export of Dohne genetics from Australia. Australia is now the major supplier of Dohne breeding material to the world. The worldwide interest in Dohne sheep has been a result of scientific articles, presentations and travel undertaken over the last two decades by South Africa, in particular Cameron McMaster and Henri Londt. This has been aided by promotion carried out by the ADBA, Australian and overseas breeders and their service providers. DMBS breeders would have benefited directly from this promotion had South Africa not incurred an outbreak of Foot and Mouth Disease in the early 2000s and therefore are not eligible to export to most countries of interest.

Australian breeders have been able to supply Dohne genetics to the world because in addition the important awareness provided, high quality Dohnes, excellent health status, meticulous pedigree and performance records and service providers to assist the required artificial breeding programs needed. As a result, Dohne genetics have been exported from Australia to many countries including New Zealand, Uruguay, Chile, Peru, Argentina, Falklands and Russia.

The ADBA across-flock evaluation system, along with skilled breeding, has assisted overseas ADBA flocks such as Tres Arboles in Uruguay to become a major supplier of genetics in South America. The ongoing input of the very experienced scientist, Roberto Cardellino, provided on the ground expertise and continuity needed to ensure the Dohne breeding system has been very effectively undertaken. Roberto and principal of the Tres Arboles flock, Daniel Rubio, visited Australia in 2006 and participated in an ADBA Ram Breeder Workshop where they were top performers in both theory and practical sections of the workshop. Roberto went on to be appointed

by the ADBA as a Dohne Assessor. Roberto's paper at this conference will I am sure, provide much more detail on the South American situation.

The Dohne breeding system in Australia. When the ADBA was being established, the steering committee took a huge step forward to ensure world best practice in breed association conduct. The ADBA aimed to maximise genetic improvement and provide the highest quality service firstly to its ram breeding members, but most importantly to their clients. The focus was on providing a quality assured standard of excellence to commercial sheep producers. The ADBA enshrined its breeding system into its constitution and bylaws to ensure this service would be maintained at the very highest level. The breeding system included the structure of stud flocks, pedigree and performance evaluation (both measured and visual), promotion and marketing. Cameron McMaster's *'Birth of a breed'* (chapter 33) and the Australian Dohne Ram Breeders Manual (Casey *et al.* 2011) has the detail of the entire system.

At the time the use of across-flock, full pedigree, performance evaluation was a very significant innovation for wool sheep. NSW Department of Primary Industries (NSW DPI) Dr Kevin Atkins and Dr Arthur Gilmur's great skills, aided by BVEST software (developed by Dr Gilmur) allowed NSW DPI's Advanced Breeding Services to conduct the management of the ADBA Dohne Database and data analysis. Due to the foresight of the steering committee, at the inception of the ADBA Australian Dohne across-flock EBVs and index values were already being reported as a component of a comprehensive Dohne breeding system. Critically as part of the system all registered Dohne sheep were required to be evaluated by an independent ADBA approved Assessor to ensure they meet the high Dohne standard for structural and wool quality traits.

In 2005, the 'Sheep Genetics' service was established and a national Merino across-flock evaluation service began. At the time, it was not possible for the Dohne Database to be included in this evaluation as there was no significant common genetics between the two databases. While the analysis was not moved to Sheep Genetics immediately the Dohne bylaws and language used was changed to the common industry format developed for Sheep Genetics. This also meant an almost seamless transfer when Sheep Genetics in June 2011 began to carry out the Dohne genetic analysis. The ADBA continued to own and maintain the database and also the quality assurance to ensure breeder's evaluations and data met the Dohne standard.

In 1999, the first index was developed to cater for the Australian Dohne production and market place and had an emphasis that reflected both the increasing meat values and the high premiums for fineness at the time with 40% emphasis on meat traits and 60% on wool traits. The second index was introduced in 2008 and reflected the trend to relative higher lamb prices and lower premiums for fineness with the emphasis on meat traits now 65%. The most recent index initiated in 2014 reflects the continued trend toward higher meat prices and effectively has all the emphasis on meat traits with only enough emphasis on wool traits to maintain production.

The Dohne in the future. While the Dohne in Australia has very much continued the commercial flock focus that underpinned Dohne development it has also adjusted to changing circumstances, just as has been done by the DMBS and indeed by other countries who have embraced the Dohne. Change is an imperative, it is not an option. If adjustments are not made the Dohne, that has embraced technology so effectively in the past, will miss opportunities such as those that will be provided by genomics and will fall by the wayside. Embracing change does not mean that practical considerations are ignored and that all breeders need to go down the same path. This is definitely not the case.

In the past, perhaps the biggest single leap of faith and perception was made by the ADBA steering committee to embrace across flock genetic evaluation. While this technology did allow for a great deal of variation in the evaluation process that could be used by ram breeders, the ADBA bylaws in the early years required the same approach by all studs. The requirements were

very comprehensive, strict and aimed to provide high quality breeding values across all flocks. Breeders had to meet all requirements to allow rams to be sold as registered Dohnes. In the circumstances of the time, this was an invaluable approach. The result was a very rapid increase in the number of Dohne breeders, very effective and rapid adoption of complex technology, and most importantly a high rate of genetic improvement across both measured and visual traits. All these outcomes could be used to market the Dohne and its ram breeding flocks as having high quality sheep with high quality independent information to assist client's ram selection.

As ram breeders became more experienced and technology improved it was possible to introduce flexibility (and reduce costs and compliance) without a significant reduction in the high standard of the individual breeder's data or the Dohne Database as a whole. Some of the flexibility came in the form of small variations, while others were not only large; they were in areas synonymous with the Dohne breeding system in Australia and the RSA. Perhaps the most iconic was the change in April 2013 away from five grades; AA, A, B, C and UR grades, to only three grades; R (Registered), C (Cull) and UR (Unregistered). Others changes included; allowing progeny to be culled and also naturally mated before their full evaluation, removal of the requirement for eye muscle and fat depth to be evaluated, introducing post weaning age evaluation of body weight and fleece traits; establishing a "Nucleus Flock" system to introduce new genes; using new technology to collect sire and dam pedigree; trialling a system to exhibit sheep: establishing three new Dohne Breeding objectives and the list continues.

The challenge for each ADBA Council is significant because such effort goes into making the system as effective as possible. Any change from the current system seems to indicate that either an error was made in the past or on the other hand the system is dropping in quality. Neither needs to be true. New technology, new market values, new market places all legitimately bring change. Yes, due diligence is critical however, decisions need to be made efficiently so as to achieve a timely advantage and not burn out those involved. In going through the change process it must always be remembered the other people involved are just as passionate about achieving the best outcome – they are not heretics, nor are they your enemies or the enemies of the Dohne. Listen and embrace them and be flexible.

Perhaps the biggest challenge that has to be considered is should the Dohne Database be amalgamated with the Merino database and report one standard of breeding values for all apparel wool sheep. The technical challenges are relatively minor, however the market challenges are huge and need to be made in one huge step. Figure 3 displays the performance of Dohne and Merino rams evaluated in Merino Central Test Sire Evaluation and reported in Merino Superior Sires (MSS) as Australian Sheep Breeding Values. It should be noted that the Dohne rams do not have on-farm records including reproduction in the anlaysis.
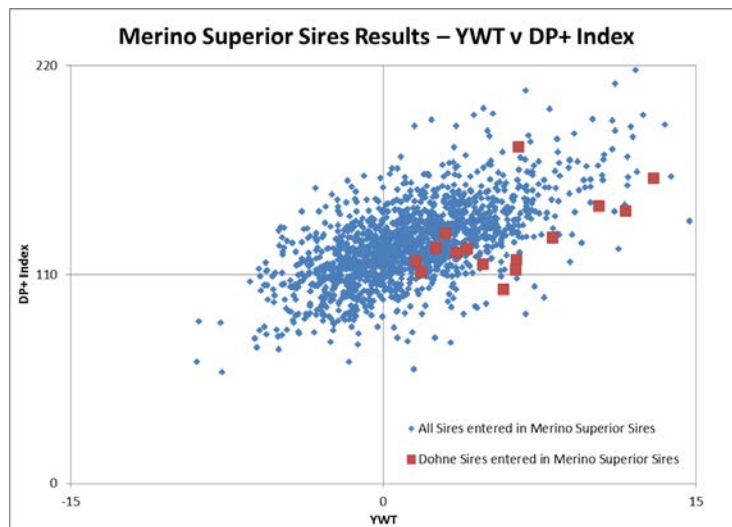
Figure 3. MSS sires performance – Merino Dual Purpose Plus (DP+) Index and Yearling Body Weight (YWT). Source: Australian Merino Sire Evaluation Association (AMSEA)

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THE DOHNE IN SOUTH AMERICA

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SUMMARY

Sheep production (meat and wool) as well as other fibres, (in particular those produced by South American camelids) in South America is very important. The two main production systems, named commercial and smallholding are briefly described, including their geographic locations. Wool is by far the main animal fibre produced in South America with a volume of 102 million kg (greasy) followed by the alpaca fiber with 4 million kg. The Dohne breed was introduced for the first time during 2002 in Uruguay, being followed by Chile, the Falkland Island, Argentina and Perú, with very good productive and economic results. It is forecasted that the use of the Dohne breed will continue being a very important tool to increase market opportunities for sheep meat and wool in these countries.

INTRODUCTION

The South American sub-continent is a vast and variable area that includes 12 independent countries and many different ecological conditions, from tropical areas in the north to temperate climates in the centre and semi-desert and cold conditions in the south. It covers a range of environments in which sheep, goats and South American domestic camelids (llama and alpaca) produce meat, fiber, milk and skins for a large number of farmers, contributing substantially to their livelihoods and to the national economies. Given the variety of ecological and socio-economical conditions it is difficult to generalize on production areas, production systems and breeding practices. Sheep are most common in the vast temperate rangelands and deserts of the south, while camelids are largely found along the Central Andean region. Sheep are for the most part dual purpose (wool-meat) whereas camelids are multipurpose. Wool is by far the most important animal fibre in South America, but other fibers, usually called "special fibers" like alpaca, llama, and mohair are also produced in large quantities (Cardellino and Mueller 2008).

Sheep producing areas. The main sheep production areas in South America are shown (Figure 1). Three main sheep areas can be distinguished. The largest one, indicated as wool producing sheep area, includes the majority of Argentina, southern Chile, Uruguay and southern Brazil. In that area, wool or dual-purpose sheep breeds prevail, mainly Merinos and derived breeds (Corriedale and Polwarth). The second area, the Criollo sheep region, includes the northern part of Argentina, and the Andean Altiplano regions of Bolivia and Perú. There is a third area, specifically a dry region in northeastern Brazil, where woolless hair sheep are raised basically for meat and skins.

Figure 1 Sheep producing areas of South America.

Sheep production systems. Two major sheep production systems can be distinguished: commercial and smallholder. Commercial systems include farmers with a variety of flock sizes depending on the region, but oriented mainly to the production of wool and meat for the market. Main areas of these production systems included in Argentina are the regions of Patagonia (dry and cold, Merino and Corriedale), Mesopotamia (mixed cattle-sheep farming, Corriedale and Polwarth) and the Pampas (mixed cropping-sheep farming, Corriedale and Romney Marsh). Uruguay, has 20,000 growers in mixed farming operations partnering beef cattle, running mainly dual-purpose sheep. In Brazil, growers run also mixed farms and are located mainly in the southern region, with predominance of dual-purpose sheep. The Patagonian region in Chile concentrates 60% of the total sheep population in the country, and involves medium to large farmers and dual-purpose sheep breeds (mainly Corriedale).

The second sheep production system is the smallholder system, which corresponds to low input, low productivity small farms with subsistence economies. Flock size is small, (20-40 head) and usually mixed with goats or camelids. Sheep are of the Criollo type (derived from the original sheep introduced by the Spanish settlers) or non-defined Criollo crosses. Main areas where these types of production systems can be found include: the Altiplano of Bolivia, a region at 3000-4500 masl (metres above sea level), involving mostly native communities; the Sierra Central Region of Peru and the area north of the Titicaca Lake, with 43% of very small producers and 32% of peasant communities. The Altiplano sheep production systems extend also to the northwest of Argentina (Tempelman and Cardellino 2007).

Table 1 shows that commercial production systems comprise some 60% of total sheep numbers and account for 85% of the wool produced. It also can be seen that most wool marketed is medium and fine wool.

Table 1. Sheep population and wool production in South American countries (2015)

Country	N° sheep (mill)	Prod. System	Fine < 24.5 mic	Medium 24.6 – 32.5 mic	Coarse/Criollo > 32.5 mic	Wool Production (mkg, greasy)
Argentina	12.2	commercial/ smallholders	29.4	15.6	1.0	46.0
Uruguay	7.0	commercial	7.5	17.5	2.0	27.0
Chile	3.0	commercial	0.2	7.6	0.2	8.0
Brazil*	3.5	commercial	1.0	8.6	1.0	10.6
Perú	9.5	smallholders	0	4.0	6.4	10.4
Total	35.2		38.1	53.3	10.6	102.0

Source: Cardellino, RC. based on different sources FLA, SUL, ODEPA, IICA, IWTO.
(*) includes only wool breed sheep

The introduction and development of the Dohne in South America. Uruguay. The predominant breeds in Uruguay are Corriedale, Merino and Polwarth, which represent 60, 20 and 10 per cent of the national sheep flock, respectively. These breeds can be defined as multi- purpose in the sense that they generate income from the sale of wool and sheep meat (surplus offspring and cast for age animals), forcing breeders to consider several traits in their selection programmes. Historically, the production of sheep meat has been a by-product of wool production, with practically no areas specialized in the production of fat lambs. However, in the last 10-15 years, as a result of low and fluctuating wool prices, better prices for lambs, meat production increased its importance in the sheep production systems, representing a higher proportion of total sheep income. So there was the need, on one hand, to reduce the diameter of Corriedale wools, that ranged between 28 and 31.5 microns, and on the other hand to increase the production of lamb meat, improving their quantity and quality.

Uruguay is the first exporter of sheep meat in the region with 25,000 ton, followed by Argentina (6,100) and Chile (5,100). However, the importance of fat lamb production and consequently prices for lamb meat are much lower than Australia and New Zealand, probably due to a less exporting capacity and also very reduced home market consumption (6,2 kg/head in Uruguay, 2,5 in Argentina and 0.3 in Chile). Uruguay, being the third world sheep meat exporter needs to export boneless sheep meat, due to its sanitary condition of "free of Foot and Mouth disease, with vaccination"

This new scenario has also led to the introduction of new breeds, some of them for terminal crossbreeding (Poll Dorset, Suffolk), and others like the Dohne Merino, to be used on Corriedale flocks to rapidly reduce the diameter of the wool, not loosing or improving the production of lamb meat. This general trend to improve meat production has also been followed by a generalized emphasis in producing finer wools, both in Merino and Corriedale flocks.

After a couple of visits to South Africa where we had the opportunity of knowing the Dohne Merino, several attempts were made (three in total) to import Dohne genetics from that country, which were unsuccessful, due to sanitary restrictions. Finally when the Dohne was imported into Australia, Tres Arboles stud imported in 2002 the first 3 rams, and 350 embryos from Summerfield stud in WA, which were followed the next year by a new importation of 4 rams, 6 ewe hoggets (to super-ovulate) and 400 embryos. An extensive program of grading up 2000 merino breeding ewes started immediately, following the standards of Australian Dohne Breeders Association in Australia. After attending a Dohne workshop at the Far Valley Dohne stud, conducted by Cameron McMaster and Allan Casey, Tres Arboles became a member of ADBA and since then, joined the genetic evaluation of Australia in order to have international breeding values (Sheep Genetics).

