A Nuffield Farming Scholarships Trust Report

Award sponsored by

Alan and Anne Beckett

Optimising ewe performance for a productive sheep enterprise and a high quality finished lamb

James Drummond

September 2015

NUFFIELD UK

NUFFIELD FARMING SCHOLARSHIPS TRUST (UK)

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A Nuffield (UK) Farming Scholarships Trust Report

Date of report: September 2015

"Leading positive change in agriculture. Inspiring passion and potential in people."

Title	Optimising ewe performance for a productive sheep enterprise and a high quality finished lamb
Scholar	James Drummond
Sponsor	Alan and Anne Beckett
Objectives of Study Tour	To examine methods to integrate into current production systems to improve profitability and performance. Determine factors that govern an increase in ewe efficiency. To look at maximising potential yields from pastoral livestock production. To determine the underlining principles of economically efficient sheep production.
Countries Visited	Australia, New Zealand, France Ireland, Northern Ireland, England, Scotland, Wales
Messages	• The maternal genetics in place are vital to improve ewe efficiency, reduce management requirement and increase productivity. • Improving grassland management to increase usable yield is essential to increase the productive capacity of pastoral livestock systems. • Economic efficiency in a commercial sheep enterprise is fundamental, derived from efficiencies in production enabling the maximum profit achievable through an increased output per hectare whilst reducing production costs per kg sold. • Meeting nutritional requirement is essential for genetic potential to be fulfilled; the ability to manage nutrition will increase the performance achievable on pasture. • Maximising production from improved genetics to target ewe efficiency; increased stocking density per labour unit and output per hectare, incorporated into grazing strategies to maximise usable yield from a pasture/forage based system, will all enable the greatest output per hectare from a reduced cost base to be achieved, and will best improve economic efficiency.

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DISCLAIMER

The opinions expressed in this report are my own and not necessarily those of the Nuffield Farming Scholarships Trust, or of my sponsor, or of any other sponsoring body.

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1. Personal introduction

Fundamentally farming is and always has been in my blood, tracing back through many generations of farmers. Initially farming around the Scottish borders, both sides of the family moved to farm near Alnwick in Northumberland four generations ago and in 1945 my grandfather took on the tenancy at Lemmington Hill Head where I farm today in partnership with my father.

Although agriculture runs through my veins I did have a brief spell away in order to confirm the farming addiction. After studying design at Loughborough University I was fortunate enough to be selected for the Leonardo Di Vinci programme and went on to work for an architectural firm in Prague. Beautiful as Prague was, and my attempt to learn Czech was certainly a challenge, a life in an office was never going to be meaningful to me. After a year in the Czech Republic I was craving to get outdoors once more and back into agriculture. Having already used up my visa quota for Australia - working there prior to starting university - I decided to spend a season working for an agricultural contractor in the Waikato, New Zealand, before returning home to the farm in 2010.

Our business is now predominantly focused on livestock production on two upland farms, Lemmington Hill Head and Birsley Woodside, totalling 220 hectares on which we farm 1300 sheep and 120 head of cattle. Along with the livestock, which also includes pigs and hens, we grow 100 acres of arable and brassicas for winter feed. Increasing the business's production and profitability by evolving our grassland management to maximise utilisation and efficiency has become somewhat of an addiction in recent years and, I suppose, was one of the key drivers in applying for my Nuffield Farming Scholarship. As well as this I am also currently undertaking a Moredun Foundation Scholarship, examining on-farm methods to reduce anthelmintic use in sheep production. I hope that it, along with my Nuffield Farming report, will not only help to benefit my business but that of others in the sheep sector. I am a firm believer that knowledge increases by sharing rather than by saving, and that making time off-farm can ultimately improve the business as much or more than time spent on-farm.

I am a firm believer that knowledge increases by sharing rather than by saving, and that making time off-farm can ultimately improve the business as much or more than time spent on-farm.

All this has led to a very busy year both on and off farm as, alongside undertaking research trips for my Scholarships, being involved in the Northumberland Grazing Discussion Group, the Northumberland CSF Steering group and being an Eblex Focus Farm, I spent 2014 as part of the National Sheep Association's Next Generation Ambassador Group as North of England ambassador.

With my year on the Ambassador Group complete, and having finished my research for the scholarships, it is time to get caught up with work on the farm and the continued development of our breeding programme. The commercial flock saw a shift away from the traditional stratified breeding system that was in place, to one focused on increasing efficiency from a maternal ewe base

suited to a forage-based system. Three years ago we started incorporating Aberfield genetics to build up the new flock. In 2014 we became a breeding partner with Welsh based breeding specialists Innovis and began a three year embryo transfer programme to develop a nucleus flock of pure Aberfields on farm. The embryo programme allows us to harness the best genetics from the Aberystwyth-based flock to develop our nucleus flock on farm which will be producing rams to go into Innovis's sale structure.

I privately consider that producing stock completely unsuitable for the commercial farmer, chasing show titles and sale topping rams, is one of the most detrimental aspects of the UK sheep industry.

I am far from being an advocate of the direction many ram breeding systems have taken in the UK. I privately consider that producing stock completely unsuitable for the commercial farmer, chasing show titles and sale-topping rams, is one of the most detrimental aspects of the UK sheep industry. It is therefore a privilege to join the ranks of those refreshing breeders focused on producing rams to suit the needs of the commercial farmer and ultimately aimed to benefit the sheep sector.

Figure 1: The author, James Drummond, on his home farm

2. Background to my Nuffield Farming study tour

Sheep production for the average UK farmer means running an unprofitable enterprise with economic margins insufficient to sustain the business without the support of the Common Agricultural Policy. We sell a commodity into a global market with output and income influenced by many factors, yet there are huge opportunities to adopt measures which can significantly influence profitability by increasing physical performance and reducing production costs. In compiling this report I hope to examine methods to integrate into existing production systems to improve the profitability of sheep farming in the UK. By studying measures to increase production efficiency to raise productivity and reduce production costs I hope to determine practices which can be implemented in current sheep enterprises to improve a business's profitability.

The research was based around examining methods to increase production per hectare whilst reducing production costs per kg sold.

My research was focused on increasing output from a pasture-based system to achieve the maximum profit from a sheep enterprise through examining economic efficiency in sheep production, and thus realise the greatest achievable profit per hectare. The research was based around examining methods to increase production per hectare whilst reducing production costs per kg sold. Examining ewe efficiency and improved pasture utilisation to increase stocking capacity and productivity whilst looking at targeted input costs would enable an increase in production to be met, resulting in improved profit.

Productive agricultural practice is essential if we are to meet the increasing demand of a growing population. This, coupled with the global rise of the middle classes and the increasing demand for red meat, means livestock production will need to be more efficient in the future. This efficiency must come from increasing production, targeting input costs to reduce reliance on a finite quantity of resources, and through adopting new technology to improve the health of our soils and that of the environment we farm.

Whilst my research examined aspects governing meat eating quality, increasing the consistency of product supplied will better suit market requirements and do most for producer profits.

- Developing lamb for meat eating quality would add value if market access could be developed for your product. Producer groups incorporating sires developed for high intramuscular fat and sheer force would provide retailers with a higher value product for the consumer.
- Even with access to currently available markets, farmer focus should be on improving efficiency which would bring a much higher return. Providing a consistent product to meet market demand from a pasture-based system will ultimately increase the quality of output via the greater nutritional benefits and flavour profile derived from pasture-reared stock.
- Improving productivity from a reduced cost per kg sold will result in the greatest scope for improvement within many businesses.

3. An overview of countries visited

3a. New Zealand – 7 weeks (in 2014 and 2015)

Seen as a world leader in sheep production New Zealand could not be overlooked whilst undertaking research for this report. With a larger landmass and a population only 7% of that in the UK economies of scale are more achievable due to land availability. That being said, due to the massive boom seen in the dairy industry many sheep producers are being forced further up the hills. Land previously used as finishing ground has been converted to dairy or is used as rearing ground for the dairy industry, and sheep farmers are having to adapt to the change of landscape and must now integrate finishing systems into a harder terrain. Farming without the aid of subsidies, productivity and profitability are key to any sheep enterprise: there is no place for the negative aspects of sentiment and tradition that can undermine many systems in the UK. Flock profitability is essential to remain in farming and a focus on output and production costs is a necessity for any business which derives from attention to detail. New Zealand has a climate very suited to pastoral agriculture with an extended growing season able to meet the year round requirements of stock through grazing. Agricultural expertise and technology research is abundant and uptake on the whole is good, and although top and bottom end variation is still present, it is not to the extent seen in the UK.

3b. Australia – 5 weeks (in 2014 and 2015)

Although spending time in WA and NSW my research was mainly focused in Victoria where in the past 25 years sheep numbers have halved, wool production has reduced nearly 3-fold (from 190,600t down to 70,500t), yet lamb production has increased by 60%. Victoria now produces 207,000t of lamb, 44% of Australia's total lamb production, with around 184,000t being exported (2014 figures). Scale of production is vast and, on the whole, systems are extensive with terrain and climate governing the genetics in place. Wool-focused producers still run a large proportion of their flock as wethers but extension work in this area is focusing on greater industry uptake from producers to increase the output from their sheep through improving meat production as well as wool. As seen in New Zealand's sheep flock, which also halved in the same period while output remained the same, Victoria has increased the output of meat considerably, especially in more favourable areas where the focus of producers has shifted away from wool. Considerable research has been undertaken within the industry to improve meat eating quality in the lamb produced, with genomic data collected to develop breeding values which will allow producers to select superior genetics to improve the quality and eating experience of the meat produced.

3c. France – 1 week (in 2014)

A key part of the global market, historically France was the largest importer of sheep meat and despite being overtaken in 2012 by the surge in Chinese imports, still remains the highest value market and is the UK's largest export market taking two thirds of all exported sheep meat. With the UK seemingly disinterested and unable to access the Chinese market directly, and developing emerging markets for export being slow, France will remain the mainstream for UK sheep meat

exports for the foreseeable future. Their national sheep sector remains under pressure whilst profitability remains an issue as the competitiveness of imports drives a decline in the national flock.

3d. Ireland – 2 weeks (in 2015)

As with many sheep producing nations Ireland has seen a continuing decline in the national ewe flock over the past few decades. This is due both to producers exiting the industry and to those still involved in downsizing as margins tighten. The majority of lamb produced is destined for export, with France accounting for half of Ireland's market. There is some growth in less traditional markets throughout Europe although volume is small and the UK accounts for the majority of Irish carcass exports after France. Flock size on the whole is small especially in Northern Ireland due to the size of the average farm meaning that, for many, farming will not be the sole income stream. That being said there is great focus on productivity from the limited land available to some producers, resulting in some of the most productive farms per hectare of anywhere visited on my travels.

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3e. UK – 6 weeks (2014-15)

Due to this report focusing on increasing productivity and profitability in sheep production, the initial research was spent assessing current levels of business performance throughout the UK. Along with examining the ability of sheep producers to develop their enterprises it was also an opportunity to examine those producers performing at the very top level. Ultimately, to develop the industry further, I was looking at how these producers are able to farm and achieve healthy margins whilst others in the same environment could not; and also to identify methods already incorporated into sheep production in the UK that could benefit many others. Looking at methods by which those at the top could progress even further would benefit productivity at the highest level and examine techniques that could be implemented to integrate best practice into the wider farming community.

3f. Footnote: abbreviations

Throughout this report I have used abbreviations as shown below:

BCS	Body Condition Score
kgDM	Kilograms of Dry Matter
BLNZ	Beef and Lamb New Zealand
dlwg	Daily Liveweight Gain
ME	Metabolisable Energy
MJ	Mega joules
MBS	Maternal Behaviour Score
mwgt	Mature weight

4. Genetics, Nutrition and Management: the key components of sheep production

4a. Matching genetic performance to the farm environment

Genetics are the driver of efficient production performance in any livestock system. Ensuring the correct genetics are in place will determine the ability of a sheep enterprise to achieve the desired output and obtain an easily managed, profitable business. With such huge variation *between* breed as well as *within* breed, selecting the right stock for important commercial and economic traits will determine the ability of a flock to maximise its potential returns.