Gradually, several other Dohne studs were established: La Pastoral, El Piramidal, Nambi Guasu, many of which were also involved in the importation of embryos and semen from Australia. These sources included: Macquarie, Roseville Park, Uardry, Mt. Alma, Kardinia, and others. All these attempts to introduce and develop the Dohne as a well established breed, capable of producing very positive results for the Uruguayan sheep industry, were absolutely private and had no financial support of any governmental organization. The involvement of INIA (the National Research Institution) and also of SUL (the Uruguayan Wool Secretariat) in performing experimental and impartial evidence of the benefits of the Dohne in crosses with other breeds, in particular the Corriedale, was of outmost importance. Despite a small reduction in fleece wt (10%) and a small reduction in staple length, there was a reduction of the diameter in 4 microns in one generation, whiter wool (reduction of 25% in y-z values), faster growing rates (10%) and better meat quality (bigger eye muscle area with less fat).

Initial clientele were mostly Corriedale breeders, but in the last years, it has been observed a very marked increase in the number of Merino breeders wanting to improve meat characteristics, without affecting their production of wool. The last three years, average prices of Dohne rams in open sales were the highest of all the breeds. At present, there is a Uruguayan Association of Dohne Breeders (SCMD), which started to function in 2013, that includes 25 members with 15 ram breeding flocks. These numbers will probably be expanded in the near future. Estimates of the presence of Dohne genetics in the Uruguayan flock indicate, that it represents between 7 and 10%. Initially in 2013, the Association decided not to compete with animals in ram shows following what were the rules in South Africa and Australia. However in 2016, this decision was changed and now breeders can compete with animals at shows. It will be discussed how to combine objective and subjective evaluations.

Chile. Chile is a long and narrow country of the western side of the Andes mountain chain, and extends from latitude 18°S in the north to 55°S in Punta Arenas and the island of Tierra del Fuego (McMaster, 2015). Total sheep numbers is estimated in 3.0 million, and are mainly concentrated in the Provinces of Magallanes and Aysén (65%), in the southern part of the country, in the Patagonian ecological region, with 220-550 mm of rain. In this region, sheep are run extensively on units of more than 4000 animals/farm, with an average of 0.8 DSE/ha. Winters are very cold with frequent snow, so shearing and lambing usually take place in late spring-early summer. Corriedale is the main breed, producing wools between 28 and 30 microns, of very good colour. The Patagonian region produces 72% of total sheep meat in Chile, with 4 abattoirs installed in Punta Arenas and Tierra de Fuego, which are open between December and the end of May, due to a very highly concentrated offer of light lambs.

As in the other countries in South America, breeders considered that they had to investigate the possibilities of changing their dual purpose production to produce finer wools and more volume of meat with better quality. Estancia Josefina was the first breeder to import Dohne embryos and semen from Australia in 2003, to grade up Corriedale flocks. Further embryo imports by other breeders soon took place. After some trials to compare the Dohne and also the MPM (multi-purpose Merino) on Corriedale ewes in Tierra del Fuego, it was decided in many farms to substitute the Corriedale by Dohne to reduce the fibre diameter in these flocks (in order to increase the value of the wool clips), but at the same time maintain or improve the production of meat. Another Dohne breeding program started further north in the area of Aysén (also in the Patagonian region), operated by INIA (the National Research Institute) that also involved the importation of semen and embryos from Australia. Results so far are very encouraging in general, with a decrease of 5 to 8 microns and close to 10% less wool than Corriedales, which means an overall increase of 40 to 50% in the gross income from wool.

At present, there are 9 Dohne studs with pure Dohne animals in the region of Magallanes, 4 in the continent and 5 in the island of Tierra del Fuego. These breeders are in the process of

forming a Dohne Breeders Association and so far, there are no competitions in the shows; they are just taking animals to be known by other breeders. It is estimated (Vera, H., personal communication) that between 15 and 20% of the Magellan sheep flocks have Dohne blood. The prospects for the breed in Chile are very good, given the results obtained so far and the growing demand for Dohne rams.

Argentina. Sheep may be found everywhere in Argentina though with large differences in density, prevailing breeds and production systems. By far the most important one is Patagonia with two thirds of the 12.2 total million sheep of Argentina.

Argentinean Patagonia is a vast barren space covering the area south of parallel 40°; thus a temperate to cold region with average winter temperatures around 0°C and average summer temperatures around 14°C. Pacific ocean prevailing westerly-winds blow dry, cold and strong winds across Patagonia to the Atlantic Ocean. This makes the region desert-like with rainfalls ranging 100 to 300 mm mainly in winter. Heavy snows falls are common in winter, frosts can occur throughout the year. Climate in the Island of Tierra del Fuego and Magellan Strait region has more Atlantic influence and is cold but more humid and stable whereas the central region of Patagonia has more extreme weather conditions (centre of Chubut and Santa Cruz Provinces). Patagonia has become a strong tourist attraction due to its marine wildlife, fly-fishing areas, winter sports and Andean scenery. This phenomenon increased land values and promoted agro-tourism business for many traditional sheep farms. In addition, oil exploitation and oil services also generate extra revenues to many farms but with these exceptions sheep production is the only income for most farmers in Patagonia.

Sheep are run on rangelands where stocking rates vary from 2 hectares per sheep in the best areas located in the more humid parts of the South and West to 8 hectares per sheep in the dry central Patagonia. In the poorer ranges of the central North Patagonia, Merino is the main breed whereas in the southern more humid areas most sheep are dual-purpose Corriedale and Merino-Corriedale crosses. Reproduction is seasonal with mating in May (autumn) and lambing in October, somewhat earlier in the more temperate northwest of the region. After lambing many farmers move their stock to summer grazing areas at higher altitude at the foothills of the Andes. In Patagonia there are about 8,500 sheep farms; of which, 80% have less than 1,000 head of sheep (18% of the total sheep population), whereas 20% have more than 1,000 head of sheep and 82% of total sheep population. Thus, sheep are found either in many small family holdings or in larger company farms. In general, meat contributes at least 60% of farmer's income.

Several breeders and scientists visited Uruguay to know the Dohne breed, its main characteristics, and check its performance in crosses with Corriedales and Merinos and were very enthusiastic about introducing the breed in Argentina, which they did in 2005. The first importations from Australia and Uruguay (semen and embryos) were initiated by INTA, the National Institute for Agriculture Technology, and taken to the Experimental Farm in Río Mayo (Chubut Province) and also to a private farm (Rincón de los Morros), located further south in the Province of Santa Cruz, both in Patagonia. Since the beginning, INTA has been in charge of the assessment of the productivity of Dohnes in different Patagonian environments as a pure breed and for crossbreeding on Corriedales and Merinos (McMaster C, 2015). At present in Rio Mayo there are 160 pure pedigree ewes being mated, as well as 350 F1 and F2 ewes Dohne x Merino. Under the present program, all registered animals have full pedigree and performance information. The genetic evaluation is carried out by INTA and the visual assessment of animals is performed by technical personnel of the AACM (the Argentinean Association of Merino Breeders). Those F3 animals with Breeding Values above the average and having been accepted after the visual assessment are incorporated to the pure Dohne nucleus, which operates as an open one. It is significant to note that Argentina is the only country in the region where the Dohne operates under the umbrella of the Argentinean Merino Association (AACM), with which there is full

cooperation. So far, there is no competition of animals at shows. The Dohne is recognized as a variety of the Merino, and there is not an autonomous Dohne Breeders Association operating. Another 5 private Dohne studs operates under this system, mainly located in Patagonia. However there is a significant number of farmers that have been using Dohne to cross Merino or Corriedale flocks in the Patagonian region but also in other Provinces further north.

The productive conditions in the Patagonian region are much tougher and difficult than other regions where temperate or sub-tropical climates predominate. In spite of this, the measured performance of the Dohne and Dohne crosses show in general terms similar results than those found in Uruguay, that is higher weaning and carcass weights (>10%), better meat quality traits (bigger eye muscle area and less fat), some reduction in fleece weights, and big reductions in the diameter with better colour (in Corriedale crosses). Results obtained by INTA also show a better maternal ability of the Dohne compared to local Merinos.

It is very likely that the Dohne, having confirmed a higher overall productivity as a dual purpose breed, will probably increase its role as a dual purpose breed, grading up Corriedale and Merino flocks.

Peru. The sheep population in Peru is estimated in 9.5 million head, and has been decreasing significantly in the last decade. 85% of it belongs to the Criollo breed and their non-planned crosses. The Criollo sheep, naturalized to the highlands of the Andes since their introduction by the Spaniards 500 years ago, have very poor productive characteristics: coarse wool, very low body weights and carcass weights of 12 to 15 kg at adult age. The remaining 15% correspond to Corriedale and Junín (a local breed derived from the Corriedale), and are in the hands of communal cooperatives and private farmers. More than 90% of the sheep population is situated in the highlands of the Andes (at more than 3.000 masl), grazing on native pastures and run by peasant communities. *"Sheep production in Perú has been based in an obsolete orientation: medium to coarse wool and meat produced mainly by adult and cast for age animals The good results obtained in Uruguay and Chile in crosses with Corriedales, and also the contacts with Macquarie Dohne in Australia convinced Dr.W.Vivanco that the best alternative for increasing the returns of the sheep farmers in the Peruvian High Andes rangelands was the massive utilization of the Dohne (Vivanco, 2014)".*

Macquarie Artificial Breeders donated to INIA Perú (Peruvian National Institute of Agriculture) in 2005, 130 doses of semen to inseminate and upgrade Criollo sheep, at two different locations, one in the central highlands at 3.200 masl (Huancayo) and the other in the southern highlands at 3.900 masl (Puno). These first importations were followed by others in 2008 (semen) and 2011 (frozen embryos). Since the initial involvement of INIA was considered too slow, Dr Vivanco was able to persuade two very important mining companies to understand and react positively to his recommendation of reorienting the sheep production towards finer wool and higher quality lamb meat using as base the Dohne. Projects with the mining companies were located at the central highlands in the Communities of Catac and Gashampampa, both above 4,000 masl, which involved the importations of more embryos from Australia in 2011 and 2013. Since there was the need to have a more controlled evaluation of the performance and adaptation of the Dohne and its crosses at the Peruvian high altitude rangeland conditions, Vivanco International SAC developed two R&D projects with this objective.

Even though good structured and organized sheep breeding programs do not exist in the country, nor performance recording systems or genetic evaluations. The current number of pure Dohne, F1 and F2 rams at the moment (less than 200), has sufficient power for a more rapid dissemination of Dohne genetics through AI and embryo transfer. It is estimated a 5 to 6 fold increase in the present farm revenues, as a result of the genetic reorientation with the involvement of the Dohne breed, and the intensification of the land use for pasture production. (Vivanco, 2014)

Brazil. Dual-purpose sheep production systems are mainly concentrated in the southern region, close to Uruguay, where temperate and subtropical climate predominates. Corriedale is the predominant breed, followed by Polwarth and Merino. However, in the last years, meat breeds have become more important. Several breeders have been using Dohne, mainly brought from Uruguay to start crossing Corriedale and other breed flocks, but not on a well organized form, and with no involvement of national research organizations. However during the last two years Brazilian breeders are showing an increased interest in knowing more about the breed, attending ram auctions in Uruguay and requesting technical information. It is likely that an increase of the importance of the breed will be seen in the future. Apparently, the importation of genetics from South Africa would be possible, representing the only country in the continent where that possibility exists.

Falkland Islands/Islas Malvinas. Located at 52° south, the islands have a very difficult environment for sheep production. The predominant breeds are Corriedale and Polwarth, with low wool cuts and lambing percentages of 60% or less. (McMaster, 2015). Stocking rates are around 1DSE every 2 ha, and animals are run on native pastures with no supplements. An abattoir was established in the early 2000, giving the farmers the access to the international meat market. In addition, there was an international decline of prices for medium to coarse wools. These 2 points provided the incentive for the introduction of the Dohne, a fine dual-purpose breed, with a reputation of hardiness, easy care, high fertility and higher prime lamb potential. In 2003, several breeders started to import embryos and semen from Australia and South Africa. After a severe process of selection for adaptation to the Falkland natural habitat, it is recognised that they have animals on the ground that have done well, and have inherited hardiness and adaptability to this environment. The main results obtained have been a big reduction of micron with little "blow out from hogget to adult, big framed meat carcass, increased lambing percentage, intelligent and easy to work with (Bernsten.B., personal communication).

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IMPROVING REPRODUCTION RATE IN THE SOUTH AFRICAN DOHNE MERINO POPULATION

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SUMMARY

The recent increase in reproduction rate of the South African Dohne Merino stud population was investigated. No significant change in environmental factors could be detected. Initial genetic change in the segment of the population using various management techniques to promote reproduction and lamb survival, was slightly higher than the segment practicing exclusively natural mating. Although further investigation is necessary on account of insufficient data, it can be concluded that no reason exists to suspect that the hardiness and adaptability attributes of the population, as measured by number of lambs weaned, are currently compromised.

INTRODUCTION

Total weight of lamb produced per hectare has the most significant effect on total farm income under South African farming and economic conditions. Measures of net reproduction rate are gene-rally used as a proxy to assess the adaptability of animal populations. The heritability of number of lambs weaned (NLW) is low (Safari et. al. 2007) and a moderate to low genetic response on selection is to be expected. However, NLW is a composite trait depending on the net result of the entire reproduction cycle (Lee *et al*. 2011). The trait is easily constructed from birth and weaning records and does not place an additional burden on breeders. Therefore, NLW was used for the purpose of this investigation.

Recent increases in the frequency of multiple births in the South African Dohne Merino population (Table 1) caused concern that use of techniques to artificially improve reproduction and survival of lambs, might compromise the hardiness and adaptability of the population. The aim of this paper is therefore to investigate the usefulness of NLW to improve reproduction rate.

Table 1 Frequency of single and multiple births in South African Dohne Merinos measured as NLW registered at the breed society

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Singles	4601	5074	6324	10336	11012	11786	13610	14860	14965	11451
Twins	4059	3739	5003	9593	10727	11331	12592	16533	16681	12741
Triplets	213	136	255	684	792	827	1062	1724	1810	1612

MATERIAL AND METHODS

The extent to which South African Dohne Merino breeders make use of drugs to stimulate ovulation rate and of embryo transfer, was established by means of a survey. Fifty percent of breeders use these techniques to varying degrees. This information was used to select data from 27 studs with animals born from at least 2006 in the national Dohne Merino database. The studs were selected on accuracy of data, complete recording, data depth and geographic distribution. Seven of these studs

have a history of exclusive natural mating and the rest conduct artificial procedures, on a regular basis. Artificial procedures were defined as the use of synchronization/laparoscopy with pregnant Mare serum PMS linked to the use of lambing pens. The data set comprised of number of ewes that weaned lambs (Table 2) together with complete parentage.

Table 2 Number of ewes with lambing records in 27 selected Dohne Merino studs from at least 2006 to 2015

Lambing opportunity	1st lambing	2nd lambing	3rd lambing	4th lambing
Number observations all data	30556	21508	14274	8167
Natural mating	4436	3165	2193	1332

A fixed effect model (R-lsmeans 2016) was used to identify significant fixed effects for year of measurement, breeder, age at lambing included as a linear regression, lambing season defined as flock year season, contemporary group defined as flock season of the ewe. Thereafter, the data was analysed by a multiple trait mixed model for variance component analysis (AS-Reml 2009). The first 4 lambing opportunities of a ewe were considered as 4 separate traits. The following repeatability model (Figure 1), using the same fixed effects, was fitted as an operational model to make use of all available records:

$$y_{ijklmn} = \mu + a_{i + PEij} + b_j + c_k + d_l + f_m + e_{ijklmn}$$

Where
y_{ijklmn} = observation on the ewe weaning a lamb/lambs
μ = mean
a_i = random effect of the ewe
Pe_{il} = permanent environmental (random) effect across lambing seasons
b_j = effect of breeder
c_k = effect of age at lambing included as a linear regression
d_l = effect of lambing season defined as flock year season
f_m = effect of contemporary group defined as flock season, of the ewe
e_{ijklmn} = random error

Figure 1. The model used to estimate the repeatability of number of lambs weaned.