Ewe efficiency, survival, growth rates and carcass quality are determined by the genetics in place to increase productivity, whilst maintaining the ability to perform on pasture to reduce reliance on volatile commodity costs. Whilst breed values undoubtedly give greater insight into the genetic performance of an animal, greater consideration must be given to the environment in which the stock has been reared. Over-feeding of stock will distort their breeding values and mask their actual genetic ability. Once placed in a commercial environment their inability to perform on a pasture based system can massively reduce productivity and profitability. Selecting not only the right breed values to enhance the genetics in place but, more importantly, the source of those genetics, is vital to ensure the ability to reach the animal/progeny's genetic capability from a pasture-based system. To reach genetic potential on a pasture system, sourcing stock from a similar system will give greater relevance to breed values as the stock will be performing in an environment similar to that in which they were developed.

4b. Meeting the nutritional requirement to exploit the genetic potential

Meeting an animal's nutritional requirements is essential if genetic potential is to be fully exploited. Failing to meet requirements will reduce potential output through neglecting to capitalise on the full genetic capability of the ewe and her progeny. To maximise productivity from the genetics in place nutritional requirements must be met at the appropriate stages of production. Good pasture management is required to ensure the full genetic potential of the ewe and new born lamb is reached through the appropriate quantity of high quality pasture being available to graze. Maintaining the quality and required amount of pasture available to the lamb will ensure growth rate and finishing time are not compromised.

Whilst pasture quality is essential to exploit the full genetic potential of the growing lamb and the productive ability and efficiency of the ewe, using fit ewes at appropriate times of the year when nutritional requirements are low will ensure pasture quality is available when required later in the season and can be used as a management tool to reduce worm burden on pasture. Ewes weaned in good BCS can take residuals down very low to remove poor quality and unpalatable areas whilst removing L3[1] larvae to ensure fresh growth of high quality is available for mating. To reduce production costs and extend the grazing season it is important to know what the ewe *needs*, not what she *wants*, in order to better ration the pasture available and increase the length of the grazing

[1] 3rd stage larva, the infective stage for worm species

season. That being said, to capitalise on high scanning percentages it is better to give the ewe more available kgDM than is needed to enable grazing preference but leave higher residuals which can then be grazed again after mating when potential production from the ewe will not be compromised.

Ensuring targeted BCS is met through good pasture management and the availability of high quality pasture at mating will allow the ewe to express her genetic potential and increase flock output and efficiency. Maintaining nutrition during gestation from grazing pasture or forage will reduce costs associated with winter keep and the reliance on more variable supplementary costs. Careful monitoring of trace elements will identify deficiencies which could cause a reduction in ewe efficiency through reduced scanning percentage, or higher lamb losses through poor vigour and impact on lamb growth. Ewe nutrition pre lambing is essential to ensure the maternal ability of the ewe is fully reached and gives the new born lamb the greatest chance of survival, thereby increasing flock productivity and efficiency.

4b. Management and environment

The genetics in place are governed by management decisions determined by the direction of a sheep enterprise's breeding plan. Tailoring these genetics to different stock classes will enhance the management ease and performance of the flock as a whole. Focusing on different aspects of the genetics used for different purposes - i.e. lambing ease for mating ewe lambs, maternal ability and ewe efficiency for breeding replacement and carcass attributes for breeding finished lamb - will ultimately enhance production performance within the flock. Objective breeding both on farm and by any breeder where incoming genetics are sourced, with data collected in an environment similar to that where the stock will be run, ensures a cumulative increase in genetic ability over time.

The ease of day-to-day management will be determined by both the breeding of stock to reduce labour requirements, and the farm infrastructure in place. Both of these factors have a massive impact on stock numbers per labour unit and overall profitability. Stock developed for management ease will greatly decrease workload and give the ability to increase numbers without additional labour being required. Developing lambing ease, lamb vigour and the ewe's maternal ability will reduce intervention needed during lambing; whilst parasite resistance, dag scoring and sound feet will reduce workload in both ewes and lambs throughout the season.

Infrastructure in place on farm may be the biggest asset in the ability to increase stocking rate per labour unit and has the ability to give a high return on investment.

Infrastructure in place on farm may be the biggest asset in the ability to increase stocking rate per labour unit and has the ability to give a high return on investment. Monitoring returns from any investment should be made to show improvements to the business. Where some infrastructure may be focused on increasing management ease - i.e. lanes/tracks to aid the movement of stock around the farm - most investments will be to increase the carrying capacity and productivity of the farm: e.g. permanent fencing and water infrastructure to improve grass utilisation.

- Addressing soil Ph and nutrients, and reseeding with more productive pasture species, can produce a good return on investment through increasing kgDM produce.
- Improving infrastructure to increase utilisation of pasture will not only improve the productive capability of the ground but also massively improve the productivity of permanent pasture.
- Rotational grazing will not only improve grass utilisation (from 45-50% if set stocked to 80-85% if grazing is rotated) it also continually rejuvenates permanent pasture, reducing the requirement to reseed, and improves the quality of pasture provided for the stock.
- Meeting the nutritional requirements from improved quality and increased production of pasture from a controlled grazing system, will not only improve the production capability, but also increase the long term health of the soil.
- Where crop rotation is involved for winter forage, cropping or reseeding, no-till practices will ensure we maintain the health of our soils.

The ability of our soils to produce more relies on the adoption of new practices to preserve and increase organic matter and so improve the production capability of our land. This, coupled with improved genetics both in the livestock grazing the land, and the pasture species grown, will combine to ensure a long term increase in productivity.

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See case study on next page (Nithdale Genetics)

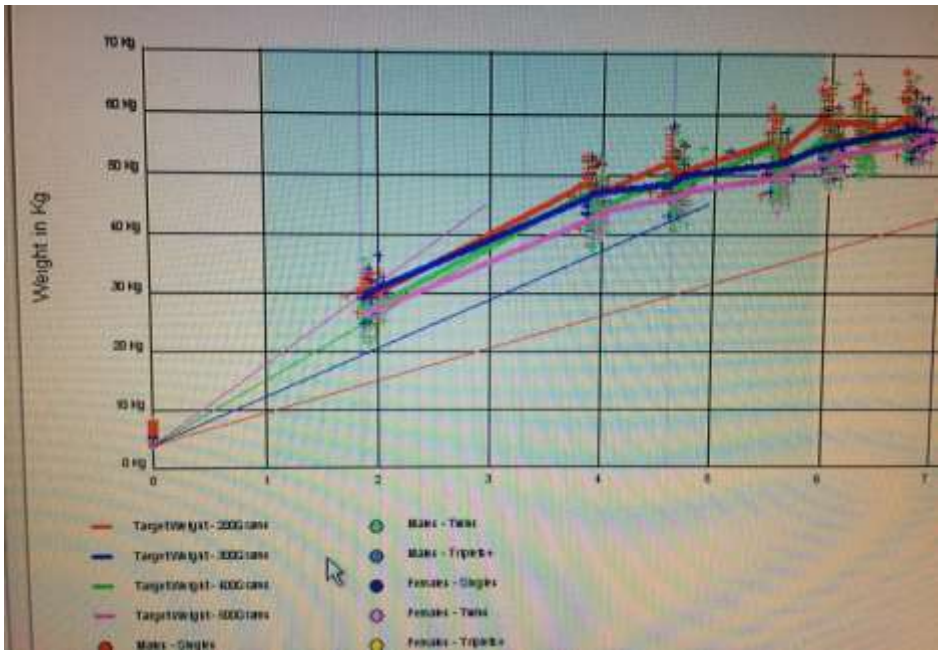

Figure 2: Data is essential to evaluate changes implemented on farm. The chart above demonstrates how growth rates can be monitored to assess performance, aid management decisions and assist replacement selection. (Source: the author's home farm)

Case Study: Nithdale Genetics

Nithdale Genetics, owned and run by Andrew and Heather Tripp, is situated near Nithdale, New Zealand. Producing Suftex and Romney rams the farm has won seven BLNZ sheep industry awards in the past four years and the 2014 Southland Balance Farm Environment Award. Covering 1478ha the farm consists of 5180 ewes, 2116 ewe hoggets and 710 ram hoggets. The farm also runs 93 beef cattle, 130 steers, has a 670 head dairy and rears close to 500 dairy heifers.

As is common practice with many New Zealand ram breeders, the Nithdale Romney flock had until recently been lambed in paddocks close to the farm, to be able to monitor and tag lambs at birth. In 2014 a decision was made to move the entire Romney stud flock into the hills and leave them unshepherded. This will enable the genetics to be evaluated in an environment more suited to that of a commercial farm. Ultimately this will enable the flock to be tested on a system similar to where their clients will be asking the progeny of the purchased rams to perform. It will ensure the stud is producing stock that can not only perform well, but has been bred to do so in the environment that commercial sheep production takes place.

Genetics are proved through DNA testing. Blood samples are taken from lambs, which determines parentage from sire and dam DNA records. This decision will better reflect the farming systems of their clients and progresses Nithdale's philosophy of breeding high performance, low input, low cost sheep.

Fig 3. Andrew Tripp going through a ram's breed values with a client at Nithdale Genetics

5. Optimising ewe performance

5a. Ewe efficiency

> *'Targeting Ewe Efficiency is key to more profitable sheep production which in turn could lower the farm carbon footprint'*
> (SRUC, Farming for a better climate)

Regardless of the farming system in place, improving ewe efficiency will in turn improve the profitability of the sheep enterprise - be it hill/lowland, indoor/outdoor, high input/low input. Targeting improved ewe efficiency will increase the output per ewe and the Kg of lamb produced from the flock. The best benchmark of ewe efficiency is in Kg of lamb produced at 90days per Kg of ewe mated. It can be improved by targeting three key areas linked to ewe/lamb genetics, nutrition and management.

1. Rearing percentage – (influenced by scanning percentage and lamb survival)
2. Lamb weight – dlwg to 90 days
3. Ewe weight at mating (targeted to optimum BCS)

Targeting ewe efficiency without the 90 day adjustment will ultimately neglect the importance of finishing time for the lambs and the maternal ability of the ewe.

> i.e. a 75kg ewe rearing 42kg lambs at 180% will have a ewe efficiency of 1:1 (kg lamb produced per kg ewe mated). Alternatively a 60kg ewe rearing 40kg lambs at 150% will also have a 1:1 efficiency. Yet neither gives any indication of the dlwg (daily liveweight gain) of the lambs or the finishing time, hence lifetime ME requirement of those lambs. With growth rates key to any sheep system, reducing time on farm and ME requirement from pasture (and supplements if used) a 90-day adjustment from weaning weights gives a more accurate measurements of the ewe's ability to rear her lambs and ultimately her efficiency.

Where a 1:1 target is the ideal goal at 90 days, a more realistic target for an upland farm would be 1:0.85. In other words this means a flock that can rear 85% of its mating weight by weaning, from a forage-only diet. For lowland target 90%, for hill 80%.

> i.e. a 70kg upland ewe rearing at 170% with an average of 35kg per lamb at 90 days = 85%

Assuming a 5kg birth weight this would equate to 330g dlwg average in the lambs which is easily achievable on pasture during this period. Although sire influence has a part to play in improving ewe efficiency through lambing ease, vigour, lamb survival and dlwg of the lamb, the maternal genetics of the flock have a greater part to play through improving the prolificacy, fertility and mothering ability of the dam to increase rearing percentage, whilst keeping the mature weight of the ewe at the desired level. These traits are expressed through the ewe's performance in the flock and influenced by the maternal rams used and the selection of breeding replacements.

Improving rearing percentage is one of the quickest ways to improve profitability of a sheep enterprise and is greatly influenced by the material genetics of the flock. Possibly the most

detrimental effect of the EUROP grid has been the shift away from a maternal ewe base in many UK flocks due to terminal genetics being introduced into the breeding ewe concentrated on improving lamb carcasses at the expense of mothering ability, prolificacy and lamb survival. Reduced survival from increased lambing difficulties plus losses due to dystocia and poor lamb vigour - as well as reducing the mothering ability of the dam and a decreased scanning percentage - are all factors incurred in introducing inappropriate genetics into a breeding flock chasing an E grade lamb. This not only results in a reduced rearing percentage but an increased ewe weight which further reduces the ewe efficiency and stocking density of the flock, greatly lowering output per hectare. With an R grade lamb meeting 85% of the market requirement it is absurd that production in the UK is being reduced so dramatically by inappropriate genetics trying to achieve an E grade lamb which only meets 10% of the market requirement.

Possibly the most detrimental effect of the EUROP grid has been the shift away from a maternal ewe base in many UK flocks due to terminal genetics being introduced into the breeding ewe concentrated on improving lamb carcasses at the expense of mothering ability, prolificacy and lamb survival.

A maternal ewe base is more than capable of producing R grade lambs and greater, thus better meeting market requirements for lamb carcasses without the reduction in rearing percentage and ewe efficiency brought about by unsuitable genetics. Concentrating selection of flock replacements and maternal rams on desirable traits to increase rearing percentage whilst maintaining the required mature bodyweight of the ewe, will increase profitability of the system. This will be achieved not only through improved ewe efficiency but also by increased stocking density resulting in higher output per hectare. Improvements in efficiency will not only increase the profitability of a farm business but will also benefit the environment through reducing carbon footprint per kg of meat produced.

Lamb growth weight to 8 weeks is greatly influenced by the mothering ability of the ewe and the amount of milk she can supply to the lamb, resulting in 80% of the required nutrition of the lamb in this period. Ewe genetics and nutrition greatly affect the dlwg achievable in her lambs to this point. After 8 weeks 80% of the lamb's required nutrition comes from pasture, so good grazing management is needed to ensure the required pasture cover is available to enable the lamb to express its full genetic potential.

Selection of breeding replacements and ram selection should be focused on increasing ewe efficiency through the use of recorded data, with both EBVs and physical performance captured in an environment suited to that where the commercial flock is run. Selection should be concentrated on improving desired Key Performance Indicators within the flock.

5b. Key Performance Indicators

Taking a whole flock approach, Key Performance Indicators (KPIs) are an essential tool to benchmark flock performance and to identify areas within a sheep system which can deliver a good return from

investment: be it vaccine use, ram purchase, feed allocation, or simply to identify weaknesses and monitor improvements being introduced. Using data collected on an individual animal level not only ensures self-replacing flocks are selecting from the best possible stock available to progress the overall profitability of the flock by improving desired traits, but also ensures the removal of underperforming individuals.

> *Improving efficiency of production and the profitability of the farm business is the goal of all sheep producers. Knowing what factors drive profitable production is the foundation of this process.* (Hybu Cig Cymru)

Implementing KPIs on a flock basis improves a sheep enterprise's profitability through evaluation of current business performance. This can be used to benchmark year on year performance, as well as enabling comparisons to similar sheep systems. KPIs will provide data to monitor flock improvements and enable production targets to be set. Whilst KPIs will identify areas to improve ewe efficiency, monitoring growth rates and production costs will highlight areas to address to maximise returns from the business. As with any business, improvements in one area can result in improvements in other areas.

> i.e. implementing improvements to reduce finishing time of the lambs will not only lead to a reduced ME requirement from pasture to reach target weight for sale, but also free up pasture for the ewes, enabling the ability to extend the grazing season and reduce cost of production; or increase stocking rate and obtain a greater output.

Identifying which areas to address and how to measure improvements will vary from farm to farm but, without basic recording, vital areas that could improve business profitability may go unnoticed.

Undoubtedly incorporating EID recording of lambs at birth will lead to the most accurate and easily accessible use of performance indicators. This will enable ewe efficiency, monitoring of growth rates, production costs and carcass information to be fed back to individual animal performance. This will provide valuable data for the selection of breeding females retained to enter the flock, plus assist the culling policy. Whereas KPIs used to identify and monitor *flock* improvements will undoubtedly help improve a business's profitability, replacement selection based on *individual* animal performance will identify animals which are constantly out-performing their counterparts, and thus increase the rate of gain in KPIs for the flock.

Flock KPIs	Individual KPIs
Scanning Percentage	**Lambing Ease**
Lamb/Ewe Losses	**Lamb Vigour**
Rearing Percentage	**Maternal Behaviour Score (MBS)**
Ewe Efficiency	**8 Week Weight**
Production Costs	**Ewe Efficiency**
Carcass Spec	**Weaning weight**
Output – Kg per hectare	**DLWG**
Profit per Hectare / Profit per Kg	**Carcass Spec**
Kg Carcass per kg of pasture DM	**Body Condition Score (BCS)**
Return on Assets / Equity / Capital	**Profit per Ewe**

Fig 4. Example of KPIs that can be incorporated on a flock and individual basis. *Source: the author*

Targeting improvements through identifying the weak points of a sheep enterprise leads to greater profit through monitored return on investment. Increased lambing ease, vigour and MBS reduce labour requirement and enable an increase in stocking rate per labour unit. Monitoring BCS at relevant points of the season ensures the flock/animal is able to achieve production targets whilst maintaining body condition from the system in place.

5c. Body condition score

> *Condition scoring is a quick and easy low cost management tool to increase ewe productivity and profitability. It is a way of comparing sheep: independent of live weight, frame size, breed, stage of gestation, gut fill. BCS is valuable as it relates to the production ability of sheep regardless of body weight.* (B+LNZ, Ewe Body Condition Scoring Handbook)

Ensuring the ewe's body condition score (BCS) is meeting required levels at key points of the production year will result in increased efficiency from the flock/individual ewe plus greater production from the kgDM available from pasture. Ewes failing to meet targeted BCS at these key times will result in decreased production and ultimately a reduction in profitability for the whole system. On the other hand, ewes exceeding the required BCS will be costing the system through utilising DM that could otherwise be used for increasing the productivity of priority stock, or be reserved to extend the grazing season, thus reducing production costs or increasing stocking density.

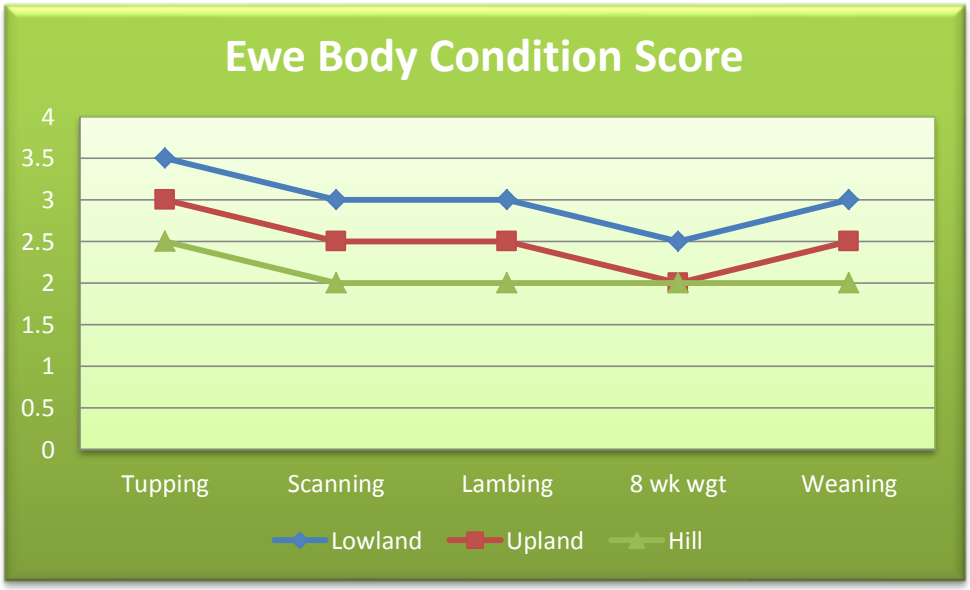

Fig 5. Targeted BCS for different farming systems (J.A.Drummond)

BCS should be monitored at five key times in the production year whilst routine work is being carried out: i.e. vaccine/drench/booster administration pre mating/pre lambing, pregnancy scanning, 8-week weights and at weaning. Ewes failing to meet the required BCS at these key times will

ultimately be causing a reduced output - be it a reduction in scanning percentage, decreased survival, or dlwg of their progeny reducing ewe efficiency, or an increase in DM requirement.

63 kg ewes, 10/ha, lambs sold @ weaning	Status quo 15% ewes < BCS 2.5	Increased CR 5% ewes < BCS 2.5	Increased lamb survival 5% ewes <BCS 2.5	Increased weaning wgt 5% ewes < BCS 2.5
Scanning %	160%	**175%**	175%	175%
Lamb survival	78.4%	78.4%	**81%**	81%
Weaning weight	26.5 kg	26.5 kg	26.5 kg	**27.4 kg**
Gross margin/Ha	$806	$854	$875	**$920**

Analysis and table prepared by Trevor Cook, Totally Vets. CR = Conception Rate. Based on 2010-11 prices.

Fig 6: The benefit of reducing the number of tail end ewes at mating and lambing (BLNZ)

Ewes able to maintain BCS whilst outperforming their counterparts prove more efficient converters of feed and require less DM of pasture during the production year.

> i.e. a 70kg ewe, BCS 3 at lambing and BCS 3 at weaning, and rearing two 35kg lambs, has a greater feed conversion efficiency and requires less kgDM from pasture for the next mating season than one of the same weight (BCS 3 at lambing), rearing the same weight of lambs but weaned at BCS 2.

Gaining one BCS requires an extra 7-9kg of liveweight to be added. So a ewe target of 70kg BCS 3 would require 1.4kgDM/d to gain 50g/day compared to a ewe already in BCS 3 and requiring only 1.12kgDM/d for maintenance. This results in a much higher DM allowance (40-50kgDM) being required to achieve the necessary BCS for mating, thus reducing pasture cover, and this would not have been needed for a ewe with greater feed conversion efficiency.

Research has shown that early weaning of lambs, at 6-7weeks/16-17kg, onto high quality pasture resulted in far greater dlwg than those left unweaned on poor pasture.

Whilst a drop in BCS from lambing to 8-week weight is expected due to the ewe mobilising body reserves for milk production, 80% of the nutritional requirement of the lamb is met by pasture after this period. To achieve maximum dlwg from the lambs, grazing management should ensure DM availability is not restricted. This way pasture will be available for the ewe to increase her BCS by weaning time (with the exception of creep grazing systems). Where there is lower pasture cover early weaning will ensure the dlwg of the lambs will continue to meet desired targets. Meanwhile the ewe can be placed on low covers or poorer ground and, because she is genetically pre-disposed to have an increased feed conversion rate during lactation, she will be able to increase her BCS more efficiently during this period from lower kgDM than she could later in the season. Research has shown that early weaning of lambs, at 6-7weeks/16-17kg, onto high quality pasture resulted in far greater dlwg than those left unweaned on poor pasture. This management decision can ensure finishing time of the lambs is not extended, hence ME requirement and conversion efficiency in the lambs is not compromised. An increase in days-to-slaughter results in

poorer feed conversion efficiency and an increased ME and kgDM requirement for that animal, reducing total feed availability.

Ultimately breeding and culling decisions will be based on an individual animal's performance. The ability to progress a flock's ewe efficiency will be determined by identifying those animals able to outperform others on the same system - in terms of rearing and the ability to maintain the required body condition without preferential treatment. Whilst these parameters are largely governed by the maternal genetics used and the nutrition available through good pasture management, these factors also govern one of the most important aspects of sheep production: producing a live lamb.

5d. Lamb survival

As with any livestock enterprise, regardless of the target market for the progeny, the ability to produce live offspring is essential to ensure a return from that animal. Targeted survival percentages will vary due to different production systems, and setting KPIs for survival at different points of the production year will identify areas within the system for improvement. The detection of high barren rates, high foetal losses during pregnancy and losses post lambing to point of sale, will alert producers to possible health issues in the flock to investigate and identify procedures to put in place - such as nutrition, trace element or vaccine use - to ensure a reduction in losses in identified periods.