RESULTS

It is accepted that first lambing is a good indication of lifetime reproduction (Lee *et al*. 1996). It can therefore be argued that the use of PMS later in life, will influence the repeatability of lambing performance. Lifetime reproduction of ewes weaning a twin at first lambing (Table 3) outperformed those with lesser performance in both the natural data set and all data. From these results it appears

Table 3 Reproduction rate from 2nd to 4th lambing of ewes weaning 0 to 3 lambs at their first lambing in the natural mating data subset and in all data

1st lambing	2nd lambing		3rd lambing		4th lambing	
	natural	All	natural	All	Natural	all
0	1.18±0.04	1.23±0.02	1.30±0.06	1.31±0.02	1.32±0.08	1.29±0.03

1	1.20±0.02	1.30±0.01	1.28±0.02	1.35±0.01	1.33±0.03	1.36±0.01
2	1.33±0.03	1.45±0.01	1.45±0.04	1.49±0.01	1.46±0.05	1.47±0.01
3	1.37±0.18	1.55±0.05	1.00±0.25	1.56±0.06	1.08±0.57	1.43±0.08

that the use of drugs has no significant effect on the lifetime reproduction as predicted by 1st lambing. The result is supported by the repeatability of 0.05 for the full data set compared to the 0.06 for the natural sub dataset.

Results for heritability are restricted to the first two lambing opportunities since erosion of data available for third and fourth lambing opportunities resulted in large standard errors. Heritability estimates for all data and for the natural mating data set are presented in Table 4. The genetic correlation between first and second lambing was 0.81±0.22. This estimate did not differ from unity, suggesting that first and second lambing records possibly represented the same trait. In contrast, Bunter and Brown (2013) suggested that reproduction records of ewe lambs were not genetically the same records at 2 and 3 years of age. Heritability at 1st and 2nd lambing for the "natural" group was double that of all the data (Table 4). This result may indicate the loss of some genetic component due to the use of PMS/Laparoscopy during mating.

Table 4 Heritability (h^2) for number of lambs weaned at first and second lambing

	All data	Standard error	Natural mating	Standard errore
h^2 1st lambing	0.02	0.01	0.06	0.02
h^2 2nd lambing	0.02	0.01	0.04	0.03

Heritability estimated from the repeatability model was 0.02±0.01 with a permanent between environmental effect of 0.03±0.00. Therefore, on the basis of genetic co-variance, treatment of the two measurements as one trait may be warranted.

Least square means for the different lambings are presented in Figure 2. The phenotypic trends (Figure 2) indicate negligible positive environmental trends (gradient 0.00 at first lambing) for the total data set and no trend for the natural data set. Slight negative gradients are indicated for all subsequent matings, which are slightly higher for the natural mating sub data set (Figure 2).

Genetic trends (Figure 3) for NLW per lambing (repeatability model) were calculated as a regression on year of birth of the ewe. Gradients of 0.13 for all data compared to 0.03 for the natural mating data set, indicates a faster initial rate of genetic change for all data.
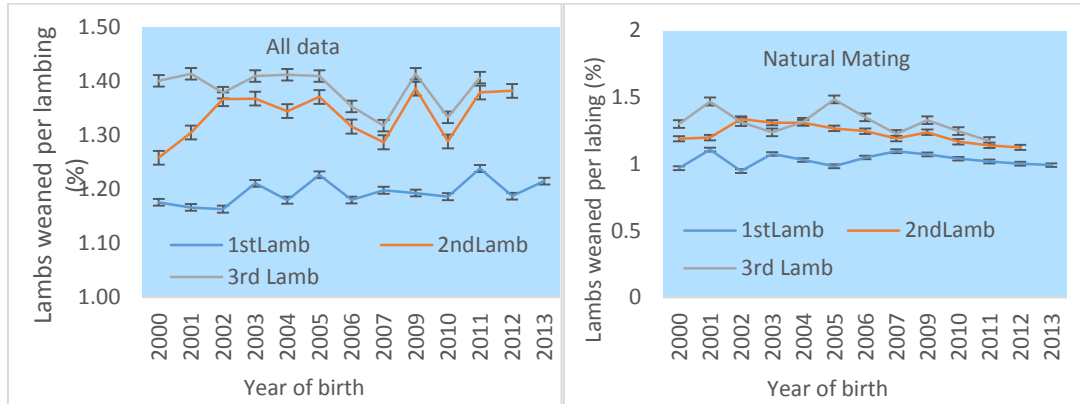
Figure 2 Environmental trend in NLW for all data and the natural mating subset.
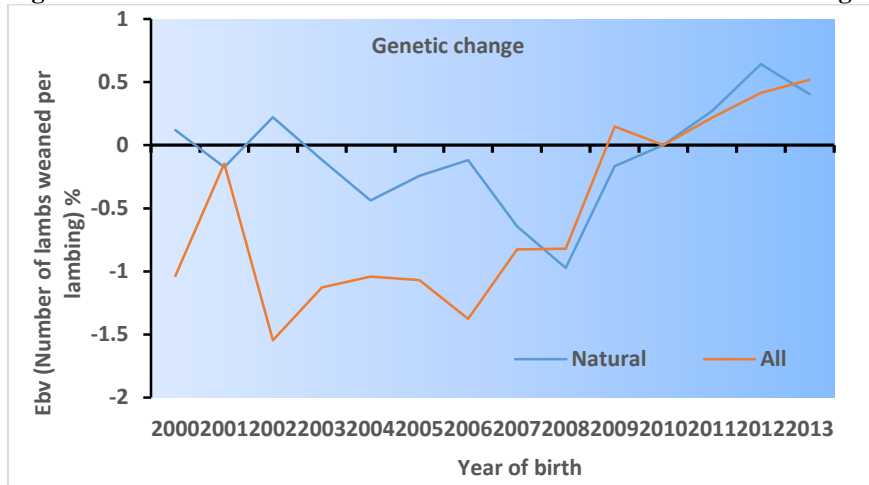
Figure 3 Genetic trend in NLW for all data and the natural mating subset.

DISCUSSION

Results for heritability are in agreement with literature (Safari *et al.* 2007). However, the higher estimates of heritability for the natural mating group of studs, needs further investigation when more data becomes available. The result of a lower level of management for natural mating studs was expected. However, a higher positive gradient for phenotypic change for studs making use of accelerated reproduction techniques was expected. NLW may be a useful selection especially when supported by genomic information (Daetwyler *et al.* 2014). Interim use of a repeatability model for routine evaluation is supported. Current results do not support the notion that the South African Dohne Merino industry is intensifying management for increased reproduction, which may sacrifice hardiness and adaptability.

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GENOMIC SELECTION AND THE SHEEP COOPERATIVE RESEARCH CENTRE (CRC) NUCLEUS FLOCK

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SUMMARY

Genomic selection is a new DNA based method of selecting animals for breeding. The test reveals DNA differences between animals for thousands of genetic markers. Prediction of an animal's genetic merit is based on DNA comparison with a group of reference animals with trait measurements as well as a DNA profile. A sustainable use of genomic selection by sheep breeders requires cheap genotyping combined with reliable predictions. A reference group of at least 2000 animals is needed. This is hard to achieve for smaller breeds, but feasible with some coordinated planning. For a dual purpose breeding objective that focuses on improvement of wool and meat we expect genomic selection can increase the annual rate of genetic gain by ~15%.

INTRODUCTION

Animal breeding research in the last decade has been dominated by the potential of genomic selection. Genomic selection refers to the selection of animals based on information obtained from a DNA test, also known as a genomic test. The DNA test provides information about pedigree and breed content, information about single gene traits such as horned-polledness and genetic defects and the test allows prediction of genetic merit for traits of economic importance. Genomic selection is not a silver bullet but an additional tool in breeding programs. The accuracy of genomic prediction in Australian sheep is currently comparable with the information obtained from a measurement on the animal itself or from a few progeny. The advantage of a genomic test is that the information is available early in life and even for traits that are hard to measure on-farm. Therefore, genomic selection can help achieve higher rates of genetic improvement, especially for traits that are otherwise hard to improve, e.g. reproductive rate, lifetime wool productivity and lamb carcass and eating quality.

Genomic testing has developed rapidly since the introduction of the first SNP-chip around 2006. Especially dairy breeding programs have completely changed. This is because the benefit is largest for dairy breeding as milk production cannot be measured on bulls and for sire selection a genomic test at a young age is an attractive alternative to a progeny test. A shorter generation interval along with abandoning progeny testing allows almost a doubling of the rate of genetic gain while the breeding program costs can be reduced. In sheep the benefit is smaller because 1) most traits in sheep can be measured on all animals and early in life, 2) the accuracy of the genomic test is lower because there is less information available due to smaller reference groups and 3) the profit per sheep is a lot lower than the profit per dairy cow so it is harder to justify investment in a genomic test for individual sheep. However, there are also significant benefits for sheep breeders.

This paper reviews the various aspects of implementing genomic selection in sheep breeding programs, including an estimate of the increased rates of genetic gain, the size and structure of reference populations that are needed, and the costs and benefits for individual breeders that invest in

genotyping and additional trait measurement. Currently, genomic testing is not available for the Dohne breed in Australia and this paper maps out a route to overcome the hurdles that prevent that.

What is genomic selection? Genomic testing involves collection of DNA samples on young breeding animals, usually via a drop of blood on a small card. These samples are sent for genotyping and based on information from tens of thousands of DNA markers (single nucleotide polymorphisms - SNPs) an estimate can be made of the breeding value, by comparing the DNA information on the tested animal with that of a reference population of animals that have information on DNA as well as phenotypes. The comparisons of DNA patterns can be seen as making comparisons with related individuals, similar to pedigree relationships. Animals related to those with a high phenotypic performance are expected to have a higher genetic merit. But rather than having just a handful or known relatives, as is the case with pedigree, genomic testing allows comparisons with thousands of other animals, each having a small relationship with a target animal to be predicted.

The Sheep CRC has demonstrated that genomic selection works. The CRC Information Nucleus Flock (INF) was set up to measure many animals and genotype them at the same time (van der Werf *et al*. 2010). Between 2007 and 2011, 18,000 lambs were born and measured for many traits, including growth rate, carcass composition, assorted wool traits and worm egg counts. About 10,000 lambs were measured for carcass traits and about 5000 animals for wool and reproductive traits. Using this resource as a reference population, we showed that breeding values could be predicted with accuracy between 25 and 50%. This was demonstrated by correlating the progeny test results of widely used rams with their genomic test prediction. Since 2011 we have delivered genomic predictions to breeders for the major breeds such as Merino, Poll Dorset, White Suffolk and Border Leicester.

Various Australian studies have reported on the genomic prediction accuracies achieved in real data (Daetwyler *et al*. 2010, Daetwyler *et al*. 2012, Moghaddar *et al*. 2013). Accuracies generally varied from 0.2 to 0.5. Genomic predictions are breed specific. It is not possible to obtain accurate genomic predictions if the reference population does not contain animals from the same breed as the animal that is predicted. Essentially, the relationships between animals from different breeds are too small to base any predictions on. Although the INF used 16 Dohne sires between 2009 and 2011, delivering almost 700 progeny, still more are needed to allow accurate predictions. The aim is to have information on about 2000 progeny, before genomic predictions are likely to be reliable.

Potential benefits. Traits with a moderate heritability that are easy to measure are relatively easy to improve. If traits can be measured cheaply, on both sexes and before time of first selection, the accuracy of estimating breeding value (EBV) at first age of selection can be high. In that case, genomic testing will have limited benefits as the increase in selection accuracy due to the genomic test will only be small. Table 1 compares the accuracy of estimated breeding value of 18 month old rams when estimated with and without the use of genomic information. The table shows that the selection accuracy is increased particularly for traits that could not be measured at the time of selection. The accuracy of the overall dual purpose index is increased by 46%. The result is that breeders can be more confident in selecting young rams, and therefore would allow more rams to be used in their stud. In practice it means that more young rams will appear in the top when ranking them. The overall effect of selecting rams at a younger age but with a higher accuracy will be an increased rate of genetic gain of 14%. The additional gain is higher for those traits that are hard to measure on young animals, i.e. adult traits and reproductive rate. The benefit would also be large for carcass traits that are normally not measured without slaughter.

Table 1. The effect of genomic selection (GS) on the accuracy of estimated breeding value (EBV) for a number of sheep traits when selecting young rams at 18 month of age

Trait	EBV accuracies of young males at 18 months		
	W/o GS[*]	With GS	%difference
Birth Weight	0.32	0.48	48%
Post Weaning Weight	0.67	0.79	17%
Post Weaning Eye Muscle	0.66	0.70	6%
Post Weaning Fat	0.58	0.64	9%
Adult Weight	0.49	0.69	41%
Adult Clean Fleece Weight	0.55	0.69	25%
Number of Lambs Weaned	0.17	0.28	60%
Dual Purpose Index	0.24	0.35	46%

*W/o: without

Reference populations. Accurate genomic predictions require a reference population of animals that have been measured for the traits of interest and that have also been genotyped. The predicted accuracy depends on the size of the reference population, but also on the diversity of the breed. A diverse breed such as Merino requires a much larger reference population than a more homogeneous breed such as the Border Leicester, because on average the relationships among the animals are much lower in diverse breeds.

Reference populations can be created for that purpose, such as the CRC Information Nucleus Flock and its successor, the Meat Livestock Australia (MLA) resource flock, and the Beef Information Nucleus (BINs) in various beef cattle breeds. Setting up a specific reference flock is required for traits that are not normally measured on farm, such as carcass and eating quality traits. Reference populations could also be created by contracting a number of breeders to record some key traits such as reproduction and adult wool attributes. If these traits were recorded in the past, than genotyping the sires with larger numbers of progeny could serve as a reference. This has been the case in the dairy industry. However, using progeny tested sires as a reference is only possible for traits already measured on-farm, i.e. easy to measure. Moreover, in small breeds it is not possible to find hundreds sires with progeny measured for weaning rate or adult fleece traits. Therefore, to build a reference population for the Dohne breed, a number of animals need to be genotyped and phenotyped for the appropriate traits each year. Measurement and genotypes on individual animals can be combined with genotypes of sires combined with phenotypes on many of their progeny. In the current MLA resource, flock the number of Dohne sires tested per year is about 10 and together they have about 100 offspring. However, these progeny are crossed with merino and therefore essentially count for a half. More genotyping of animals in industry flocks is needed before enough animals are recorded for a reference population.

Animals to be tested in the reference populations should be selected from a diverse genetic background within the breed, but also from family lines that can be expected to contribute to the future gene pool in that breed. There needs to be a balance between merit and diversity. A good strategy is to measure and genotype progeny from young sires of high genetic merit, yet these sires are relatively

unrelated to each other. The number of progeny tested per sire should be small because smaller progeny groups allow testing of more sires, which is desirable from a genetic diversity as well as an 'industry engagement' point of view.

Strategies for implementation. To assist breeders in their decision to invest in genotyping their selection candidates, we modeled predicted benefits and balanced them against the associated cost of genotyping. In a number of individual case studies those models were discussed with breeders and findings were presented and discussed with a wider audience of progressive breeders with an interest in the technology.

For individual breeders, there are various ways to save on genotyping costs. Firstly, genotyping of females is less efficient due to the lower selection intensity in females. Secondly, breeders can apply two-stage selection. Genotyping only about 20% of a young sire crop, would give more than 80% of the additional benefits of genomic selection when genotyping all males.

An important factor is whether breeders are able to mate their stock within the first year (at 7 months of age) as genomic information is relatively more beneficial for genomic estimated breeding value accuracies of younger breeding animals. Whether a breeder can afford testing depends also on the proportion of his stud-born rams that he can sell, and how much of the benefit is actually received by the breeder. Most of the benefit occurs in the commercial flocks where the offspring of the improved rams are more profitable. Typically, breeders only capture a small percentage of those benefits through increased ram prices. However, we found that even under such conservative assumptions, the break-even price of a genomic test is well above the current price of about $50. It is expected that the price of genomic test will reduce further in the near future.