In a recent study 81% of flocks tested showed exposure to *Toxoplasma Gondii*, the parasite causing Toxoplasmosis. 52% had been exposed to *Chlamydophila abortus* bacteria, the organism causing Enzootic abortion (*MSD Animal Health*). These financially damaging diseases showed widespread prevalence and are major contributors to increased barrenness and foetal losses due to abortion, which can be easily identified through sampling if high losses are shown in the flock KPIs for this period. These, along with other diseases causing production losses in this period (e.g. Clostridial diseases, Campylobacter) and many causing losses to young adolescent lambs, are identifiable through blood tests or post mortem examination, with vaccines available for use in the UK. Identifying the cause of increased losses at varying times in the production year will mean the relevant procedure can be put in place to ensure a reduction in lost output.

Where losses caused by infectious disease are in no part down to the animals themselves, instead governed by management practice and the ability to identify and protect against these production-reducing diseases, there are many areas where the ewe/genetics in place can govern increased survival rates particularly at lambing time and in the first few weeks after birth.

5d.i. Lost lamb, lost profit – the importance of lambing ease

The ewe's ability to give birth and raise her progeny unassisted is crucial to ensure increased ewe efficiency and to reduce labour requirements. Both maternal and terminal genetics used must be selected for lambing ease, with any stock requiring assistance at time of birth identified and culled. Removing both the ewe from the flock once her lambs are reared and not selecting replacements from her progeny will ensure a reduction in interventions needed during future lambing periods. Any stock sourced from outside the system, be it maternal/terminal sires or breeding replacements,

should be bought from producers recording levels of intervention at lambing on an individual animal basis, to ensure stock is being selected from family lines with a history of unassisted births. Losses due to lambing difficulties are the leading cause of lamb mortality in this period. A study by Twin Farm Genetics, Gore, New Zealand, in which all lambs that died within 72 hours of birth were autopsied, showed dystocia to be the main cause of death in lambs and is a result of the lambing process. Ruptures or damaged organs can result in lamb deaths days after birth, but are caused by difficulties at the time of lambing. With lamb losses for this period ranging from 2-20% in the UK there is huge scope to reduce losses in production and increase output/profit simply by ensuring the correct genetics are in place to improve lambing ease.

Any stock sourced outside the system …. should be bought from producers recording levels of intervention at lambing on an individual animal basis, to ensure stock is being selected from family lines with a history of unassisted births.

5d.ii. Lamb vigour

The study carried out by Twin Farm Genetics, the results of which were mirrored in other similar trials I came across in New Zealand, showed that - after losses caused by dystocia - 90% of the lambs which died within 72 hours of birth were born alive, 80% had stood, but only 20% had suckled. The results were obtained by examining stomach contents and even though the ewes had sufficient colostrum in their udders there would be none present in the lambs. This highlights two very important points to ensure high survival rates at lambing: the ability of the ewe to remain with the lamb, governed by her maternal behaviour, and lamb vigour.

Lamb vigour and survival have a very strong correlation due to more vigorous lambs being quicker to suckle their mother and ensure intake of colostrum. The longer it takes a lamb to suckle for the first time the lower its chance of survival, both within the first 72 hours and to weaning. Colostrum not only helps maintain the lamb's body temperature preventing hypothermia and increasing survival, but is the lamb's only source of energy once it has utilised its brown fat reserves which are present within its body tissue for only a few hours after birth. Antibodies concentrated in colostrum to protect the lamb against infection and life threatening diseases in later life are only able to pass through the gut wall and into the bloodstream within the first few hours after birth.

A vigorous lamb which is quick to get on its feet and quick to suckle has a much greater chance of survival: 90%+ chance of being alive at weaning if suckled within 15 minutes of birth (*Richard Lee*), and the longer the time taken to suckle the lower the chances of survival. There is a large variation between breeds in both lamb vigour and maternal instinct, but variation within breed and heritability of these traits can increase lamb survival and ewe efficiency within a flock. Culling ewes/rams producing lambs with poor vigour plus not selecting breeding replacements from their offspring will improve vigour on a flock basis. Ram selection based on collected data regarding lamb vigour will ensure that superior genetics for increasing lamb survival are being introduced to the flock. With such a large percentage of lamb losses during and post lambing being due to poor lambing ease and poor lamb vigour resulting in starvation, hyperthermia and poor immunity because of an inadequate uptake of protective antibodies from the ewe through late suckling, improvements

in the genetics incorporated within a flock can result in a considerable increase in its productivity and profitability. These genetics will not only help the lamb's ability to increase its chances of survival but also improve the ewe's maternal instinct and behaviour.

5d.iii. MBS - maternal behaviour score

A ewe's maternal behaviour score (MBS) is a measurement of the maternal instinct and behaviour of the ewe regarding its new born progeny. A ewe with a greater MBS will be a more attentive mother and show greater maternal instinct. This increase in mothering ability results in a greater survival rate in her progeny and ultimately a more productive ewe base. A ewe which stays within 2 meters of her lamb after birth has an 80% success rate regarding her lamb's being alive at weaning, and one which stays within 5 meters will wean 10kg heavier total lamb weight (*Julie Everett-Hincks*). Recording and selecting for MBS at Twin Farm Genetics for the past 16 years has resulted in ewes lambing at 1 year of age having a MBS 5, the highest score, resulting in a flock of ewes with greatly improved maternal behaviour and increased survival.

Description of MBS	MBS
Ewe flees at the approach of the shepherd, shows no interest in the lambs, and does not return	1
Ewe retreats further than 10 m but comes back to her lambs as the shepherd leaves them	2
Ewe retreats to such a distance that tag identification is difficult (5 to 10 m)	3
Ewe retreats but stays within 5 m	4
Ewe stays close to the shepherd during handling of her lambs	5

Fig 7. Description of maternal behaviour scores when assessed at tagging (O'Connor et al)

> Ewe maternal behaviour score has a significant effect on lamb death risk, due to starvation, exposure and dystocia, where ewes with lower scores have higher lamb mortality rates. *(Everett-Hincks et al, 2008)*

Whilst a commercial farmer may see MBS as more work at an already busy period, selecting incoming genetics from breeders who are recording will improve a flock's MBS and survival by introducing improved genetics. Like all traits MBS lies on a bell curve, so simple selection and culling from either end of the curve will ensure the flock is always progressing in the right direction. An example of this is incorporating a simple recording system to take out the bottom end. Whilst visiting earlier Nuffield Farming Scholar and BLNZ chair James Parson, his shepherd showed me a

very simple and effective system to record the top and bottom end MBS within the commercial flock and so assist in replacement selection and the culling of low scoring ewes. Any ewe showing exceptional mothering ability got a VGM (very good mother) put on her record which would then give preference to replacements being kept from her, whilst any with poor mothering ability got BSB (bloody silly b…..) and would be culled following rearing, and replacements would not be kept from her progeny.

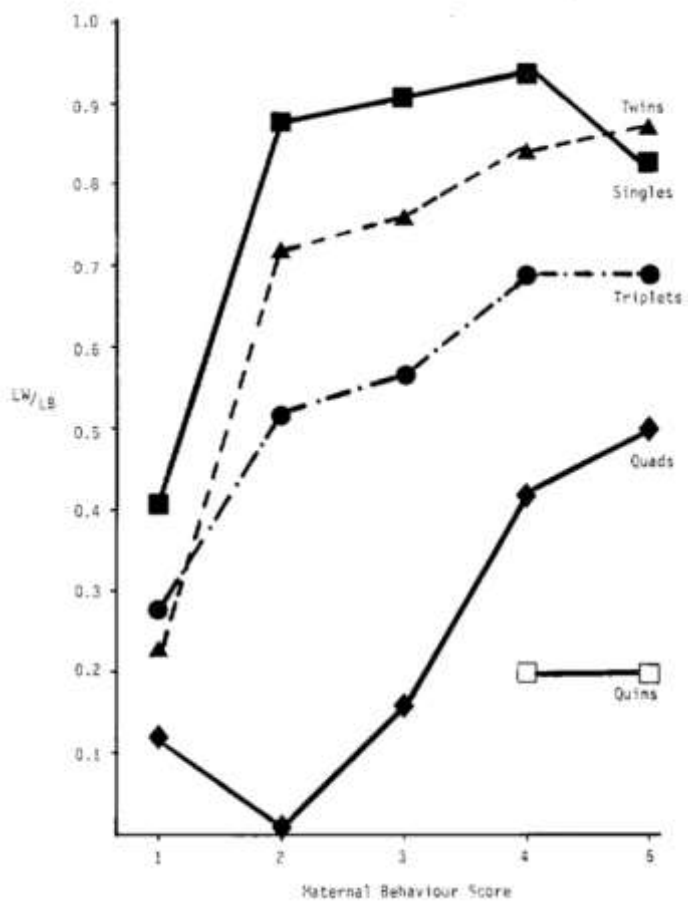

Fig 8: Relationship between maternal behaviour score and LW/LB (lamb weaned per lamb born) within birth rank (*O'Connor et al*)

Incorporating a system to remove ewes with poorer MBS from the flock will greatly increase its productivity and ewe efficiency. With the difference between MBS2 and MBS4 resulting in 10kg extra lamb weight produced at 12 week weaning weight, this has a huge impact on efficiency both through improved dlwg and survival. As O'Connor et al show in fig.8, the recorded data for twins had a lamb-weaned to lamb-born difference of 0.72(MBS2) to 0.84(MBS4). This represents an increase in rearing percentage from 144% to 168%, greatly increasing the performance of the ewe and the ability to meet the 85% ewe efficiency target for lamb weaned/ewe mwgt mated. Added to this is the poor performance across all birth ranks regarding survival for any ewe with MBS1, showing that removal of these underperforming ewes will greatly increase the efficiency of the flock.

The ability to identify and remove underperforming stock - be it poor MBS, poor lamb vigour, assisted or difficult births - will ultimately help the survival rate and increase the rearing percentage

of the flock, greatly improving ewe efficiency. Recording of identified stock can be electronic or manual. Simply ear notching ewe and progeny or using a spray marker will ensure stock can be removed at a later date. The genetics incorporated within the flock play a major role in increasing the lamb's chance of survival, the ewe's maternal ability and the capability to increase efficiency within the flock, but there are several management and environment practices to put in place to ensure ewe performance.

5d.iv. Aiding an attentive mother

Pre- and post-partum nutrition has a great effect on the ewe's ability to perform to her full capability, and meeting her nutritional requirements is needed to capitalise on the ability she possesses to express both her and her progeny's genetic potential.

- Failing to match the requirements of the ewe in this period will result in higher losses, poorer vigour, reduced MBS and ultimately a decrease in ewe efficiency.
- A failure to meet pre partum nutritional requirements will result in a reduction in ewe BCS which increases losses due to lower birth weights, poorer colostrum supply and a decrease in MBS.
- A reduction in BCS results in the ewe accessing her fat reserves resulting in an increase in beta-hydroxybutyrate, a major ketone body, which in turn lowers the MBS of the ewe, resulting in a 'dopey', inattentive mother.

The quantity of brown fat in the new born lamb is determined by the ewe's nutrition in the 2 weeks prior to lambing with lamb vigour, time to feet and time to suckle, all affected if there is poor nutrition in this period. With adequate pasture cover at lambing (1500kgDM+) the ewe will stay with her lambs longer as she does not need to move to find feed, increasing her MBS and hence improving survival and resultant ewe efficiency.

Meeting the ewe's nutritional requirement at time of birth results in a more attentive mother, improving bonding, licking and vocalisation, so ensuring the required pasture cover at lambing time gives the lamb the greatest chance of survival and enables an increase in ewe-lamb bonding and MBS, improving both rearing percentage and ewe efficiency. Having the required pasture cover will not only ensure feed supply and animal demand are met, but it also aids lamb survival from reducing wind chill when lambing has occurred in an exposed area.

Ensuring good nutrition - not just pre/during mating for an improved scanning percentage but for the first 90 days of gestation - will result in greater ewe efficiency through increased survival at lambing time, plus increased milk production and resultant lamb dlwg post lambing from improved placental development in the ewe. To enable development of the foetus nutrients must be transported across the placenta and mammary gland. A reduced development of the mammary tissue due to inadequate nutrition in the ewe will reduce colostrum and milk production during the lactation period. The surface area of the placenta affects the nutrient and oxygen transfer between ewe and foetus, meaning lamb birth weight and resultant lamb survival are also affected by ewe nutrition in this period. 10% lower birth weights have been observed in ewes losing more than 12% of their bodyweight in this period, and it cannot be regained through pre partum nutrition.

Case Study: Twin Farm Genetics

Twin Farm, run by the Welsh family Russell, Pam and Andrew, is situated near Gore, New Zealand. They are a leading producer of TEFRom and Suftex rams and winners of 2013 & 2014 NZ Sheep Industry Awards. The flock comprises 1200 ewes and 500 hoggets fully recorded for ram production, along with a commercial flock of 3200 ewes and 1200 hoggets. The family have developed the Suftex terminal sire since 1999, from their original Suffolk flock, which now contains a double copy of the myomax gene introduced from Texel genetics in the composite, and are now introducing Charollais genetics into their terminal sire. Their TEFRom was, in my opinion, the most commercially efficient ewe I came across in New Zealand and a true dual purpose composite, with exceptional maternal ability and ewe efficiency matched by management ease and growth. Only 7% of ewe lambs mated scanned barren and are culled to improve fertility with their scanning recorded up to 140% and rearing is usually 100-115%. Scanning as two-tooths then regularly achieves over 200% with only 7% triplets which they have the ability to rear successfully. As an aged ewe the TEFRom is a high fecundity, efficient ewe with high survival and growth rates in her progeny. The ability to rear so well as a hogget and gimmer also means lifetime efficiency is excellent. This is down to the development of the genetics, originally 25% Texel, 25% East Friesian, 50% Romney, and now a stable breed, and also down to their low maintenance requirement through extensive work carried out to increase survival and ease of management.

Fig 9: TEFRom and Suftex ewe lambs at Twin Farm Genetics

For six years from 2006-2011 Twin Farm Genetics was part of an Ovita and AgResearch Lamb survival trial in which all lambs that died within 72 hours of birth were autopsied to confirm cause of death. *'It was interesting to see that many lamb deaths within three days of birth were caused by damage at birth. Whilst we like to blame the weather or other factors, it is good to know that some of those factors don't play as large a role as we perhaps thought*.' *(continued overleaf)*

The trial showed the extent that difficulties in the lambing process have on losses during this period. Whilst losses due to visible dystocia may be apparent it was found that a far greater number of deaths within the 72 hours examined were a result of the lambing process itself. Damaged organs, ruptures and other internal injuries are the cause of a high percentage of losses in this time, which highlights the importance of lambing ease to reduce lost output.

Objective breeding for economic and commercial production traits was key to the breeding programme. As well as developing lambing ease, recording and selection for lamb vigour, teat placement and MBS were seen as vital to progress the productivity of the breed through reducing losses and management requirement. With starvation the next leading cause of lamb deaths within the first 72 hours (after losses caused by the lambing process itself) developing these traits will reduce the number of deaths caused both by starvation and heat loss. After losses caused by damage occurred in the birth process, 90% of the remaining lambs had been born alive, 80% had stood, but only 20% had been found with any uptake of colostrum. Aiding the ability of the lamb to get colostrum quickly is vital to survival and every second counts. Poor teat placement was found to add 3-4 minutes to the time taken to find the udder. With improved MBS in the ewe, good pasture cover and improved vigour, the lamb has a greatly increased chance of survival.

Fig 10: TEFRom Ewe with lambs at Twin Farm Genetics

6. A productive sheep enterprise

6a. Production efficiency – output per hectare

To increase profitability sheep producers must focus on improving production efficiency, or more accurately economic efficiency, through an increase in productivity and a reduced cost of production per kg sold. Increasing ewe efficiency to improve production per ewe must be focused on ultimately increasing output per hectare whilst concentrated on obtaining the maximum profit achievable per kg produced. Whilst ewe efficiency has a major role to play, increasing flock size to improve stocking density and output per labour unit focused on achieving improved production per hectare, along with targeted input costs, will maximise efficiency and improve the business's profit margin. With improved grass production and utilisation an increase in stocking density can be achieved with targeted inputs and pasture/forage mixes to extend grazing potential, reducing the cost per kg produced through increased output.

Whilst ewe efficiency has a major role to play, increasing flock size to improve stocking density and output per labour unit focused on achieving improved production per hectare, along with targeted input costs, will maximise efficiency and improve the business's profit margin.

The cheapest system to run is not the most profitable; maybe it is per ewe, but certainly not per hectare, while increasing stocking density although potentially increasing cost of production will be offset by higher output, achieving greater profit per kg produced. Whilst running smaller ewes may be an easy way to increase stocking density, care must be taken to maintain output and growth rate. Essentially, running a higher number of lighter ewes with reduced rearing percentage may achieve the same ewe efficiency as a medium weight ewe, and obtain the same output per hectare; but if finishing time of progeny is extended and labour requirement increased with higher ewe numbers per lamb produced, plus a high winter stocking rate, it may prove detrimental to the overall profit achievable from the enterprise.

Though fixed costs remain unchanged the major saving and increase in profitability is obtained from a reduction in variable costs through carrying a reduced number of ewes for the same output.

With higher rearing percentages from a medium sized ewe achieving the same output as a higher number of lighter ewes, kgDM requirement will not be reduced at mating or into the winter grazing period as there will be a higher requirement per ewe. Similarly having higher multiples in late pregnancy will result in higher ME requirements per ewe so feed demand will be similar to running a higher number of lighter ewes scanning lower. Though fixed costs remain unchanged the major saving and increase in profitability is obtained from a reduction in variable costs through carrying a reduced number of ewes for the same output. That being said,

increasing stocking rate dramatically and therefore also variable costs, can lead to a much more productive and profitable enterprise.

The chart in Fig. 11 below shows the output, fixed and variable costs of an extremely productive sheep farm in Northern Ireland. Run by Isaac Crilly the focus of the sheep enterprise is on production efficiency from the limited land available. Last year he produced 592kg of carcass per hectare and although variable costs are more than double that of the top 25% producers in his benchmarking group, due to the massive increase in output, profit at £897 per hectare is 3.5 times higher than these producers obtained. This was a result of an extremely high stocking density, 19 ewes/ha, and high rearing at 183%, with careful management of input costs. Lambs however are creep-fed to ensure they were off the system quickly to maximise the grazing potential of the land for the ewes, with 50% of the variable costs being concentrates. This cost, although causing uncertainty for future production costs, was easily made up for by the increased output obtained and the quick finishing time of the lambs freeing up pasture. Even though stocking density was at 19 ewes/ha, ewe mwgt was heavy at around 80kg to ensure minimal finishing time in the lambs. At 183% rearing with the achieved carcass weight and stocking density the genetics in place were efficient on a ewe, production and economic basis.

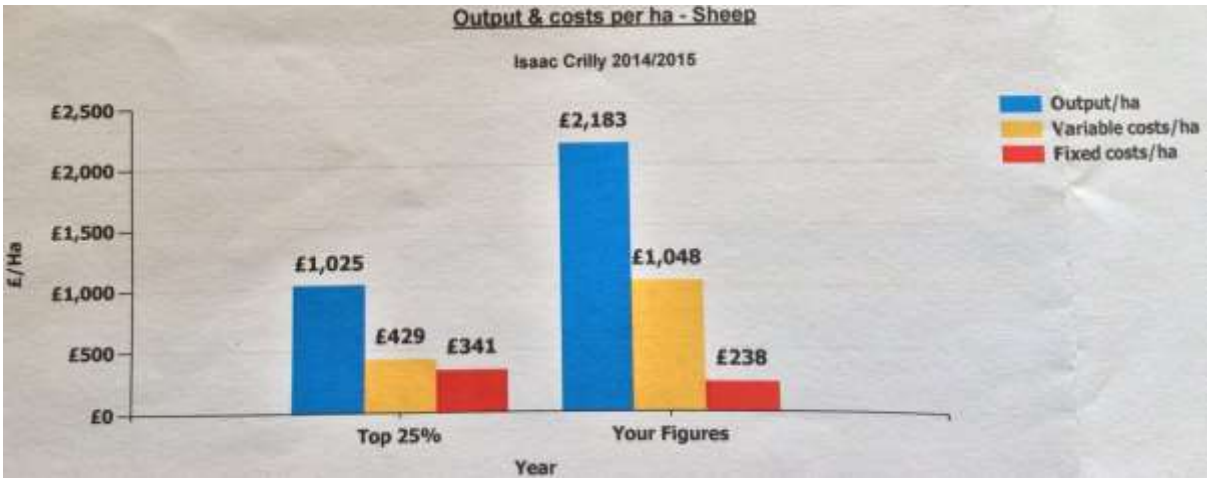

Fig 11: Output and production costs per hectare on Isaac Crilly's farm, Northern Ireland, compared to the top 25% of his benchmarking group

> *Improvements in efficiency on farms is possible by exploiting changes in genetics, nutrition and management of the ewe flock.* (Dr. Tim Keady et al)

An increase in ewe efficiency through incorporating improved genetics, plus the selection of superior replacements based on objective performance data, will enhance the productivity of a flock and improvements will be cumulative and permanent. Improved pasture management to increase its production and utilisation will enable a higher stocking capacity, whilst breeding for easier

management will reduce labour requirements meaning an increase in stocking density per labour unit alongside an increased output per hectare. With targeted inputs to meet the nutritional requirements of the stock from a reduced cost per kg produced, greater output can be matched with greater profit. Mating of ewe lambs will enable an increased output from stock carried and improve lifetime efficiency of the ewe.

Mating of ewe lambs will enable an increased output from stock carried and improve lifetime efficiency of the ewe.

6b. First mating – Year 1 or Year 2

Ewes bred as ewe lambs have a higher lifetime production rate compared to those bred as yearlings. (Dr Elwyn Rees et al)

The ability to breed as a ewe lamb greatly increases the lifetime efficiency of a ewe. Studies have showed an increase in productivity of 14% over a ewe's lifetime when able to be mated as a ewe lamb. Future prolificacy has been observed to be 11% higher in ewes mated as ewe lambs, and they also have improved fertility. Mothering ability is better in ewe lambs than in yearlings and they also prove to be better mothers throughout their lives. Milk production as a ewe lamb is lower than ewes lambing for the first time as a yearling so dlwg in the lambs can be lower. Therefore good pasture management is required to achieve the maximum dlwg from the lambs once they start eating and to achieve desired growth in the mother. Ewe lambs require 20% more feed than a ewe of the same weight for sufficient nutrition to aid her own required body growth, so a good supply of high quality pasture should be available during lactation. A ewe lamb rearing twins uses 7MJ/day more energy than one rearing a single, which equates to the amount required for 150g dlwg. This is higher than that targeted for the ewe lamb herself in this period, so fostering of a twin is desirable if possible.

Studies have showed an increase in productivity of 14% over a ewe's lifetime when able to be mated as a ewe lamb.

When selecting ewe lambs for mating it is important lambs have grown until weaning without check, as a 10% reduction at this time will result in prolificacy being permanently reduced throughout adult life. Growth should remain above 150g/day post weaning until mating and 60% of mwgt should be reached before going to the ram. Supplementary feeding of concentrates should not be used as potential future milk yield will be compromised through an increase in fatty deposits in the udder. Instead ensure a good supply of high quality pasture

When selecting ewe lambs for mating it is important lambs have grown until weaning without check, as a 10% reduction at this time will result in prolificacy being permanently reduced.

is available to maintain required growth. To improve fertility it is good practice to mate 15-20% more ewe lambs than required and only keep those holding in the first cycle. Following rearing as a ewe lamb 80% of mwgt should be achieved before next mating.