CONCLUSION

Sheep breeding programs can benefit from genomic selection by increasing rates of genetic gain, with more emphasis on traits that are otherwise hard to improve. Since prediction do not extend across breeds, and a reference population is required for each breed. This makes it hard to implement genomic predictions for small breeds. The sheep CRC is currently working on a whole genome sequence to check whether the information will allow prediction of genomic breeding value across breeds. This could be useful especially for the smaller breeds. However, in the meantime it is advisable to genotype well recorded animals and sires with recorded progeny.

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COMMERCIAL FLOCK GENETIC PROFILING AND TOOLS FOR RAM SELECTION

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SUMMARY
　　　　Using Australian Sheep Breeding Values (ASBVs) to select rams and drive genetic gain has been estimated to add $2.20 per ewe per year to flock returns. Despite the benefits, the Sheep Cooperative Research Centre (CRC) research identified barriers to adoption of ASBVs amongst some ram breeders and ram buyers. Investments in training, computer applications and genetic profiling have strategically addressed these barriers and made ASBVs simpler to use.

INTRODUCTION
　　　　Whether you are a stud breeder or commercial sheep producer, selecting rams that will deliver improvement in the flock is one of the most important business decisions you make.
As the sheep industry moves from a focus on wool production to a balance between wool and meat; genetic improvement incorporating reproduction, carcase and disease resistance traits becomes much more complex (Rowe and Banks, 2015).
　　　　Australian Sheep Breeding Values (ASBVs) generated from pedigree, phenotype and genomic information are an important tool for predicting genetic performance and selecting breeding animals. The value of ASBVs in predicting genetic merit has been well documented and demonstrated over many years. This information has been collated in "Using ASBVs – What's in it for me?" (Ramsay, 2012).
　　　　Genetic gain is cumulative and the improvement has been valued at $2.02 per ewe joined per year in terminal breeds using ASBVs participating in LAMBPLAN. Genetic gain in leading Merino flocks, using MERINOSELECT ASBVs, has been estimated at $2.20 per ewe joined per year, but much less in non-participating flocks (Rowe and Banks, 2015).
Despite the benefits of using ASBVs for selection, reluctance to uptake the technology has been observed in both the stud and commercial sectors, particularly for Merinos. In 2011, the Sheep CRC undertook research to understand the barriers to adoption of ASBVs and develop strategies to address these barriers. Some of the key reasons for not adopting ASBVs for ram selection included;

1. A lack of awareness and understanding of ASBVs amongst commercial ram buyers
2. No simple method by which to benchmark the genetic merit of a commercial flock
3. Complexity in using ASBV information to set a breeding objective and selection criteria
4. A lack of confidence amongst ram breeders to explain and promote ASBVs to their clients
5. A lack of advocates for ASBVs amongst key influencers such as stock and station agents, sheep classers and processors

　　　　The CRC has undertaken a range of research and development activities to address these barriers and increase the use of ASBVs for ram selection.
Ramselect training workshops. The RamSelect training workshop was developed to increase the knowledge, skills and confidence of ram buyers and industry influencers to use ASBVs for ram selection. The workshops, hosted by ram breeders, had the added benefit of building the confidence of breeders to discuss and promote ASBVs with their clients. The workshop is based

around a series of practical exercises to describe a breeding objective, set benchmarks for ASBVs and grade rams for their suitability. Assessment of the genetic potential of the ram is combined with visual assessment for conformation and other traits that do not have ASBVs, to come up with an overall grade and estimated value. The workshop concludes with a mock ram auction.

Since 2012, 150 workshops have been delivered to 3000 participants across Australia. Evaluation data showed that participants valued the workshop highly and would recommend it to others. Despite the success of the workshops, the selection process requires confidence in using ASBV figures, which are expressed as deviations from a zero base, have differing directionality, units and scales. For commercial ram buyers, who generally only look at ASBVs during the ram selling season, it can be difficult to remember all the details from one year to the next. In response to our experiences with the workshop and feedback from participants, the CRC embarked on a new project in 2015 to develop a state of the art computer application that would simplify the process of using ASBVs for ram selection and purchase.

A new web based application –Ramselect.com.au The Sheep CRC worked with Telstra, Pivotal Labs in San Francisco, Sheep Genetics and NSW Department of Primary Industries to develop a web based application to search and rank rams for purchase. RamSelect.com.au accesses sale catalogues generated by ram breeders. The catalogues and ram data is automatically updated every day from the Sheep Genetics database.

The user sets criteria for a ram search in terms of number, breed, type, sale type and location. The application initially ranks rams according to one of the standard industry indexes (eg the Dohne Index). The user can then adjust the emphasis placed on traits in the breeding objective by moving a simple set of slider bars that use plain English descriptors rather than complex trait names. The ram list re-ranks as emphasis on traits is modified. ASBV details can be accessed and reviewed at any time. The slider bar settings can be saved for future use. The ranked ram list can be saved, printed or downloaded in preparation for the ram sale.

RamSelect.com.au was first used in the 2015 ram selling season with 145 breeders listing 12,000 rams. This included 18 Dohne breeders listing 1400 rams. Several hundred ram buyers visited the site each week to search for and rank rams for their breeding objective.

Benchmarking the commercial flock-genetic profiling Participants in RamSelect workshops consistently expressed concerns about how to set benchmarks for ASBVs for the key profit drivers such as fleece weight, fibre diameter and growth. For ram buyers who have previously purchased rams with ASBVs, it is possible to develop a list of tag numbers and search the Sheep Genetics database for the ram ASBVs. The team average provides a useful basis for informing future ram purchases and driving improvement in key profit drivers. However very few producers currently keep tag records or ASBV details for rams in their team.

For commercial producers that have not purchased rams using ASBVs previously it can be difficult to know where your flock sits relative to others and where to target ram purchases. To address this issue, a new method for genetic profiling of the flock is under development at the CRC. The Genomic Test, based on a blood card or tissue sample, was developed to provide genomic estimates of breeding values. The test works by comparing 50,000 genetic markers with thousands of other animals that have been tested and also have extensive trait measurement. This information is combined with phenotypic and pedigree data to improve the accuracy of ASBVs for individual animals in the Sheep Genetics database. Recent research has found that the Genomic Test can also be used to estimate flock average breeding values. The idea is to randomly sample 20 ewes from the youngest age group and develop a genetic profile for the flock. Flock average ASBVs can currently be generated for Merino, Border Leicester, White Suffolk and Poll Dorset flocks. This information can then be used to set benchmarks for future ram purchases. For traits where positive improvement benefits flock performance (eg fleece weight and growth) producers should look for rams with ASBVs greater than the flock average. Where a reduction in trait value

is a benefit (eg fibre diameter) then ASBVs less than the flock average will be a benefit to the business.

Prediction of breeding values from genomic tests is not currently available for Dohnes as there are inadequate numbers of animals genotyped to form a reference population. The Sheep CRC will continue to genotype Dohnes with pedigree and trait measurements, so genomic testing is available in the future.

Enhancements to the Ramselect app. In August 2016 RamSelect Plus will be launched for the upcoming ram selling season. RamSelect Plus will include additional functionality;

- to select which index is the starting point for ranking rams
- to benchmark search results against the national database
- to upload and manage your current ram team data and track progress over time
- to upload your flock genetic profile test results to assist in setting search criteria

CONCLUSION

Delivery of the RamSelect workshop and subsequent development of RamSelect.com.au and flock profiling has successfully addressed the key barriers identified by industry stakeholders in the 2011 needs analysis. It is fully anticipated that RamSelect.com.au and flock profiling using genomic technology will become major tools for driving genetic gain across the sheep industry, using the power of ASBVs.

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DOHNES: HOW THEY STACK UP FINANCIALLY

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SUMMARY
Since its inception the aim of the Dohne Merino has been well defined with the breeding objective to improve meat, wool and reproductive traits. In comparison, Fine Wool enterprises have focused on just wool in the past, and similarly, prime lamb enterprises have tended to focus just on meat and reproduction. This analysis modelled the Dohne, Fine wool Merinos and a crossbred Prime Lamb enterprise run in three different environments and found the Dohne Merino is more profitable based on the last 10 year prices whether it is being run in high, medium or low rainfall environments. It would appear that the adoption of objective measurement and modern breeding tools has meant that the breed's objective has been well implemented over the last 50 years.

INTRODUCTION
The Dohne sheep presents a very different alternative to sheep producers than previously available sheep genetics in Australia. With emphasis on both meat and wool traits, it presents the potential to have a true dual purpose sheep, which provides an alternative to the fine or medium wool Merinos and specialist prime lamb breeds or composites that have been traditionally used in sheep enterprises. The latter generally have very broad wool with little value and focus purely on high reproductive rates and high lamb growth rates to enable high meat production per ewe. The former generally focus on wool production traits, such as fibre diameter and wool cut. There are other dual purpose breeds, but their wool tends to be broad and of lower value.

While a few hundred sheep measurements are likely to yield statistically significant differences between breeds for wool cut, bodyweight and fibre diameter, due to the volatile nature of the trait, the number of sheep measurements to determine statistically significant differences in reproductive rates is very large.

This author is unware of any breed comparison run with appropriate numbers to determine real differences between these breed types over a number of seasons undertaken in Australia. Therefore the sheep industry must either depend on South African based comparisons or computer modelling of these different breed types. The environment around the Cape region of South Africa is similar to southern, temperate Australia in terms of rainfall and timing of that rainfall, but nevertheless; it is different, with different soil types and pastures. It is also possible that their Merino sheep are different too. Thus, it is logical to seek appropriate ways of modelling Dohne performance to provide a realistic comparison of breed performance in the absence of realistic alternative comparisons.

MATERIALS AND METHODS
GrassGro® is a CSIRO developed computer program that models the returns and productivity of different sheep and beef cattle enterprises over the long term. It uses soil, weather data, financial data

and animal production traits to simulate a grazing system. GrassGro® calculates animal production and subsequent financial performance for each year and presents the average for the simulated period as well as the variation in results over the simulated period. GrassGro® has been validated numerous times in different Australian locations (Donnelly et al. 2002).

GrassGro® was used to model a Merino fine wool flock along with a Crossbred prime lamb flock, as well as a Dohne flock for the period from 1965 to 2015. There are published differences between medium wool Merino and Dohne sheep (Cloete and Cloete 2015) from South Africa, and these results fall in line for wool and bodyweight traits with other trials such smaller trials undertaken in Australia with predominantly F2 Dohnes, (Ransom et al 2015). Other trials have shown a higher reproductive rate in the Dohne and this is summarized by Graham and White (2005), who put the Dohne reproductive rate 17% better than a fine wool Merino.

In this modelling exercise, GrassGro® simulated the breed reproductive rates, while the wool and bodyweight characteristics were taken from Cloete and Cloete (2015) and entered into GrassGro. Bodyweight was 20% higher than a fine wool Merino, with wool cut 10% less and fibre diameter about 1.9 μ broader. A specialist fine wool strain was chosen over a medium wool strain as a fine wool strain is more likely to be the choice nowadays through most sheep raising districts, although it may not be the obvious choice in lower rainfall environments. The characteristics of the fine wool flock and the prime lamb flock was largely based on the DEDJTR Livestock Monitor Farm Project over recent years (Blackshaw and Ough 2015), with the Dohne production characteristics adjusted as described above. Thus the fibre diameter of the Dohne was 2.9 μ broader than the Fine wool strain.

Prices were based on real (inflated adjusted) prices for wool based on weekly AWEX quotes for the last 10 years to reflect the normal variation in economic activity that impacts on the demand for wool. There was no wool stockpile sales in this 10 year period so that abnormal supply was not detrimentally affecting prices, something that would not be anticipated to occur in the future. Meat prices were based on the last 10 year real (inflation adjusted) meat prices as quoted by MLA. This period was chosen so that the substantial sell off of the Australian sheep flock prior to and culminating in the 2006/07 drought did not skew meat prices down abnormally. Again, it would not be anticipated to see a major sell off of sheep numbers in the future that might depress meat prices. Current wool and meat prices as of July 2016 are significantly higher than these long term averages, thus they should result in even high profitability than forecast for all three enterprises.

The simulations were based on the three flocks grazing highly improved and fertilized perennial ryegrass and sub clover pastures at Hamilton VIC, phalaris and sub clover pasture at Kybybolite SA and an annual grass and medic pasture at Roseworthy SA. These three locations were chosen to provide a comparison of performance at higher rainfall (approximately 685 mm, 525 mm, and 490 mm respectively. The stocking rates are consistent with the optimum stocked plots of the Long Term Phosphate Stocking Rate trial run at the Victorian DEDJTR Research Centre (Cayley et al 1999) and other stocking rate trials (Saul and Kearney 2002). This level of stocking rate and fertilizer was chosen to reflect "best practice" in this location and was extended to the Kybybolite and Roseworthy locations. This stocking rate is comparable to that achieved by the some of the top farms of the Victorian DEDJTR Livestock Farm Monitor Project given similar rainfall (Blackshaw P. and Ough, M. 2015). The main issue with the Roseworthy site is that GrassGro doesn't take into account other farm feed sources, such as stubble, which can be significant in these lower rainfall locations.

RESULTS AND DISCUSSION

The different breed systems resulted in different reproductive rates, with the lambing marking percentage in the Fine wool Merino averaging 77%, the Dohne at 94% and the Crossbred ewe enterprise at 115% at Hamilton. This is in line with farm benchmarking results and industry experience (Blackshaw P. and Ough, M. 2015). Given the size of the Dohne ewe, the fact that it started out at a stabilized cross between a medium Merino sheep and the SAMM; and that genetic selection has been applied to improve reproductive rate further over 50 years, it would have been surprising to find that the Dohne reproductive rate was not higher than the Merino.

There are more sheep run per hectare in the Finewool flock than the Dohne flock, and in turn than the Crossbred flock due to differences in mature sheep size and lambing time. For example, the Dohne and Crossbred ewes lambed earlier than the Merino ewe so that their lambs could be finished. However, they were all stocked at similar dse levels and pasture availability was similar across the three different simulations.

The Fine Wool flock ran ewes and wethers, whereas the Dohne and Crossbred flock had ewes joined to terminal sires and in the case of the Dohne flock, enough were joined back to the Dohne to enable the flock was self-replacing over the 50 years of the simulation.

Table 1 outlines some key financial output from the three sheep production systems at the high rainfall location, Hamilton VIC. The Dohne is the most profitable, but the Fine wool Merino has the least variable gross margin due to the reliance on wool income, rather than meat income, which is more variable as it is highly dependent on seasonal conditions. On the other hand, the Crossbred prime lamb enterprise, which is far more dependent on meat income is more variable in gross margin returns than the Merino and the Dohne enterprises. Further it is the least profitable on this analysis.

	Fine wool Merino	Dohne	Prime lamb
Wool Income/dse	$30	$19	$10
Young stock sales/dse	$1	$29	$46
Cast for age sales/dse	$17	$8	$10
Total Income/dse	$48	$56	$66
Total variable costs/dse	$15	$17	$39
Gross Margin/dse	**$33**	**$39**	**$27**
Gross Margin variability/dse	$4	$6	$9

Table 1: Key financial output from GrassGro for different sheep breeds and production systems

Note, in Table 1, the cast for age sales are elevated for the Prime Lamb ewe enterprise due to no replacements kept and variable costs are similarly elevated due to replacements purchased in at $180 per crossbred ewe hogget. Lower ewe replacement costs would have a positive impact on the Prime Lamb ewe enterprise, but this value reflects industry averages over recent years for this type of ewe.

This analysis does not take into account: -

- Variation in commodity prices from year to year. For example, wool traditionally has been the most volatile of commodities, however over recent years it has been more stable.
- Environmental impacts other than rainfall, such as very wet soil conditions.
- Differences in labour input with different enterprises.
- The impact of easy care sheep, such as the Dohne or prime lamb breeds on labour costs.

- Overhead costs or interest. A gross margin has been developed, but that is not necessarily profit as labour and overhead costs should be taken into account. The capital values of the three enterprises are different too.