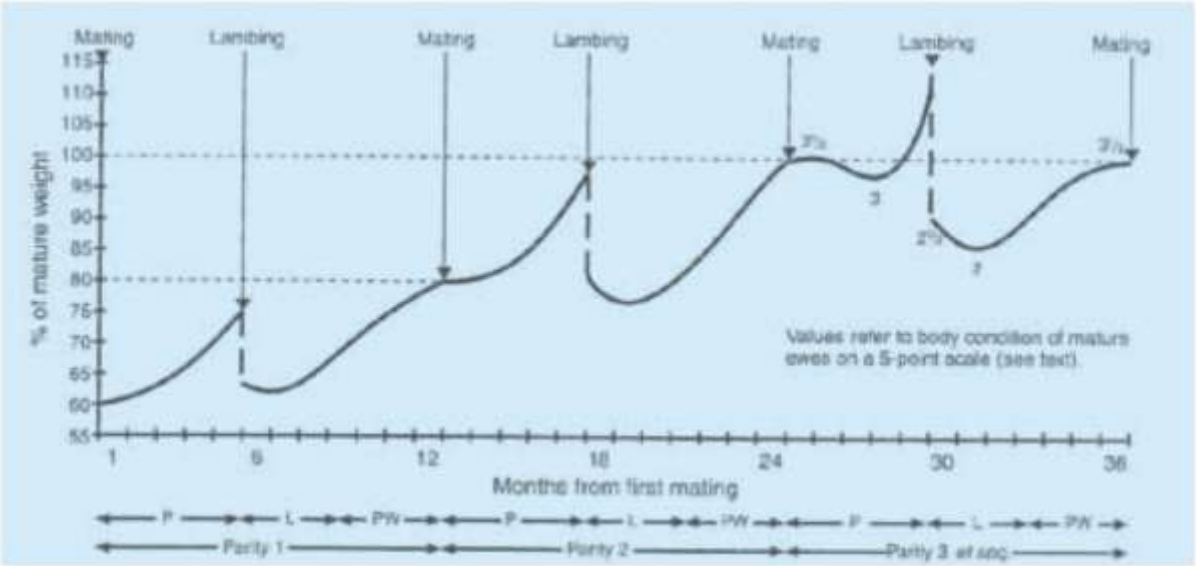

Fig 12: Mature weight targets for mating sheep over lifespan *(J Vipond et al)*

> *Breeding ewe lambs, provided they are managed to meet their nutritional requirements, reduces the cost of rearing replacements and increases flock output and profitability. Other reasons for breeding ewe lambs include increasing lamb carcass output during the ewe's lifetime, and thus overall efficiency, and speeding up genetic gain due to a reduction in the average generational interval.* (Dr. Tim Keady)

The onset of puberty to ensure mating as a ewe lamb is influenced by age and breed although the major influencing factor is liveweight, which also affects potential scanning percentage. First oestrus is generally later than the onset of the breeding season in mature ewes although the use of vasectomised 'teaser' rams can be used to induce the start of cycling. This compacts the mating period, and subsequent lambing, and ensures a higher proportion is able to mate in the first cycle. Live weight gain of 80g/day is required over early-mid pregnancy and nutritional needs must be met in this period to reach normal mature weight in later life.

Where traditionally mating as ewe lambs was seen as a way of reducing mwgt and improving ewe efficiency in later life, research shows that ewe lamb nutrition during that first winter, whether mated or not, has a big influence on productivity in later life, reducing barrenness by 46% and increasing weaning weight by 0.5kg per lamb per year throughout the productive lifetime of the ewe. In fact, improved nutrition in this period could prove one of the biggest factors in improving ewe efficiency as a mature ewe, regardless of the ability to meet her nutritional requirements in later life.

Although ewe genotype plays a role in the prolificacy and fertility of the ewe lamb, as it does in the ewe, the overwhelming factor affecting the ability to be mated as a ewe lamb is liveweight. The simple fact is that to progress production efficiency and profitability on farm, ewe efficiency should ensure that all progeny is finished off pasture well before mating of ewe lambs would occur. Thus any stock selected for breeding replacements should have easily reached mating weight well before the potential breeding period. i.e. 60% of a 70kg ewe is 42kg, the same as the average target market weight. If a breeding replacement is not able to reach this weight before the potential mating date serious questions need to be asked regarding ewe efficiency on farm, and replacement selection.

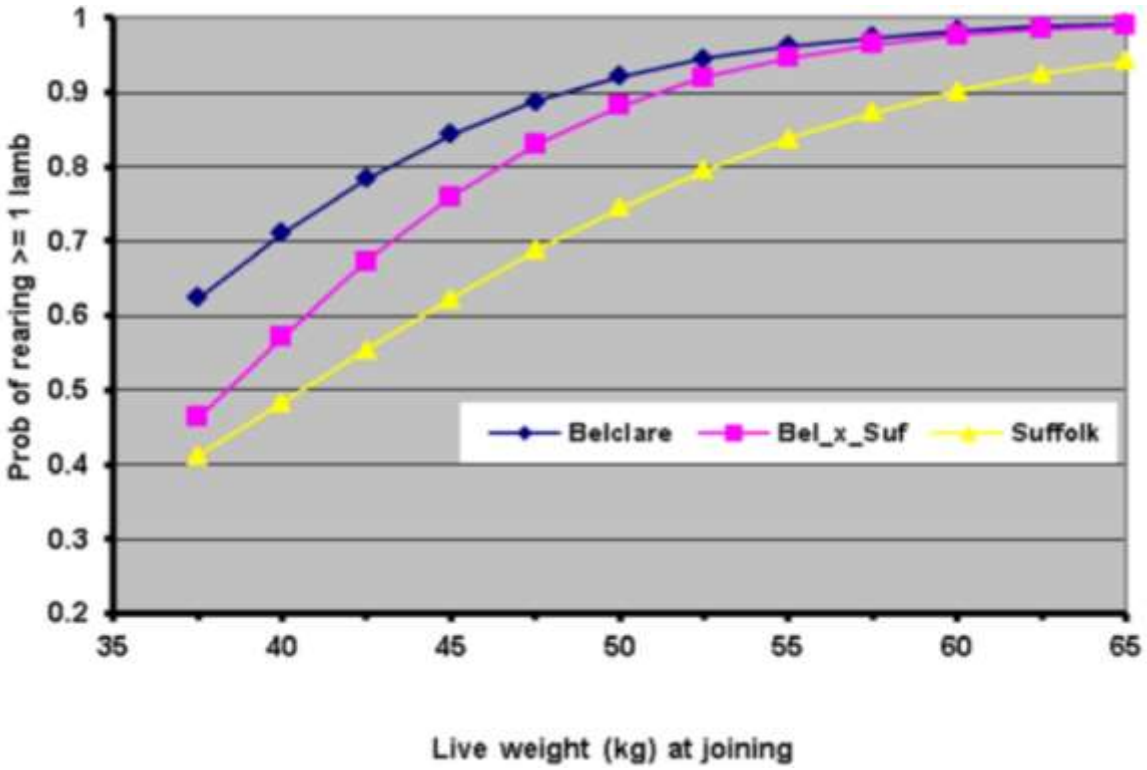

Fig 13: Rearing performance of ewe lambs compared to liveweight mated at Teagasc Animal and Grassland research and innovation centre, Athenry, Ireland

Where output is undoubtedly increased through the mating of ewe lambs and future productivity is increased as an aged ewe questions will be asked regarding the ability of a ewe lamb to be able to perform in the subsequent mating season if rearing as a ewe lamb. In the ongoing trial on lifetime performance from mating ewe lambs at Athenry in Ireland, half of the trial was mated as ewe lambs and half not as a control group. Subsequent mating at 19 months found no notable effect on scanning or rearing percentage from mating as ewe lambs; however ewes that were joined as ewe lambs reared 2kg heavier lambs over 2 year old ewes joined for the first time as hoggets.

	Age at first joining (months)	
	7	**19**
Litter size	1.76	1.81
No. reared/ewe lambing	1.40	1.46
Lamb weaning weight (kg)	31.4	29.40

Fig 14: Comparing age of first mating on rearing performance at 2years of age. Teagasc Animal and Grassland research and innovation centre, Athenry, Ireland

Mating ewe lambs not only improves carcass output (hence production efficiency: improves ewe efficiency as a two-tooth through greater dlwg in the progeny from better maternal behaviour, and in aged ewes through improving productivity and fertility) but can also greatly increase the profitability of breeding replacements. It reminds me of something mentioned whilst out in a field with Dr. Tim Keady: '*Five years ago I'd say you were mad if you mated ewe lambs, now I'd tell you, you're mad if you don't!*'

A report on the economics of breeding from ewe lambs showed a gross margin increase of over £48 observed between ewes lambing as ewe lambs, and those left until 2 years of age, which goes a long way to prove '*you're mad if you don't'.*

	£/ewe lamb purchased	
	Bred as ewe lamb	**Not bred as ewe lamb**
Value of shearling (one year after purchase as ewe lamb)	130.00	120.00
*Lamb output (0.8 lambs reared per ewe lamb @ 18kg carcase weight @ £4.10/kg)	59.04	0.00
Wool	1.00	1.00
Total output	177.00	121.00
Less 1) Purchase Price	80.00	80.00
2) Mortality	3.0 (3%)	1.0 (1%)
Output	107.04	40.00
Variable costs		
Concentrates – ewe nuts @ £170/tonne	5.10 (30kg)	
Creep feed to sale at14 weeks of age @ £215/tonne	11.00 (50kg)	
Forage	6.50	8.00
Vet and med	7.00	5.00
Bedding	0.70	0.00
Pregnancy scanning	0.60	0.00
Contract shearing	1.10	1.10
Lamb tags	0.80	
TOTAL VARIABLE COSTS	**32.8**	**14.10**
GROSS MARGIN	**74.24**	**25.90**

Fig 15: The economics of breeding ewe lambs and resultant gross margin increase,
(AHDB Better Returns Programme – Breeding from ewe lambs (Dr. Elwyn Rees and Kate Phillips)

Case Study – Isaac Crilly

Isaac Crilly farms near Castlederg in Northern Ireland. A member of the Tyrone quality livestock marketing group, the Sainsbury's lamb steering group and former AFBI research farm, Isaac runs the most productive farm per hectare I came across during my research. Limited by land availability, as the vast majority of farms in Northern Ireland are, last year Isaac ran 428 ewes rearing at 183% able to achieve 592kg of carcase weight per hectare at a profit of £1.50 per kg produced.

Physical performance	2 years ago	1 year ago	This year 2014/2015	Average all	Top 10%
Average Sheep Numbers	500	496	428	239	258
Lambs Sold or Weaned/Ewe	1.62	1.58	1.83	1.47	1.76
Concentrates Fed/Ewe (Kg)	171	209	161	60	92
Carcase weight of lambs (Kg)	20	19	19	20	20
% Stored lambs	4	6	0	10	14
% Fat Lambs	83	86	82	69	63
% Replacement Lambs	13	8	18	16	25
carcase weight produced per /ha (Kg)	523	567	592	256	429

Fig 16: Production figures compared to Isaac's benchmarking group

Driven by increasing production efficiency through maximising output per hectare at the highest achievable profit per kg produced has enabled an £897/ha net profit. As can be seen below, comparing kg/ha of carcass output to gross margin/ha, Isaac (gold star in top right corner) is at the tip of a correlating line between kg/ha produced and gross margin.