These factors can be significant and will vary from farm to farm. For example, farm benchmarking performance highlights that there is a large variation in performance level within each farm enterprise that is usually of greater magnitude than the difference between enterprises.

The gross margin performance over the three sheep enterprises in the three different locations is summarized in Figure 1. The Dohne is the most profitable in all three locations, with the order of the enterprises unchanged depending on the location. The profitability of the low rainfall site at Roseworthy SA is reduced due to heavy supplementary feeding due to time of lambing, which in actual fact is likely to be largely supplied at no direct cost from stubbles in this location. At the medium rainfall site all three enterprises benefited from higher lambing percentages due to better survival rates. Thus benefiting the Prime lamb enterprise.

The Dohne sheep perform well in this analysis, which is not surprising given their dual purpose nature and the high prices that have been on offer for meat and wool over the last 10 years. It is in line with results from previous analyses that have been undertaken by this author and also to an extent with Graham and White (2005), whose analysis predates recent higher wool and meat prices. Of course, like any enterprise, poor management or animal health issues could easily erode these advantages, so to realize this potential good management inputs are required, just as it would be with the other enterprises. Further, breed averages have been analysed in this paper. Individual flocks could have better genetics in either of these three breeds, which will change the financial outcome significantly.
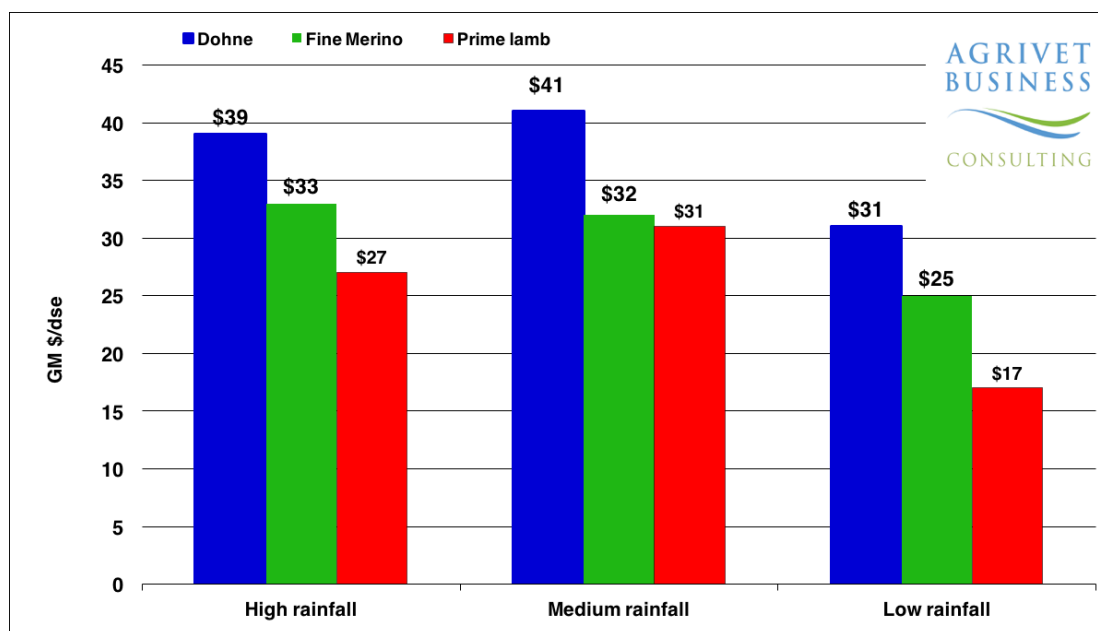
Figure 1: Gross margins of three enterprises in high, medium and low rainfall locations

The Fine Wool enterprise has least production risk, hence translating into less business risk in this analysis. As noted previously, in reality commodity price risk would need to be taken into account too. The prime lamb enterprise has considerably more risk due to more reliance on seasonal variation to drive production and hence financial results. The Dohne being more diversified into meat and wool, is not so exposed to seasonal factors, while being more profitable.

In conclusion, it would appear that the Dohne does stack up well financially and its performance is testament to clearly stated breeding objective and achieving that through the efficient implementation of modern genetics tools.

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THE DOHNES ROLE IN THE AUSTRALIAN SHEEP INDUSTRY

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SUMMARY

The Dohne is a true dual-purpose breed option capable of performing in a variety of environments. The use of objective testing programs and a focus on the major factors driving profit, performance and efficiencies within sheep enterprises, has seen the breed increase in number and importance in recent years. Continued improvements in wool and sheep meat returns ensure that the Dohne will remain a major contributor to the maternal ewe base nationally.

INTRODUCTION

The introduction of Dohne genetics into Australia in 1998 coincided with significant changes in breeding objectives and productivity within the Australian sheep industry. Persistent low wool returns and a continued growth in export access and demand for sheep meat products saw an increasing emphasis placed on sheep productivity, on-farm and breeding efficiencies, sheep meat production and, importantly, cost of production considerations.

Over the past 2 decades we have seen an ever-growing focus on improving fertility, fecundity, lamb survival and growth rates, resilience of the breeding ewe base, increased focus on animal health and welfare practice, selection based on a sire/breeds genetic merit and the cost/benefit of sheep meat and wool production. These issues, combined with a declining national flock/breeding ewe base, and a greater focus on dual-purpose and/or composite breeds and crosses has seen an increased interest and accelerated use of Dohne genetics nationally.

So what is the role of the Dohne? To answer this question, we need to look at tangible, repeatable benefits the breed offers, ignoring hearsay and public hype.

Market Forces. We have witnessed the continued decline in national sheep numbers (-41%) and wool production (-50%) since 1998/99 as illustrated in Table 1. Improvements in wool values (237%) during this period (driven by diminishing supply, improvements in demand and concerted marketing campaigns), has been a welcomed directional change.

Table 1: National flock, wool production, sheep meat values and respective percentage change for the period 1998/99 to 2015/16 (Source: NLRS, ABARE, MLA)

Fiscal Year	Sheep Number (million)	Production (mkg greasy)	ESMI (cents/kg cfw)	Trade Lamb (18-22kg)	Merino lamb (18-22kg)	Mutton 24kg+ (c/kg)
1998/1999	117.5	665	520	191	131	74
2015/2016	69	332	1230	548	502	312
% Change since 98/99	(-) 41%	(-) 50%	237%	286%	383%	422%

Since 1998/99 however wool category premiums have constricted and the median micron average nationally has shifted slightly higher to sit around 20 microns. The improvements in 'bread and butter' 19 to 21-micron wool returns has meant that the Dohne has been increasingly competitive against finer categories. Sheep meat returns have also shown a strong upward movement since 1998/99 as shown in Table 1 and Figure 1 below. Driven by strong export demand, sheep meat remains the primary profit driver with Australia's sheep industries gross value of production - now estimated as 60:40 for meat (slaughter lambs, mutton, surplus ewe sales) and wool (ABARE 2015) across all sheep-based enterprises nationally. Dohnes, as a true dual-purpose breed, are therefore increasingly well positioned to benefit from improvements in sheep meat, breeding ewe and wool receipts.
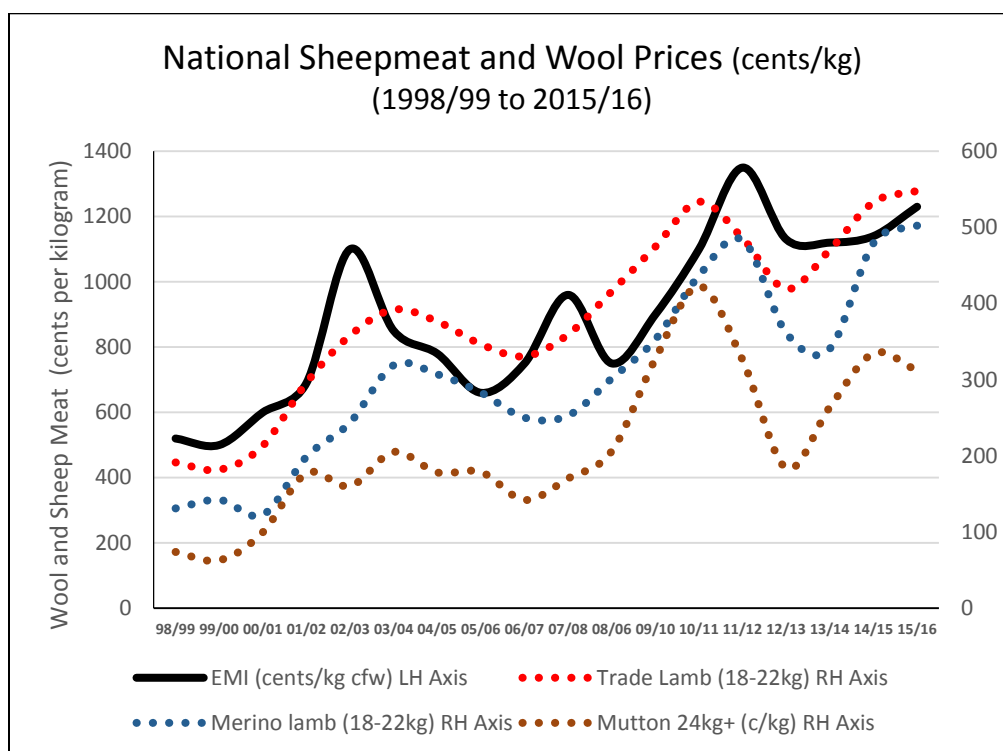
Figure 1: National Sheep Meat and Wool Prices for period 1998 to 2016 (Source: NLRS 2016)

In terms of mutton value the Dohne typically produces a heavier, higher yielding carcass than traditional medium framed Merino ewes. Breed growth rate advantages also offer opportunities for earlier (or heavier) sale of replacement breeding ewes and wether siblings, reducing on-farm production costs and increasing production efficiencies (discussed in detail below).

Dohne lambs generally fall between Merino and Crossbred lamb categories in terms of price received on a hot standard carcass weight (HSCW) basis. While most major processors offer slightly

lower price schedules for Dohnes direct to works, crossbred lamb prices are often achieved for Dohne lambs in open auction systems.

Interestingly the average skin values for merino-style wools have averaged more than crossbred sucker (+$4.99) or older lamb skins (+$5.90) over the past 2 decades, with differences of between $10 to $14 in 2015-2016 in line with improvements in wool prices (Figure 2). As a result gross returns for Dohne lambs are generally greater than Merino lambs and/or on par or above gross prime lamb returns based on the combined carcass and skin values.
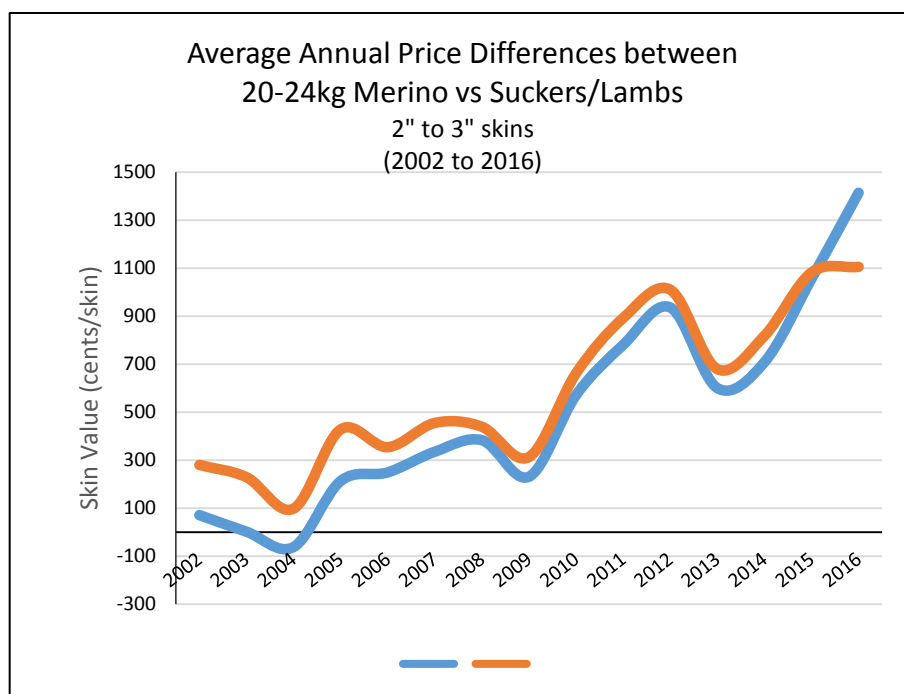

Figure 2. Average annual price differences (2002 to 2016). between Merino and Crossbred Sucker/Lamb skins carrying 2-3" wool lengths (Source: NLRS 2016)

Trait Selection and Emphasis. The Australian Dohne Breeders Association (ADBA) has overseen the continued use of performance testing and pedigree recording for commercially relevant traits since the breeds inception. Having all registered studs undertake stringent objective measurement has not only been a major driver behind the continued improvement of the Dohne breed nationally; but has also provided commercial producers with confidence when sourcing Dohne genetics. Genetic gain in major wool and carcass traits since 2005 for the Dohne are shown below in Figures 3 and 4.

An increase in clean fleece weight (CFW) has major implications for on-farm productivity and income share with selection for 'high CFW' negatively impacting on the rate of survival of lambs

to weaning (Hatcher and Atkins 2006). This may, in part, explain why historical Merino weaning percentages have remained well below potential lamb numbers based on scanning data.

While Dohne CFW genetic gain has linearly improving; (Figure 3) the selection emphasis on this trait has been relatively low so as to reduce the risk of correlated trait 'blow-out' (increased body weight, fibre diameter, fibre CV values, wrinkle score and a decline in genetic fat and reproduction efficiency).
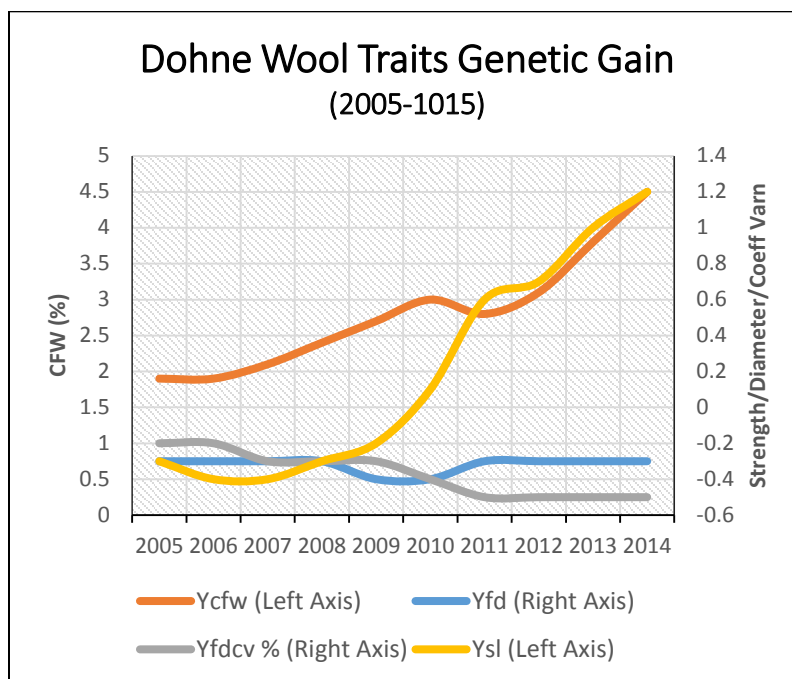
Figure 3: Dohne Wool Traits (2005-2015) Genetic Gain (Source: Sheep Genetics Australia 2015)

Genetic gain in growth rates, eye muscle and fat traits (Figure 4) positively impact on carcass dressing percent, meat eating quality, turn-off times, reproductive efficiency, 'resilience' and worm resistance. Negatives in terms of improvements in these carcass traits may include increased lamb birth weights (possible dystocia) and a reduction in fleece weight.
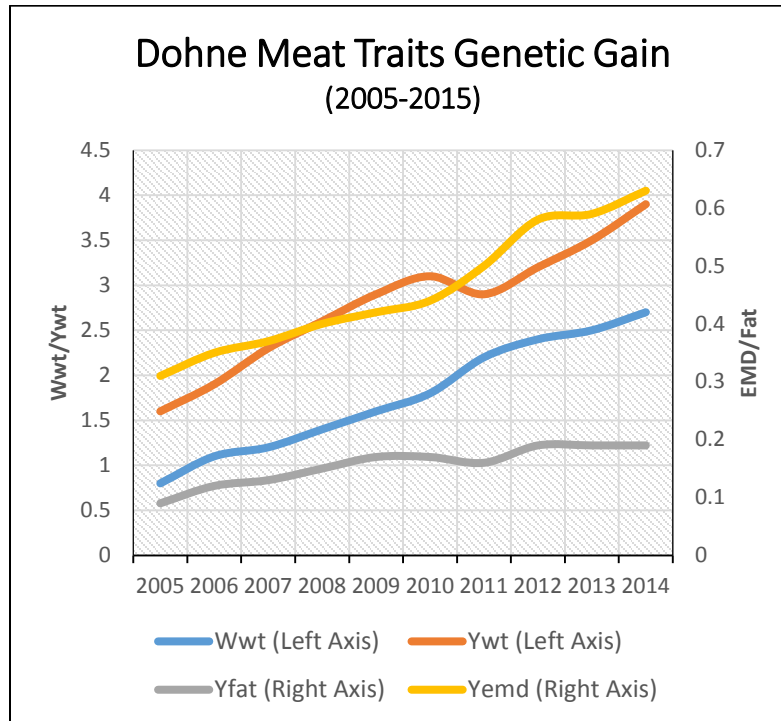
Figure 4: Dohne Meat Traits (2005-2015) Genetic Gain (Source: Sheep Genetics Australia 2015)

Drummond (2015) suggests that it is possible to improve productivity by 14% over a ewe's lifetime when able to be mated as a ewe lamb. Growth rate is a critical driver in terms of a breeds' ability to successfully join at younger ages and is a major trait focus within Dohne performance testing programs. Balancing the relative emphasis placed on both carcass and wool traits is critical for maintaining the Dohnes dual-purpose nature. Thankfully this has continued to be the case within the breed nationally.

Efficiency/Resilience. The Australian sheep industry, regardless of breed or enterprise mix, are increasingly focusing on improving ewe efficiency and resilience. Efficiency can be measured as kilogram of product against mature ewe live weight/ha/DSE/100mm rainfall etc. Regardless of the measure used, increasing efficiencies are critical given our ever diminishing breeding ewe base and rising production costs. Resilience, or "a ewes ability to 'bounce' back and/or perform under periods of nutritional stress" is a major factor contributing to ewe efficiency.

The Dohne potentially offers improved fecundity, fertility, mothering ability, growth rate to weaning and an ability to perform in a range of environments (including pastoral areas). Improvements in weaning rates, driven principally through increased twin lamb survival, are a critical profit driver and a means for reducing costs/kg of product produced.

Despite the Dohnes comparatively heavier maternal body weights; their ability to convert many poorer quality feeds and feed seldom grazed by the traditional Merino, improves pasture

utilization efficiency. Vipond (2011) has shown that increasing lamb number per ewe reduces energy required by ~ 40% per kg of carcass produced, improving ewe and production efficiencies. Given also that ~ 60% of total annual feed requirements are required for ewe maintenance (Fogarty et al 2005), heavier mature ewe weights need not be a major concern if lamb turn-off remains appreciably higher compared to (say) a traditional Merino ewe enterprise.

Animal Health and Welfare. The Dohnes plain bodied, open faced and bare breech/mules free nature not only improves reproduction efficiency and reduces flystrike/grass seed issues but lends itself to appeasing powerful welfare and animal activist lobbyists intent on undermining and controlling livestock production world-wide. A self-replacing breed, the Dohne also offers greater prevention and control of disease introduction than enterprises based on buying-in replacement stock.

Summary

The dual-purpose self-replacing nature and use of performance recording of commercially relevant traits of the Australian Dohnes lends itself to

- capitalizing on short to long-term changes in wool/sheep meat and breeding ewe values
- use as both a terminal and maternal sire
- increasing the national breeding ewe base
- retention of on-farm quality assurance status
- improvements in lamb survival, growth rates, wool and meat production efficiencies
- improvements in ewe efficiency and resilience
- increased speed of genetic gain for replacement breeders (reduced generation interval, earlier mating of ewe progeny) and
- reduced costs of production/improved benefit/cost ratios

and therefore plays an increasingly important role within the Australian Sheep Industry.

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HANDS ON EDUCATION - THE PRACTICAL ADVANTAGE

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SUMMARY:
Tocal college offers a range of agricultural courses designed to provide students with a diverse range of skills through first-hand experience. As part of the subjects offered, Tocal students have been involved in the running of the self-replacing Dohne flock. From this, we have witnessed the advantages of high fertility, fast growth rates and exceptional wool quality that are considered standard to the Dohne breed. Tocal students graduate as agriculturalists having experience in help running the college farms and completed commercial work placement, which prepares them to move forward into their working lives.

INTRODUCTION

Tocal Agricultural College is a 2200 ha residential college providing full and part-time courses to students aged from 16 years of age. Since the Colleges establishment 50 years ago, hands on farm skills and training has been a high priority. How we deliver knowledge is a balanced mix of theory, hands on training, and is our point of difference. Students are involved with the Tocal farm at all stages of the management cycle. Certificate III students muster, draught, drench, vaccinate, milk and handle livestock as needed. Certificate IV students are further involved in feedlotting, breeding and associated sheep management activities common in running a self-replacing sheep flock.

Tocals sheep enterprises past and present. Traditionally, Tocal has run a 200 head first crossbred ewe flock joined to Dorset rams and additional 100 Merino wether wool cutters. These enterprises were highly productive, but had low to medium educational value for students. Replacement ewes were replaced 200 at a time and all progeny sold or slaughtered in the on-farm butchery training.

As part of the Tocal sheep training program, students visited top performing sheep enterprises around the north of NSW covering fine, superfine and soft rolling skins enterprises. Exposure was also given to wool testing companies, meat enterprises and sheep meat processors/abattoirs. On our tours, we visited a number of Dohne enterprises and we were impressed with the dual-purpose performance of the breed.

Wishing to continually improve our education experiences for our students, we explored starting a self-replacing sheep flock. With production goals of achieving high fertility, high meat and wool production we were drawn to the Dohne Breed. With encouragement and support from Graham Coddington (Roseville Park Dohnes), Tocal college purchased 50 in lamb maiden ewes in 2008 (Figure 1). The next year, the students selected further cast for age ewes, which was the first of many new positive educational outcomes with guidance from Graham (Figure 1). An additional two rams were also selected to mate to the existing flock.

Figure 1. Clockwise (left to right): Tocal students inspecting sale rams with Graham Coddington from Roseville Park Dohne stud. The purchase of 50 Roseville Park cast for age Dohne ewes. (5-6 years). The visual inspection both joining of Dohne ewes .Tocal students inspecting Dohne rams on their sheep and wool tour

The Performance of the Dohne. The 100 Dohne ewes were than run side by side with the remaining 100 crossbred ewes under the same conditions to evaluate their performance (Figure 2).

Figure 2. The performance of both crossbred and Dohne ewes were evaluated at Tocal college.

Table 1 documents the wool specifications of the Dohne enterprise. Over this period, the wool produced from these ewes met the high standard required from a Merino enterprise seen within Australia.

Table 1. The wool performance of the Dohne enterprise run at Tocal college.

Year	Fibre diameter *	Fleece weight

2011	19.9	5.1
2012	19.9	4.2
2013	19.3	3.8
2014	19.4	4.2
2015	19.5	4.6

* Fibre diameter is average of wool sold at market.

The pregnancy rate was also recorded for both breeds (Table 2). The results demonstrate the fertility of the Dohne breed was comparable to the crossbred system. However, the benefits of the self-replacing nature of the Dohne breed gave it the economic advantage.

Table 2. The pregnancy rate of the dohne and the crossbred enterprise at Tocal college.

	Pregnancy rate (%)	
Year	Dohne	Crossbred
2011	120	95
2012	135	115
2013	123	123
2014	107	120

The surplus Dohne and crossbred ewes were sold into the same markets for similar comparison. Dohne wether lambs and crossbred lambs were sold for the same price over the hooks at a local meat works at 22kg carcase weight. Cast for age ewes were also sold to the local saleyards and received the same returns. Overall, being able to retain the ewe lambs from the Dohne enterprise saves Tocal college $20,000-$25,000 every 5 or 6 years through the production of replacement ewes.

In 2015, we sold store ewes for $84 and wether lambs 2 months after weaning for $75 (Figure 3). Due to extreme weather conditions in this year, there was a shortfall in the feed availability during May to August, which resulted in a lower, lambing percentage. However, in our opinion the Dohne breed still showed its prolific adaptability to a diverse variety of climate conditions.

Figure 3. Dohne ewes and wethers sold for meat production.

Challenges of sheep production at Tocal. *Rainfall* .One of the greatest challenges to running sheep at Tocal college is the high rainfall. Tocal receives an average of 950 mm of rain each year. Together with high temperatures and high humidity, any sheep run at Tocal has to be of

high quality. With high rainfall comes flooding (Figure 4) and the sheep paddock area can be inundated up 3 times a year with floodwater. The inundation comes with logistical challenges to feed stock during events. Of the 50 ha area available to the Tocal sheep flock, 10 ha is high enough to never be flooded. To overcome these conditions sheep are supplemented with home grown pasture silage.

Figure 4. The inundation of flood water at Tocal college.

Wild dogs. Tocal is a large 2200 ha farm with large amounts of scrub and is also bordered by absentee farmers and a small town blocks. This is the perfect environment for dingos, wild dogs and town dogs to attack domestic livestock in the area. Tocal runs a program of shooting, baiting and employing a sheep protection dog (Figure 5). Since the drought in 2000, close to 200 dogs have been shot, trapped or poisoned on station.

Figure 5. The sheep protection strategies utilised by Tocal college.

Internal Parasites. Due to its location and high rainfall, Tocal is the perfect environment for Barbers Pole worms (*Haemonchus contortus*). As with most farms, we have drench resistant strains of worms and we rotationally graze to minimise the reinfection of the sheep in the paddocks that they are grazing. To manage the timing of drenching we use the Haemonchus Dipstick Test kit (® Merial) to monitor the amount of Barbers pole worms being carried by the sheep. With the advent of Barbervax (® wormvax Australia) (Barbers pole vaccine) our lambs have improved weight gains from weaning to 12 months of age and carry a low burden of worms.

The Future. Over the past 7 years, Tocal has been in a flock building phase; keeping the bulk of ewe lambs on as breeders. In 2015, we have moved into our consolidation phase. Using data collected by the students, ewes were culled on fleece weight, fibre diameter, fleece visual traits, lambing performance, lamb survival and structural conformation. In the future, we will keep our flock at 200 ewe breeders of which will comprised of the selection of 50 replacement ewe hogget each year and 25 wether lambs for the student farm butchery training.

The Hands on Education. Across all the enterprises run at Tocal, the education of future agriculturalists is the overarching principal of experience. Experience through hands on real time education and back ground knowledge gained in the class room. A typical Tocal student will spend 50% of the course in the field. The educational value of participating in a self-replacing flock expanded the opportunities for students to select replacement ewes, purchase rams, shearing (Figure 6), crutching, wool classing, sheep store sales, electronic tagging/recording, joining and lambing management as part of their course.

Figure 6. The shearing of Dohne ewes at Tocal college.

All certificate III students study the sheep industry and learn basic hands on skills through lamb marking, drenching, vaccinating, culling and general livestock husbandry tasks. Over half of the returning Certificate IV students study sheep management and breeding as an elective. In this students are involved in shearing, crutching, wool classing, ram and ewe selection, joining, lambing and mothering activities.

The certificate IV sheep electives are very popular due to the hands on experiences and responsibilities the students leave with a sense of pride and accomplishment that come with working with the Tocal's Dohne flock.

DOHNE PARTNERSHIPS WITH EDUCATION AND TRAINING

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SUMMARY

Muresk Institute is a broker of, and venue for, the delivery of a suite of post secondary qualifications in agriculture and agribusiness from certificate to degree levels. One of the key elements of the brokerage role is the development of partnerships with a range of training providers and industry organisations. Muresk Institute have partnered with the Western Australian Dohne Breeders' Association to host a 200 ewe Dohne Merino flock at the Muresk farm. This flock provides students (in a range of disciplines and courses) with the opportunity to apply their understanding of the theory of animal breeding and selection to a practical situation; to develop relationships with Western Australian Dohne breeders; and facilitates the collection of an independent body of data on the performance of the Dohne in West Australia (WA).

INTRODUCTION

For nearly 90 years, agricultural education has been delivered at the Muresk campus in WA. Commencing in 1926 with the establishment of the Muresk Agricultural College, there have been a number of organisations responsible for the delivery of post-secondary agricultural and agribusiness education at this site. The most recent manifestation is the Muresk Institute, a training provider within the Western Australian Department of Training and Workforce Development. Muresk Institute is a provider and broker of education and training, especially in the vocational sector. This paper will describe the partnership between Muresk Institute and the Western Australian Dohne Breeders' Association which commenced in July 2015.

Background. On Tuesday 14th September 1926, Muresk Agricultural College opened with 16 students and 2 staff (McLaren 2001). The foundation Principal, Hugh Jason Hughes, considered that students should be trained in '…*the science and practices of farming, in business principles and in rural economy.*' Hughes also perceived a role at Muresk for research trials and the opportunity to capitalise on an identified need within the farming community by offering short courses for working farmers.

For the next 40 years, Muresk Agricultural College operated as part of the Western Australian Department of Agriculture. It became part of the Western Australian Institute of Technology (WAIT) in 1969, the first agricultural college in Australia to become part of a larger institution of higher education.

On its 50th anniversary in 1976, Muresk hosted the International Sheep Breeding Congress which attracted delegates from around the world and in 1977 introduced the first undergraduate degree in agribusiness in Australia.

Nineteen eighty seven saw the transition from WAIT to Curtin University of Technology (now Curtin University). In 2012 the responsibility for Muresk's operation was transferred from Curtin University to the State Government.

Since the Department of Training and Workforce Development took over ownership and operations of the facility in 2012, the Muresk Institute has continued to broker and facilitate vocational training and tertiary education (from a range of providers) and continues to be a multi-tenanted, multifunctional training, education and research facility. One of the key aspects to the business of Muresk Institute is the development of partnerships with training providers and

industry organisations.

Muresk Institute, in collaboration with its education partners offers a wide range of courses, including;

   -Agricultural Short Courses
   -Equine Short Courses
   -Certificate IV in Vet Nursing
   -Diploma in Agriculture (International)
   -Integrated Diploma in Agricultural Technologies
   -Degree in Agricultural Business Management

One such partnership with the WA Dohne Breeders' Association, is the subject of this paper.

Location. The Muresk Institute Farm is located approximately 10 kilometres south west of Northam in the Western Australian Central Wheatbelt. Comprising of 898 ha, 56% of the land is arable, whilst 90% is grazable. The farm is home to 1300 Merino ewes weaning, 1500 Merino lambs and 16 rams.

Other resources supporting educational activities on-site include the State Soil Archive and a new sire evaluation site with the Stud Merino Breeders Association of WA to be overseen by the Australian Merino Sire Evaluation Association (AMSEA).

The partnership. The concept of a partnership between Muresk Institute and the WA Dohne Breeders' Association was initially raised in August 2014. Students in their first year of study of the Charles Sturt University Bachelor of Agricultural Business Management degree attended the WA Sire Day as part of their studies in livestock production. A core component of the learning program is an introduction to animal breeding and genetics. The opportunity to attend the Sire Day allowed students to view first hand the application of breeding and selection theory to practical situations. The Sire Day provided the initial exposure to the Dohne breed and its philosophy for students at Muresk.