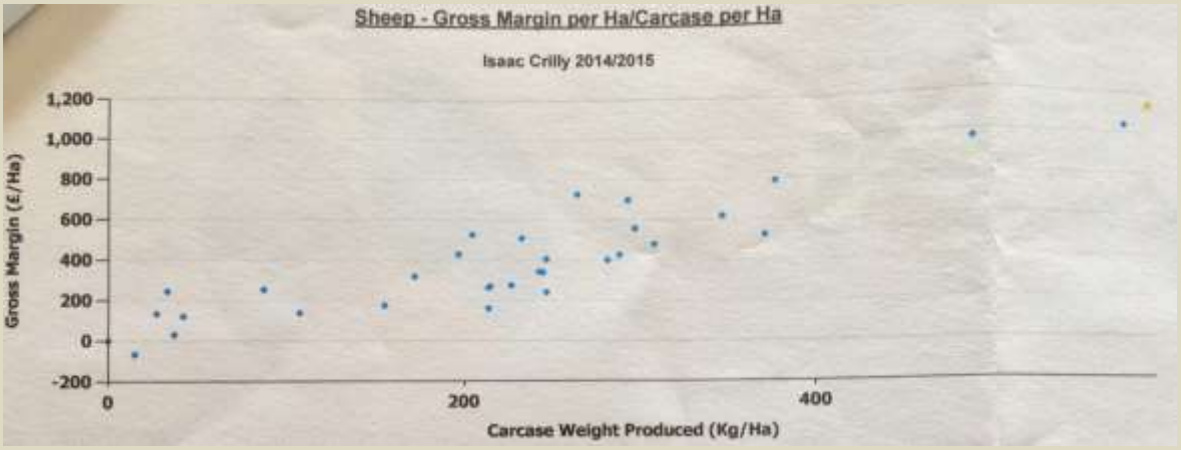

Fig 17: Gross margin compared to carcass output per hectare

6c. Matching the grass curve

The ability to maximise output from the pasture available will ensure an increase in production efficiency can be met by an improved profit per kg through better utilising the feed grown on farm. Although not inexpensive, grass is the cheapest form of feed available in sheep production and best matching of feed demand to grass availability will reduce the cost of production, both in the costs associated with feeding the ewe and in finishing the lamb. Correct grazing management will improve utilisation to increase the quantity and the nutritional quality of pasture available to enhance animal performance and increase the production efficiency of the system.

Good management in spring is key to achieving high clover levels when grass quality decreases in mid-summer. Using priority stock - i.e. finishing lambs - at the front of a rotation receiving preference to the grazing available, with low priority stock behind to tidy up, will improve pasture quality into the season. An increase in production efficiency to improve stocking density will mean more ewes carried during the winter low period of pasture production where little or no growth will occur. Improving ewe efficiency and dlwg to ensure that all lambs are finished from pasture during the peak pasture growth season of spring and into mid-summer will enable late-summer/autumn pasture growth to be used to feed the ewes through mating, and be conserved to extend the grazing period into the winter when grass production is not able to meet feed demand.

Knowing the nutritional requirements of the stock and the kgDM available from pasture will ensure shortages can be foreseen and a grazing wedge can be set up in advance to overcome periods of decreased pasture production. Where seasonal and yearly variations in pasture supply will inevitably mean adjustment to the system will be necessary, knowing the general pattern of growth and requirements will mean these adjustments can be made without a reliance on purchased feed and an increase in production costs. An increase in production efficiency and carcass output will mean more lambs are available to utilise the peak pasture growth season post lambing into early summer and, with more stock on the ground in this period, grazing quality will be easier to control and less conserved forage will be required to remove excess growth.

Fig 18: Feed demand and pasture supply (BRP+ manual – Planning grazing strategies)

Where Fig. 18 (above) shows a well matched supply and demand line, although lower than expected April growth, many farms especially in northern England/Scotland and those at higher altitude are unlikely to see this growth during the winter period and demand will greatly outstrip growth in the November-March period. Where a grazing wedge built up in late summer/autumn can be used to meet the nutritional requirements of the ewe from mating through to lambing, ensuring a good winter rest period for adequate pasture cover at lambing time is vital to meet nutritional requirements at this period and into lactation. When residuals are taken down to 1000kgDM in early winter, at 5kg/DM/day growth 100 days would be required to achieve the desired 1500kgDM cover at lambing. With high stocking levels and in areas with poor winter growth all-winter grazing and achieving required pasture covers at lambing time may not be achievable from pasture alone.

6d. Bridging the feed gap

Increasing stocking density to improve production efficiency will enable better use of the pasture grown throughout the season, especially in times of peak production. With improved growth in the lambs through the genetics incorporated into the system, and the nutrition requirements met from good pasture management, with the lambs off the system early a grazing wedge can then be conserved to carry the ewes into the winter and, in some cases, right through the year. In areas of poor winter growth and high stocking density, pasture availability at lambing may well be insufficient to meet the requirements of the ewe in this period. Lambing date should be set to coincide with annual pasture growth to ensure nutritional demand can be met from the increase in pasture production starting in this period.

Where many systems in the UK have a heavy reliance on purchased feed during the winter period, reducing the requirement for this additional cost will greatly improve profit per kg produced. Where pasture growing patterns in different parts of the UK will determine the methods used to bridge the shortage in pasture growth during the winter months, incorporating differing techniques to meet the required nutrition from pasture/forage will ensure the reliance on fluctuating supplementary costs is replaced with a more profitable method of overcoming the winter feed shortage.

6d.i. All grass wintering

Undoubtedly the cheapest way to meet the nutritional requirements of the flock throughout winter is from grazed pasture. Where winter growth is enough to carry the required stocking density, rationing the grazing wedge throughout this period with the ability for re-growth to meet requirements at lambing time will greatly reduce the cost of carrying ewes through pregnancy. Even with lower winter growth, reducing stocking capacity and a delayed lambing date will ensure the ewe's requirements are met. The start of pasture growth in the spring should be able to meet requirements at point of lambing and into lactation.

In areas of the UK with more favourable grass production a good stocking density is achievable from an all-grass wintering system. Even with a slightly reduced carrying capacity the reduced cost of production can lead to a greater profit/kg and profit/ha resulting in the most commercially efficient system to run. With the growing season in the UK varying by as much as 4 months depending on location, all-grass wintering in some areas can greatly reduce the stocking capability and productivity

of a system and, although reducing production costs, can have a negative effect on profit achievable per hectare. That being said the ability for grazed pasture to reduce production costs should not be ignored and extending the grazing season from pasture as long as possible is necessary to increase a sheep enterprise's margins. Where stocking density is too high, or a large enough wedge of pasture is not achievable to carry stock through an extended winter shortage, incorporating alternative grazing will help bridge the gap and ensure nutritional requirements are met.

6d.ii. Winter grazing

Incorporating brassicas into a winter feed supply gives the ability to extend the grazing season whilst ensuring targeted pasture covers are met at lambing time. Adding brassicas to a pasture-based grazing system can greatly increase stocking potential by meeting the nutritional requirements of the ewe during pregnancy and thus conserving winter and early season growth whilst utilising a relatively small area of land. Brassicas prove a cost effective method to increase output in both KgDM produced and in animal productivity, and the ability to graze in situ means minimal capital investment is required. As with all-grass wintering, investment in electric fencing required for grazing brassicas is quickly returned through the reduction in production costs for the flock. Brassicas also prove very beneficial incorporated into crop rotations or as a break crop when reseeding pasture, adding fertility into the soil when grazed. Brassicas offer high yields and the ability to match nutritional requirements to different stock classes, or differing stages of gestation, although care must be taken in sudden changes of forage especially at point of lambing, as the rumen can take up to 15 days to adjust to a change in diet. Correct management can reduce the impact a change in diet can have by changing that diet gradually, or by having mixed forage species to graze in the transition period.

> i.e. when moving from grass to brassicas, having an adequate grass runoff and grass available in field margins when strip grazing will reduce the impact on the rumen, both when beginning to graze the brassicas and when returning back to grass-based pasture. Direct drilling into lightly sprayed-off pasture will ensure grass is killed for the establishment and initial growth of the brassicas, but it will come away again later in the season, giving a greater amount of grass to graze within the brassica crop, filling in gaps and improving soil structure to reduce poaching.

Fig. 19 on next page shows a more common supply (black) and demand (red) line for a UK upland farm. An autumn spike in growth ensures covers for mating and extending the grazing season into the winter but, with little growth in December through to March, the ability to meet the ewe's demands in late gestation and have adequate covers for lambing on an all-grass wintering system here would delay lambing date, put pressure on the ability to get all lambs away before September when a wedge would need to be built up for the following winter, and impact stocking rate.

Reducing production costs from an all-grass wintering system will ensure profit can still be made from selling lambs as stores if needs be, but fitting brassica grazing into this example would help extend the winter grazing and give the ability to preserve more winter growth for a slightly earlier lambing. This would mean lambs could be finished before conserving pasture for the following winter, giving the ability to carry more stock through the winter and increase production efficiency. Grazing a kale/swede mix in mid pregnancy will give a good ME/protein balance, although moving to

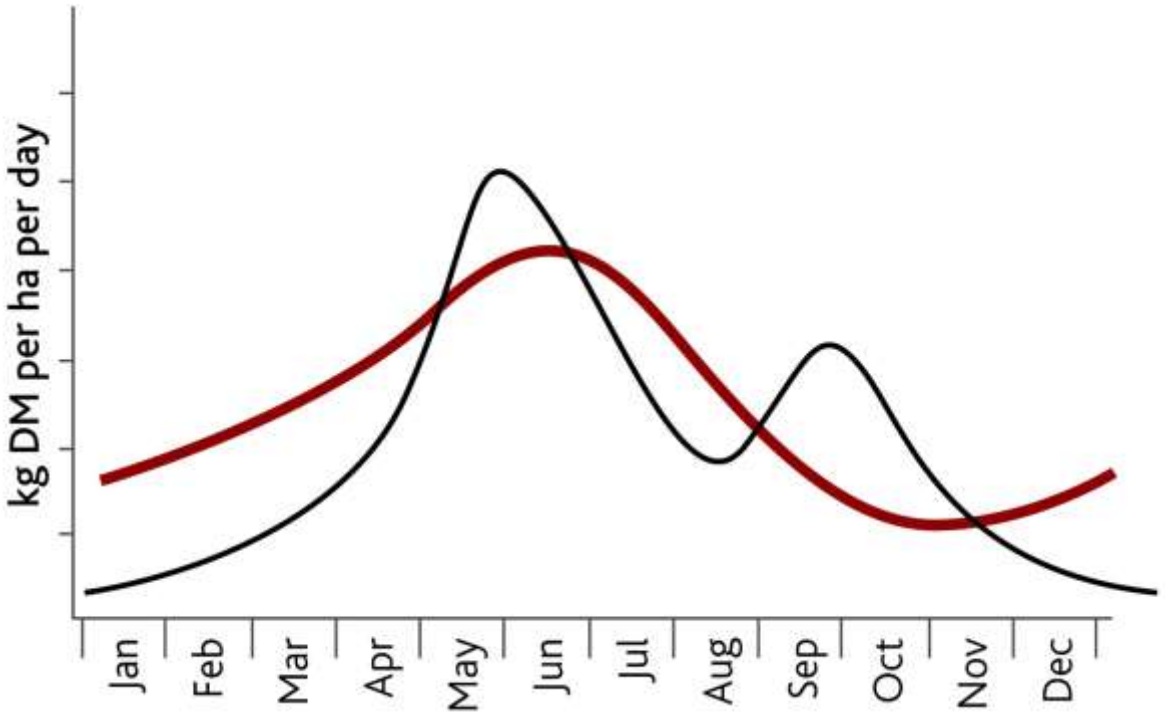

Fig 19: Pasture supply and animal demand for average UK upland farm

grazing swedes only in late pregnancy will better meet the ME requirements of the ewe, albeit a source of protein will be required. As only 70% of the diet should come from grazing brassicas, supplementing with high protein silage/red clover silage will mean more of the available protein will be able to be utilised via the high 12-13ME content of the swedes. Multiple-carrying ewes should cease grazing brassicas 3 weeks prior to lambing due to risk of twin lamb disease, so moving to pasture (or high ME silage and a source of DUP – digestible undegradable protein) in this period will ensure nutritional requirements are met and gives the rumen adequate time to adjust before lambing.