The opportunity to build on this initial exposure by providing a demonstration flock to be run at the Muresk Institute is consistent with the development of the breed in South Africa.

The partnership was launched on 29 July 2015 with the donation of 200 commercial Dohne ewes to the Muresk Institute flock and the signing of a Memorandum of Understanding by the Minister for Training and Workforce Development and the President of the Dohne Breeders. Opportunities created through the partnership include sharing of expertise, work experience and employment opportunities.

Figure 1. Ross Fenwick, Secretary, Muresk Institute General manager Prue Jenkins and Rhys Parsons, President of the WA Dohne Breeders Association at the partnership launch.

Proceeds from the sale of the first wool clip shorn from the Dohne flock have been donated to charity – the Royal Flying Doctor Service, and beyondblue.

Figure 2. Muresk Institute General Manager Prue Jenkins, Ian Hanna and Rachel Browne from the WA Dohne Breeders Association and Reece Morton from Landmark at the wool sale.

Benefits. From an educational perspective, there are a range of benefits to students engaged in learning at the Muresk campus. These include;

- Being able to connect theory with practice in objective breeding methods, including understanding ASBVs
- Hands-on experience of sheep selection
- Performance monitoring of the Dohne flock, and the capacity to conduct trials and assessments
- Build students' professional networks with Dohne breeders
- Participate in industry workshops such as RAMSELECT
- Student/commercial membership of the WA Dohne Breeders' Association

On the flipside, benefits to members include;

- Ongoing exposure of young professionals to the Dohne breed and philosophy
- Opportunities to work alongside students to develop their skills and knowledge in animal breeding and selection
- Opportunities for post-graduate study using data collected on the Dohne flock
- Development of a large body of independent data documenting the performance of the Dohne in WA

CONCLUSION

When agricultural education commenced at the Muresk campus in 1926, perhaps few would have envisaged that 90 years later Muresk Institute would be operating true to the original aims as described by founding Principal Hugh Jason Hughes. Muresk Institute's role as a broker of post-secondary courses in agriculture and agribusiness, as a host for research trials and a venue for

short courses offering accreditation within the Australian Qualification Framework (AQF) is supported by the development of partnerships with industry organisations such as the WA Dohne Breeders' Association. This partnership allows the Dohne breed to engage with future industry participants at a formative stage and offers benefits to all.

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THE MATERNAL QUALITIES OF THE DOHNE

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SUMMARY

Since the inception of the Dohne breed in our property, we have seen the benefits of the breed. Dohnes have proven their superior mothering ability and growth rates to meet lamb market specifications and also still produce a reasonable fleece at shearing. The Dohne fits into our sheep and cropping operation efficiently as documented below.

INTRODUCTION

I would like to share with you my journey of how I initially became involved with Dohnes and why I believe they are the 'sheep of choice'. My focus will be on how their strong maternal instinct and attributes have proven to be a positive and financial gain for my farming enterprise.

In 1996, when our family partnership dissolved, my wife, Sally and I went out on our own and formed Circle H Farms. In the split up my share was 1000 hectares and 6000 wethers. My passion had been cropping and I saw the sheep solely as a supplement income with the wool. The 1000 hectares was all cropping country so I had to look for somewhere else to place the sheep. I found some leased country where I grazed my wethers. The sheep were minimal work and it was easy.

In 1998, I went on a trip to China with the Green Triangle group to learn more about wool. While visiting the Chinese woollen mills, I saw there was a strong market for quality fine wool and decided it was in my best interest to produce quality wool. On my return, I bought over 2000 Merino ewes and started a breeding programme.

In the early 2000's, agribusiness consultant Ken Solly, was taking a group of people on a MacKillop Farm Management tour and as part of the trip we looked at some Dohne operations in Western Australia. Ken always said at the beginning of a tour – "If you go on a tour, you have to come home with an idea to make money to cover the trip."

On this trip, I had a lightbulb moment. I was breeding sheep for wool. Wool prices were low at this stage. I needed to make more money. I decided the world needed to be fed, and meat was a great source of protein in the human diet. My focus changed, it went from wool to meat. I wanted to produce quality prime lambs. Not just any lamb, a lamb with a good carcase and one which had significant weight gains. This started my journey to find the ideal sheep that would have the attributes I wanted – decent micron wool, good quality meat and an excellent breeder. We visited the Dohne operations, and I liked what I saw. Here was a proven sheep breed that met all my needs. It was my ideal sheep.

The major feature that I particularly liked was that the Dohne was a great mother. Once I got the Dohne ewes home, the maternal qualities of the Dohne soon became obvious.

Benefits of Dohne ewes.

- They are fertile, natural breeders with a high libido.
- Great mothers – caring sheep that look after their lambs.
- They have lambs that want to '*get up and live. They slip out like a cake of soap.*'
- They are excellent milk producers.

- Their lamb percentages are consistent and high.
- Lambing percentages are normally 115% – 125%.
- They have the ability to hold condition after lambing, even in tough conditions.
- They breed lambs that have high weight gains within 5-8 months of age, while maintaining a good fat cover.
- They are non-seasonal breeders – they are cycling all the time.

Our own Dohne breeding program. Our goal was to have a highly functioning self-replacing Dohne flock. We began by buying old ewes with Dohne embryos from the existing studs we had seen in WA. To quicken the process, we bought embryos and started doing our own embryo programme here. This was so we could fast track our genetic gain and have purebreds on the ground as quickly as possible. With the rams, there was a lot of work involved and we didn't have the correct management practices in place to do it ourselves. We contracted a local ram breeder to help us with our breeding program.

In the early 2000's, during the dry times, we were fortunate to have the opportunity to buy over 2000 purebred Dohne ewes from Western Australia. These ewes, added to our existing flock, boosted our numbers considerably. Everything from then on was mated to a Dohne ram. We were eager to multiply our purebred status as quickly as possible. It was so much easier due to the maternal qualities of the Dohne ewe. They bred easily and they produced a lamb that lived.

To run this number of sheep, and allow us to keep our cropping country , we leased good quality grazing land for the sheep down at Harrow, Victoria, 100km south east from our home property. This worked well and the sheep thrived in this environment. At our peak we had 20-22,000 breeding ewes and 860 bales of wool.

History of sheep – where do Dohne's fit in? In the late 1990's the gross margin of a sheep was 20% meat and 80% wool. Today, the gross margin for a sheep is 70% meat and 30% wool. This identifies the shift from wool to meat. This justifies the choice of Dohne as the 'sheep of choice' in today's world with its dual-purpose excellence in wool and meat. The Dohne sheep has proven to be the ultimate dual-purpose sheep for Circle H Farms. The main reasons for this success is the following:

- During tough drought times on our farm they have proven to be resilient – they are low maintenance.
- Good movers in the yards – often don't need dogs. You could almost call them 'intelligent'.
- They produced good quality wool, which met my expectations of micron, length and quality.
- They are great breeders. Seeing the lambs slip out like 'a piece of soap' and be strong and healthy at birth is heartening.

The one area which excited me the most was being able to increase my flock significantly quicker than I had been doing, due to the improved fertility and successful lambing of the Dohne ewe. Once the rams were put out it would seem that the ewe fell pregnant almost instantly. This is apparent at lambing time when the ewes basically all lamb around the earliest lambing date. It is heartening to see the ewes give birth so easily, whether it be single, twins or triplets. The lambs are strong and healthy and the mothers produce plenty of milk. Dohne ewes can easily manage lambing percentages of 115-125%.

The lambs are fast growing and they have significant weight gain, allowing them to be marketed earlier. Even though they have a quick weight gain, they maintain their muscle definition and structure.

The excellent lambing percentages, coupled with the early turn off of lambs allows me to maximise productivity.

Lamb Management. *Winner of the JBS Lamb Producer 2015*. When I won this award, I sat back and looked at what had helped us come to this point. We had to constantly meet certain specifications to win, and I believe it was our management of our lambing programme that had a big part to play.

A lot of our success is due to our incorporation of the Lucerne circles. Once the Lucerne is harvested in March, the early lambing ewes are moved onto the circles, ready to lamb around 14th of April. This ensures they have plenty of nutritious feed and are at optimum condition when they lamb. The ewes that lamb on 1st of June, are put on the dryland pastures.

Together with good feed and the strong maternal qualities of the Dohne ewes, the lambs have the best start in life. The lambs are born easily, they receive lots of milk and they gain weight quickly.

Lambs are weaned after 12 weeks. The lambs are given priority of the existing feed and are returned to the circles to fatten. They are weighed and condition scored around August-September, and as soon as they hit 48 kg we start marketing them. We separate them into their weight ranges and continue to weigh them every month. The lambs are sold when the weight and condition score are spot on.

Depending on the season and the availability of feed, we also trade lambs, buying lambs in, fattening them and then marketing them. This starts in September on green feed followed by bean stubbles.

We also run a twenty pen feedlot, which is used when numbers add up and profits can be made. In the bad drought years of 2002 and 2006, it was invaluable for maintaining and finishing sheep. It can be used depending on the season, and can be used for 'opportunity purchase and finish' options. The feedlot gives us flexibility when needed. Our overall aim is to be consistent and reliable with our lamb program. This way we have been able to foster strong relationships with our stock agents and buyers.

Marketing. From August on, through the spring, we sell our lambs over the hooks to the domestic and export markets.

The reasons for choosing to sell over the hooks are:

- The lambs leave the property and go direct to the abattoirs.
- Ability to build a strong relationship with the buyers.
- Certainty – we know the price we are getting for the meat.
- Skin price is our only uncertainty.

Where are we now? When we won the JB Swift Lamb Producer of the Year, this reinforced my decision back in 2004 to start breeding Dohnes. Our farm culture is to do the best we can, to seek expert help and then act and make necessary changes. We like to keep up to date with technology. We have been using automatic weighing machines, scanning ewes and using capsules from when they first came on the market. They have all been valuable management tools; which have improved stock health and management, by keeping us better informed to make better decisions. The better decisions have led to significant cost savings.

The Dohnes have proven to be successful, both commercially and financially. The main reasons for this is that there are fewer losses of lambs and their ability to be consistent with their weight gain.

We have recently downscaled our enterprise and currently run 5000 Dohne ewes and 600 White Suffolk-Dohne ewes. This year, Circle H Farms has only 300 ha grazing for our total

number of sheep. When they aren't on the grazing land, irrigated circles, or the stubbles, they are fed in containment in the feedlot area.

Overall impression *'Stick to the Dohne programme.'* The Dohne industry should be the benchmark that all other breeds look to! The Dohnes more than adequately cover all aspects of what a good breed can achieve. Breeding is a long term process and it is proven that over time, the Dohnes will always do well, whether it is wool or meat that is the stronger commodity at the time, due to their strength in both areas. They are also survivors and excellent breeders.

I question why farmers sometimes switch their breeding programme to fit in with the latest commodity prices/stronger cycle. They chop and change to chase the markets. For example, they will start to put Merino rams over their Dohne ewes to get a larger cut of wool. You don't want to do anything at the expense of the strengths of the Dohne, in this case, their strong maternal attributes. My advice is "stick to the programme". The long term benefits will outweigh any short term gain.

The future. Farming is a professional industry today. My challenge has been taking Circle H Farms into the 21st century, making the necessary changes to remain competitive to keep in the top 10% of farms and adapting to the latest technology. The challenge for the sheep industry is to ensure Dohnes stay the 'sheep of choice'. To do this I believe there are two areas that should be addressed for Dohnes to be/remain leaders:

- **Increased numbers/production of lambs.** It would be great to have the technology or systems in place that can trace the processing data and/or dressing percentage results that identify the lean and high yielding carcases of the lambs processed from the carcase right back to the maternal ewe. This would then enable the breeder to quickly identify which maternal ewes in his or her flock produced the highest performing lambs. From this information these ewes could be placed into a program where the eggs could be flushed and placed in recipient ewes as embryos enabling the breeder to fast track the build-up of a high performance maternal ewe commercial flock that consistently produces fast growing, high yielding meat quality lambs providing increased profitability for the breeder or trader. As an industry, we have all being increasing our technical and visual assessments over the past ten years in understanding our Australian Dohne breeding capacity. I believe with this additional data we could increase our industry efficiencies, performance and make our industry more profitable. This already happens in the chicken and pig industries.
- **Survival rate in Australia.** From the number of foetuses that are scanned pregnant, through to lamb marking there can be a 25% loss. A 25% loss in production adds up to twenty million lambs in Australia. I would like to put the challenge out there to the sheep industry to investigate what happens between scanning and lamb marking.

Everyone would agree that the maternal qualities of the Dohne ewe are perfect for Australian conditions. They are survivors - resilient and fertile. They are natural mothers who produce and rear high performance lambs. Our challenge is to manage them more effectively to get the optimal results using their exceptional mothering abilities.

ETHICAL LIVESTOCK FARMING AND FEEDLOTTING DOHNES AT RIVALEA

Barry Hutton

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SUMMARY

Rivalea is a vertically integrated company, which processes 700,000 pigs a year and processes 250,000 tonnes of grain through its feed mill. The company also employs approximately 1000 employees at a variety of locations around Australia. Rivalea also has interests in the sheep meat and wool industry. Rivalea has developed a breeding program to capitalise the benefits of the Dohne sheep breed. Since the inception of the Dohne at Rivalea; the company has seen the benefits of improved mothering ability, increase lamb survival and better turn off of wethers within 12 months into the lamb slaughter market. The improved growth rates and finishing ability of the Dohne is a hallmark trait of the breed and in this instance has met all expectations. Rivalea is aiming to further capitalise on these attributes into the future.

INTRODUCTION

Rivalea owns two sheep and wool producing properties "Hillside" at Corowa NSW used as a grow out enterprise and also Balpool Station Moulamein NSW in the Riverina of New South Wales. Originally, Balpool was stocked with 2,500 dual-purpose medium wool Merinos, focussing on running a self replacing flock and offloading wether lambs to corowa before the age of 12 months. However, both properties had difficulty reaching the required slaughter weights before they reached hogget age, and lambing percentages were also below the industry average.

DISCUSSION

Ethical livestock farming at Rivalea. Rivalea has always prided itself on its ethical treatment of their animals and were aiming to move away from controversial practices such as mulesing, which is common practice in Merino enterprise systems. In 2011, Rivalea evaluated the dual-purpose advantage of the Dohne breed, and with the added advantage of not needing to be mulesed, the breed met the criteria. Rivalea set about sourcing the appropriate genetics from recognised leading Dohne studs in Australia.

Sourcing Dohne genetics. Rivalea were advised by classers and industry publications. about suitable studs to source the required genetics. Rivalea decided to purchase 400 pureblood Dohne ewes and 25 rams from Roseville Park Dohnes, Yeoval NSW, to mate and convert the existing Merino flock to pure blood status .Rivalea selected these rams and ewes based on their wool type, structures and Australian Standard Breeding Values. Later on that year, Rivalea also purchased another 400 full blood Dohne ewes and 25 rams from Uardry Dohne stud at Hay NSW. Once again these sheep were selected based on similar breeding direction as the previous purchase. These ewes and rams were the cornerstone of the makeup of the breeding flock and were shown to be superior in growth and carcase composition. Since then there has been further purchases of sires from Macquarie Dohne stud Warren NSW and Coddinton Dohnes in Yeoval NSW. Rivalea set out with the breeding goals of:

- Reaching acceptable slaughter weights of wether lambs within 12 months of age
- Increase lambing percentages above industry average for each of the properties, without needing greater inputs
- Understanding the breeding value of the Dohne ewe when mated with our maternal sires
- Achieve acceptable staple lengths to justify shearing every 6 months.

All these objectives were evaluated by Rivalea on an on-going basis to assess the effectiveness of the breed.

Management practices at Rivalea. *Lambing***:** Rivalea breeding and management program focussed on achieving the three main aims. The ewes were lambed at Balpool with management of the property by the farm managers. Ewes at Balpool were joined to rams at 2% of the flock for 42 days. Scanning data from the Dohne flock averaged 92% in lamb.

Ewes were lambed down in mobs sizes of 600 and managed appropriately (Figure 1). From the first mating, lamb marking rates increased dramatically from a rolling average of 90% originally in the Merino flock to 120% in the Dohne flock. Part of this increase in the marking percentage was put down to the superior mothering ability of the Dohne ewe.

Figure 1. Dohne ewes managed to conception at Balpool station Moulamein NSW.

The lambs were marked at 1.5 months old. The incidence of flystrike within the flock was similar for the pure blood Dohnes and the Dohne x Merino cross progeny. The plain bodied phenotype of the Dohne breed helped developed a viable product that did not require mulesing or further management.

Weaning: The Dohne offspring were weaned at 3 month of age onto improved lucerne pasture (Figure 2) at both properties. Once weaned and grown out they were put into a feedlot for a total of 44 days or until they reached an average weight of 52 kg ready for a targeted carcase weight of 25kg. The growth rates and feed conversion efficiency of the lambs was calculated at the start, middle and end of the period the lambs when confined to the feedlot is provided in Table 1.

Figure 2. Grown out Dohne lambs on lucerne pasture.

As demonstrated in Table 1, the progeny displayed exceptional feed efficiency which increased as the time past. The average weight gain was fast and consistent until the appropriate weight range was achieved to slaughter. Anecdotal reports suggest that the growth rates achieved by the Dohne breed were greater than what was achieved in the Merino enterprise before the change in breed.

Table 1. feedlot performance of Dohne lambs at Rivalea.

	Start[#]	Middle	End	Average
Average weight (kg)[*]	31.6	38.9	45.6	NA
Average daily intake (kg/day)	NA	1.37	2.00	1.71
Weight gain/sheep/day[∞] (g/day)	NA	364	279	318
Feed conversion ratio (kg)	Not estimated	3.80	7.21	5.39

*Average weight is estimated from the first day of the period

#All values presented in Table one are averages estimated across the 10 pens included in this enterprise

∞Weight gain and average daily intake is calculated across approximately 20 day period when divided by the number of lambs in the pen.

The Dohne breed growth potential as demonstrated by the performance of the offspring validate the potential for this breed to work in a diverse variety of operations and reach the expected slaughter weights before the lambs become of age.

The Dohne lambs were sent directly to the abattoir over the hooks and reports from the slaughter company was all positive and demonstrate the benefits of the Dohne carcase. ……….

CONCLUSION

The performance of the Dohne breed has met all expectations at Rivalea. The performance of the sheep at both Rivalea properties has seen dramatic improvements in growth potential, lamb survival and mothering ability. The benefits of these qualities are providing significant financial benefits to the company. The traits that the Dohne breed is becoming renowned for are truly on displayed in this flock.

CELEBRATING 50 YEARS SINCE THE ESTABLISHMENT OF THE BREED SOCIETY

Cameron McMaster

SUMMARY.   A brief review of the beginnings of the Dohne Merino breed and the breeding and management principles that were established by its founder, Mr JJJ Kotzé, is followed by a description of the formation of the Dohne Merino Breed Society of South Africa in May 1966. I am privileged to have been continuously involved with the new breed from that time to the present day. In June 1970 I was appointed administrator of the young breed society, and part of the team responsible for the development and promotion of the Dohne Merino Breed. Reference is made to some of the persons and institutions who had a major influence on the systems that were developed by the young society. Tribute is paid to persons who contributed substantially to the growth of the breed. The expansion of the breed to other countries in the Southern Hemisphere is described and in conclusion an appeal is made to breeders, both current and future, to adhere to the fundamental breeding principles that led to the success of the Dohne Merino sheep breed.

The start of the breeding programme. The breeding programme was initiated at the Dohne Agricultural Research Institute in 1939. One of the goals set after the establishment of the research station at Dohne in 1937 was the development of a better adapted wool sheep breed for the harsh sourveld region of the Eastern Cape where the Merino was poorly adapted. The implementation and development of the programme was entirely due to the initiative and drive of Koot Kotzé, the director of the research station, who rightfully earned the title "Father of the Dohne". Mr Kotzé was a brilliant and insightful scientist with a clear view of what was necessary to uplift the sheep breeding industry in the region. From the start he set the parameters that would be used and are still used to this day: Individual mating should take place, pedigrees and performance should be recorded, and sheep should run under identical conditions in a natural commercial environment. He defined the selection procedures that are followed to this day. These were very advanced requirements at this time (the early and mid 1940s) before there was a hint of performance recording in sheep breeding. By observing the most productive and best adapted sheep in each generation, Koot Kotzé himself defined the ideal breed type that would form the basis for selection. Over the years that followed, he imparted this image of breed-type and the practical application of the grading system to his colleagues and protégés, including myself, and these were later encapsulated in the breed standards and bye-laws when the Dohne Breed Society was formed.

The concept of a "new" locally adapted breed captured the imagination of some prominent sheep farmers in the area, who were enlisted as co-workers in the development of the new breed. His great friends Gerald Featherstone, Deemie and Jack Blaine offered their flocks to him and eventually became the first foundation studs - Waterford, Wauldby and Ross and the breed was poised to take off.

The formation of the Dohne Merino Breed Society of South Africa. The Society was launched at a meeting held at the Dohne Agricultural Research Institute near the town of Stutterheim in the Eastern Cape on 16 May 1966. It was well attended by over 50 persons of whom 39 were either already active breeders or potential breeders. I am possibly one of only three persons still living who were at that meeting. Our first President was Roelie le Roux of the Dirko stud, Somerset East, who served us with distinction for the first 10 years. Noel Geach, manager of the Waterford stud, was elected first secretary and member of the first Council, eventually becoming a Dohne assessor. At the end of the first year 36 Studs were registered with a total of 2500 recorded ewes - small beginnings but with enormous promise.

A new paradigm.   Having already embarked on a new trajectory, being innovators by inclination and unencumbered by the constraints of tradition, the small band of enthusiastic breeders who formed the Society in 1966 readily embraced new concepts being propagated at the time. Armed with a blueprint established by the founder of the breed, Koot Kotzé, they keenly accepted and applied the modern breeding and selection principles being introduced to the ram breeding industry. After the establishment of the South African Fleece Testing Centre in 1970, the Department launched a series of performance testing courses for ram breeders where the principles of population genetics, the setting of breeding goals and selection strategies were explained by Dr Almero de Lange, a geneticist attached to the department, who had the unique ability to inspire and motivate his students. All aspirant and open-minded Dohne breeders who attended these courses were motivated to adopt measurement and the new selection and management programmes this entailed.

We established contact with sheep breeders and animal scientists in Australia and New Zealand. There was a wealth of new information available at the time. We drew heavily from books such as "Science and the Merino Breeder" by Dun and Easto and "Breeding Merinos" by Scott Dolling, both published in 1970, which explained how sheep breeders could employ proven genetic principles to obtain worthwhile improvements in the Australian Merino. We even borrowed heavily from the logical and practical principles set out in the "Lasater Philosophy of Cattle Breeding". His statement *Females are the basic business of livestock breeding* struck a chord with us. Selecting rams that were the progeny of highly productive and fertile ewes became standard practice.

Consequently when innovators in Australia and New Zealand introduced the system of Open Nucleus Breeding, we enthusiastically followed suit. We maintained close contact with these innovators, exchanging ideas and visiting each other from time to time. On the advice of Prof Al Rae of Massey University, Tony Parker of the NZ Romney Development Group, after failing to make progress in a small closed stud, began to introduce high performing females from his clients' flocks, thus "opening" his stud to ewes of proven performance. In effect this increased the gene pool by a massive amount and permitted very much higher selection differentials for traits of economic importance, thus producing rams of superior merit at a lower cost than in a traditional stud. The most valuable lesson we learned from Tony was to enlist Nature as a partner and observe the shape and type of animal that would evolve through selection on performance. No longer were replacement sheep required to conform to the outdated breed standards dictated by the show ring. Our experience over the years confirmed this. The concept of the open nucleus system was so logical and practical and offered so much promise, it was rapidly incorporated in our system and extended to the Foundation Flock Register where provision was made for promoting females from commercial flocks. In this instance we followed the principle of promoting only ewes in the top 20% of a measured age group at the F3 generation. This was a principle adopted by Prof Coop of Lincoln University in the development of the Coopworth, a synthetic breed developed along the same lines as the Dohne with strict emphasis on performance. Over the decades that this principle has been applied in South Africa, it has had a profoundly positive result.

Another important mentor was Jim Shepherd of the Australian Merino Society in WA. He believed that genetic merit was not necessarily confined solely to parent studs and that outstanding breeding material was also present in daughter studs and commercial flocks and should be utilized. He often stated that it was tantamount to a national sin not to identify high performing females in commercial flocks and use them in ram breeding programmes. This led to his de-registration "for conduct contrary to the objects and ethics of the Australian Stud Merino Breeders' Association". It was strange that the Stud Breeders at the time considered this attempt to improve the productivity of Merino sheep as a malpractice.

During the first three decades after the formation of the Society the fundamental principle of selection based on economically important traits was closely followed by the early breeders.

The most important criterion adopted was the measured relative efficiency of their sheep as producers of marketable produce. To preserve and improve the inherent hardiness and adaptability of the new breed, exposure of the sheep under selection to a natural commercial environment was encouraged. Consequently rapid progress was made over this time. The superior productivity of the Dohne soon became evident and it very soon became a major player and competitor in the industry. By 1990, there were over 300 breeders with nearly 48,000 recorded ewes, spread over the entire country.

As a consequence of the rapid growth of the society it became necessary to employ addition technical staff. Henri Londt joined the staff of the society in 1988 initiating a new era of progress. He was energetic, enthusiastic and ambitious, but above all highly capable and passionate about performance recording and scientific selection. For the next 24 years he became the face of the Dohne Merino, taking it to ever greater heights and extending its boundaries to all the countries of the southern hemisphere. Conscious of the importance of international communication , Henri embarked on a visit to Australia and New Zealand in 1991. Sire reference schemes (SRS) were largely replacing nucleus flocks as an instrument for breed improvement in New Zealand. Having been thoroughly briefed by Professor Al Rae of Massey University, Henri proceeded to establish a number of SRSs in different parts of South Africa. Using the new technology of breeding value determination, Henri was able to accurately assess the direction in which the breed was heading. This lead to the remarkable realisation that too much emphasis on fleece weight was inhibiting the progress that was being made in terms of reproduction and growth rate, the major components of flock income. At this time targeted research at Grootfontein revealed that excessive fibre producing capacity inhibited an animal's resistance to stress and negatively affected fitness traits which influence reproduction and growth rates.

The research workers involved were Dr Danie Wentzel (1991) and Tino Herselman et al (1993) who coined the term Wool Production Potential(WPP) - the ratio of clean fleece weight to body weight at yearling age. Henri recognised the danger of an imbalance between fleece weight and body weight in dual-purpose sheep. In 1994 it was decided to reduce the value of fleece weight in the selection index which resulted in a rapid improvement in reproduction. Statistics pertaining to the average body and fleece weights, fibre diameter and WPP% in all studs were meticulously recorded over the years and the progress that was made testifies to the wisdom of the decisions made at the 1994 workshop and later. The WPP% and fibre diameter declined, the fitness of our sheep improved dramatically as did lambing percentages and growth rate. In 1996 the average WPP% of all Dohnes was 6.76% and the average lambing percentage was 108%. Thirteen years later in 2009, the WPP% was 5.15% and the lambing percentage over all studs had risen to 141%!

In addition to fine tuning the selection indices, with the help and guidance of Dr Kobus Delport and Dr Buks Olivier, Henri managed the transition to across flock breeding values, bringing the Society fully in line with international best practice. From 1998 and for as long as it remained possible, he supervised the export of Dohne embryos to Australia and undertook a number of trips to Australia, South America and the Falkland Islands to assist with the establishment of the breed in these countries. It is impossible to quantify the enormous contribution that Henri made to the development of the Dohne Breed worldwide. It is a tragedy that he was taken from us in 2012 at the height of his career.

The introduction of the Dohne to Australia from 1998 onwards proved that Dohnes could perform equally well here. Dohne pioneers in Australia were Alex Leach and Geoff Beeck of Katanning, WA, followed soon after by Graham Coddington, Roseville Park, Dubbo, the Macquarie Stud, Warren and Uardry, Hay NSW. The Dohne ushered in a new era of prosperity for Australian woolgrowers who could now add lucrative prime lamb production in self replacing flocks. It also heralded the introduction of the Dohne to the rest of the world, a market Australian breeders soon took full advantage of. From 2002 to 2007 I visited Australia every year to conduct

workshops to familiarise new and aspirant breeders with Dohne standards and principles. The welcome and kindness I received was overwhelming and I made many lasting friendships. I will always be indebted to Allan Casey who was my co-presenter in nearly all of the many workshops we held, and who generally looked after my welfare. He authored a chapter on Australian Dohne history in "Birth of a Breed" and when visiting me last year, we took delivery of the book together - hot off the press from the publishers. I wish also to pay tribute to the first two assessors, Bevan Taylor and Alan Clark who assisted with the practical work at many of our workshops and spent many days driving me to the many places they were held.

David Kain, honorary life member of the Australian Dohne Breeders Association, served for 8 years on the council and 5 years as national president. The Far Valley website is one of the most informative and educational sites I know, illustrating the dramatic improvement in productivity since Dohnes were introduced in 2000. When I showed him the manuscript of my first book "Sheep in my Blood", David immediately adopted it as a Dohne project and wrote the foreword. It was published by the ADBA and enjoyed wide circulation. Thank you David for your friendship and support.

The phenomenal expansion of the Dohne to countries in South America is perhaps the greatest testimonial to the superior adaptability and productivity of our breed. Dohnes are causing a revolution through their ability to substantially reduce fibre diameter in the Corriedale and other coarse wool breeds and at the same time improve both reproduction and growth rates. My friend Roberto Cardellino has been a major role player in the introduction of Dohnes to South America. He first saw Dohnes when he attended the 3rd World Merino Conference in South Africa in 1990 and was impressed. This led to an invitation to me to speak at the next World Conference in Montevideo in 1994, affording us a great opportunity to promote Dohnes. He arranged the importation of Dohnes to Uruguay in 2002 when the Tres Arboles Stud was formed. Dohnes are now a major sheep breed in Uruguay and continue to expand with the formation of a number of new studs. This year Dohnes achieved the highest average price of all breeds on public ram sales. Persons who have made an important contribution to the expansion of the Dohne in South America are Alejandro Vozzi in Argentina, Hugo Vera and Hernan Felipe Elizalde in Chile and William Vivanco in Peru.   We have Dr Vivanco to thank for the design of a chart which compares the Dohne with other breeds in the world, emphasizing the fact that it is unique in being the only breed capable of weaning weights in excess of 30kg and growing wool of 20 microns and less - a true dual purpose breed.

The Dohne is making an important contribution to increased flock productivity world-wide. Looking back to the beginning, it is clear that the initial rapid success of the breed was due to the harsh environment in which it was developed – the sour grassland of the Eastern Cape. By constantly exposing animals to these tough commercial conditions and relentless selection of the most productive in this environment, a truly hardy, well adapted and efficient sheep breed was developed.   The effective management and breeding principles implemented by the society ensured that the productivity of the breed continued to improve, wherever it was bred. Today it is up to us as Dohne breeders, to continue to improve and enhance the attributes of our sheep by adhering to the fundamental principles that led to success. Of equal importance is the necessity to preserve the correct relationship between body and fleece weight for a true dual-purpose breed. As a result of years of careful research and the monitoring of this ratio in the breed, it is clear that we are currently at an optimum level to maximise the combined income from meat and wool. In the 50 years of its existence, the Dohne Merino Breed Society of South Africa has made a major contribution to sheep production, not only at home, but in every country where Dohnes are run. I predict a brilliant future for our breed which will continue to improve and expand.

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