6d.iii. Conserved forage

Although a more expensive method of meeting the winter shortage in feed supply, conserved forage does have many benefits. It is still required in brassica grazing systems and should be made when surplus pasture is available - even in all-grass wintering systems - to act as a buffer for when grazing is unavailable. Even the best of measurements and rationing for winter grazing are absolutely useless if pasture is under a foot of snow for 2 months. Making wrapped silage from surplus grass during peak production can act as an insurance policy for unexpected weather, inadequate pasture cover going into the winter, and lower-than-budgeted winter growth; or can be sold when not required, providing additional income to the business. In years of excess production wrapped silage can be carried over to the next season without detrimental effect on quality, and does not require infrastructure for storage.

Conserved forage used to overcome the winter shortage in pasture growth means excess pasture can be taken from times of plenty and fed in times of need. Although additional machinery costs are required for feeding, using conserved forage gives the ability to match silage/hay made at different

times or from different fields to the stock requirements, depending on stage of gestation, through basic forage analysis. Feeding lower cost hay in mid pregnancy (8-9ME) is more than adequate to meet the nutritional requirements at this time, and high quality silage or red clover silage (11ME) can be fed to meet the ewe's requirements in late pregnancy supplemented with an additional source of DUP (digestible undegradable protein).

The ability to meet the nutritional requirements of stock through the winter period of low pasture production, at a reduced cost, has a great effect on the profitability of the ewe. Ensuring targeted pasture cover is available at point of lambing is the key factor to successfully carrying ewes through pregnancy and this period of demand outstripping supply. Failing to achieve adequate pasture cover at lambing will increase costs, both at lambing and into lactation if supplementary feed is required during this period. It will have a negative effect on ewe MBS and survival in the lambs and, with pasture on the back foot from the start of the season, reduce growth in both kgDM produced into the season and dlwg achievable in the lambs. When setting up a winter feed budget, meeting targeted pasture cover at lambing time must be the number one requirement. If a shortage is budgeted, supplementing conserved forage on a sacrifice field should ensure winter growth can be preserved from a larger area of the farm for lambing. Alternatively when grazing brassicas a run-back area can hold stock on high ME silage in late pregnancy. If they would normally be placed on pasture during this period, in years of poor winter/early season growth the grass can be conserved until lambing. Brassicas offer a great opportunity for high kgDM to extend the grazing season once the winter wedge has been utilised, and to conserve pasture on farm. However consideration must be given about the proportion of land used to grow the crop due to the duration the field will be out of pasture production. It does however fit well into a reseeding plan, enabling the improvement of poorer performing fields to increase the kgDM available from pasture to augment the productive capability of the land. Incorporating more specialist leys can also target areas within a system that need enhancing, such as hogget performance or lamb growth.

6e. Finishing systems: nature vs nurture – genetics vs nutrition/health

> *Approximately 60% of feed in a ewe breeding flock is maintenance. However, we can improve efficiency by getting more output for a given maintenance requirement.* (BLNZ)

Targeting production efficiency to increase carcass output - through increasing stocking density, rearing percentage and survival, as well as the ability to rear as a hogget - will greatly increase farm productivity and the ability to improve profitability. But increasing output per hectare will mean one very important thing: a lot more lambs on the ground. This creates a requirement to be able to finish them quickly. Having the correct genetics in place will ensure the ability to finish quickly off pasture, and the pasture's nutritional quality and utilisation will allow the genetics in place to be fully expressed. To be able to ensure conserved grazing for the winter period lambs should be off the system as soon as possible to build up the required wedge. Ensuring the nutrition required from the lambs is provided will be paramount to enable the maximum achievable dlwg of the genetics to be met.

Nature - the genetics incorporated into a system - alongside *nurture* - management decisions to ensure the health and nutritional requirements of the lamb are met - are absolutely key to maximise productivity from both the ewe and the growing lamb. The ability to provide high quality pasture to the growing lambs is key to finishing quickly. The quantity in front of the growing lambs is also important, allowing grazing preference and resulting in a high ME intake from the pasture available improving dlwg. *'Increasing grass height from 5cm to 6cm reduced the age at slaughter by 13days, equivalent to feeding 16.3kg concentrate per lamb from birth to slaughter'*. (Dr. Tim Keady et al.)

> *Concentrate feeding at pasture in mid-season: prime lamb producing flocks do not even come close to covering the cost of concentrate offered. Therefore, to improve financial margins the majority of producers should focus on improving grassland management which is low cost, rather than trying to replace poor grassland management with concentrate which is an expensive solution and guaranteed to reduce margins.* (Dr Tim Keady et al.)

Improved grazing management of permanent pasture will increase its quality and productive capability over time. Newer leys will have a lower worm burden, hence should be the preference for finishing lambs. But both can be used to extend grazing throughout the season. Improved utilisation - from 50 to 80% - results in a 92% increase in usable yield. (*Dr. Liz Genever*). This is obtained both through increasing annual yield and the amount utilised, thus hugely increasing output potential simply from improved management. Where grass/white clover-based pastures may be the most flexible in terms of year round usage, incorporating more specialised pasture mixes can help enhance targeted areas of productivity. Whilst not necessarily having a year-round usage they can improve the system as a whole. An example already in use on UK farms is incorporating red clover/high sugar grass leys, which provide high yielding, high quality early season silage for conserved forage without the requirement of nitrogen, plus an excellent finishing pasture able to achieve improved dlwg and reduce finishing time in the lambs.

A herb able to really push performance for sheep producers in New Zealand and one which could prove extremely valuable to UK sheep producers is plantain.

A herb able to really push performance for sheep producers in New Zealand, and one which could prove extremely valuable to UK sheep producers, is plantain. Plantain is a high yielding herb with an enhanced metabolic profile, which when grown alongside legumes proves an excellent pasture mix to improve ewe and lamb performance. Being a herb, plantain requires nitrogen, so sowing with legumes ensures these requirements are met from the pasture itself without the need for artificial fertiliser. Used as a finishing mix plantain can achieve excellent dlwg in the lambs. Although stocking density can be slightly lower on a plantain-based pasture, output per hectare is greatly increased due to improved growth rates. Plantain proves extremely efficient in reducing the finishing time of lambs mainly due to the digestibility of the plant. It can pass through the rumen in 4 hours whilst grass can take over 24 hours, and stem or dead grass takes up to 4 days, meaning lambs

are able to eat a large quantity of plantain and improve nutritional uptake. The deep tap root of plantain means it is drought tolerant and will not, like grass, reduce in yield during dry periods. It also has the ability to access more trace elements in the soil, so that the requirements of the stock are better met. Plantain not only has the ability to access trace elements in the ground but has a much greater mineral composition: meaning much higher calcium, magnesium, sodium, phosphorous, zinc, copper and cobalt retention. Containing aucubin, a naturally occurring iridoid glycoside, and its derivatives means plantain contains very important biologically active compounds which have a large number of positive effects including: antimicrobial, tissue growth promotion, non-steroidal anti-inflammatory properties, a weak anti-oxidant effect and liver protection.

As well as serving the purpose as a specialist finishing ley, plantain-based swards have proved extremely beneficial as a pasture for lambing hoggets on. Able to produce 6kg heavier lambs by 12 weeks of age it also has the benefit of weaning heavier hoggets at BCS3 and above, meaning very little weight gain or body condition is required to reach mating weight as a gimmer. The increase in nutritional quality shows greater dlwg achievable in the hogget herself with greater lactating ability, and the improved pasture quality for the lamb once they start grazing greatly increases ewe efficiency. Once weaned, and hoggets removed from the pasture, more lambs can be added as the plantain-based sward is then used as a summer finishing pasture. In years of poor pasture growth, the drought-tolerant abilities of the sward means lamb finishing time is not compromised.

Trials at Massey University examined early weaning systems in years when declining pasture growth was apparent. Lambs on plantain-based swards could be weaned at a very young age, 6-7 weeks, and still maintain sufficient growth rates to ensure finishing time was not extended. In a trial comparing the performances of plantain- and grass-based swards, lambs of 16-17kg at 6-7weeks of age were split into three groups. One group was left unweaned on ryegrass/clover pasture, a second unweaned group was moved onto a plantain/clover sward and a third group was weaned onto a plantain/clover sward. At traditional 12-week weaning lamb weights were 28kg for the unweaned group on ryegrass/clover and 33kg for both the weaned and unweaned group on plantain-based swards *(Prof Peter Kemp).*

The ability for weaned lambs to outperform unweaned lambs by 5kg when placed onto a plantain-based pasture shows the massive potential for sheep producers here in the UK. Whilst some NZ producers were grazing at a slightly lower stocking density, although achieving a higher output per hectare, research at Massey University showed under good grazing management a higher stocking density was achievable on plantain-based pasture over a ryegrass/clover based pasture, and was able to produce over double the output at 700-750kg carcass weight per hectare. Killing out percentage was always at least 2-3% higher on plantain-based pasture and anthelmintic use was reduced considerably. This is due to the morphology of the plantain: with an erect growth and ridged base the L3 larvae is unable to move up the plant as it would on grass, resulting in over 90% of the worm burden being below the bottom 2cm of the pasture. With residuals targeted at 8cm after grazing, the young lambs have a massively reduced uptake of L3 larvae. Due to better nutrition, mineral composition and biologically active compounds, immune response is also improved in lambs grazing plantain (*Dr Nicola Schreurs).*

Plantain has good autumn growth helping to extend the grazing season, although care must be taken if adding red clover to the seed mix as, due to boosted oestrogen levels negatively affecting fertility,

the pasture must not be grazed by breeding animals from 6 weeks prior to 6 weeks post mating. Plantain pasture not containing red clover proves very beneficial for mating on, especially for ewe lambs, as the additional dlwg achieved on the pasture can lead to a higher scanning percentage. Soil temperatures of around 10 degrees are required for sowing and it has shown to have established well in wet conditions. John Heald, who runs an elite Highlander flock with over 12,600 ewes/hoggets included in the 20,000 livestock unit, on the 2000ha Pohuetai Farms near Dannevirke, commented that he has seen fields under water for weeks after drilling plantain mixes and the seed will still establish after the water has subsided, when other crops would have been destroyed. John runs over 200ha of plantain-based pasture for lambing hoggets and finishing lambs. These pastures were able to achieve 370g/day growth compared to 240g/day on grass/clover. Stocking at 75 lambs/ha the plantain mix was able to produce close to 28kg dlwg/ha. The only pasture mix achieving high dlwg *per animal* (not per ha) was ram lambs on pure chicory. But with establishment cost similar for the two, the ability for plantain to last 4-5 years whilst chicory would only last 2 made plantain a much more profitable pasture. For use in the UK, plantain is much more winter hardy and seed costs equates to around that of a ryegrass/clover mix. (The cost for a plantain mix I put in this year was £47/ac).

Figs 20 and 21: These two photos (Fig 21 is on the next page) show a plantain, red and white clover mix 7 and 9 weeks respectively after sowing at my farm in north Northumberland. This 20-acre field, along with another 17 acre field of plantain, lucerne and white clover is currently being trialled. Each is subdivided into 8 paddocks on a 3-4 day rotation.

Fig 21: For description see previous page

6f. The future direction for sheep production?

After discussions with Dr Alec Mackay, a principal scientist at Agresearch, based around the smartest use of finite resources and the economically unsustainable extraction of those essential to agriculture, we moved on to the topic of how livestock production, in particular sheep production, could progress to make better use of the limited quantity of finite resources we have. Through optimising the use of finite resources available we can increase productivity and prolong resource availability to ensure we continue to meet the requirements of a growing world population and an increasing demand for red meat. Many major sheep-meat-producing nations have seen an increase in national productivity in the past few decades, none more so than New Zealand which now produces the same amount of carcass weight as it did 30 years ago, but from a national sheep flock half the size. Similar increases in productivity have also been achieved in Victoria in the same time scale. If we are to meet the future demand for our produce from the resources we have available will a similar increase in productivity not be a requirement to achieve this?

Sheep producers around the world seem to have reached a mental plateau for production targets. Push these targets too high and hesitation arises in management ability to be able to achieve them. But with the genetics and infrastructure in place to be able to maximise pasture production and utilisation, the ability to achieve higher productivity becomes more realistic. So the question is: why target 170% rearing, why not target 270% ?

Technical advances can add efficiency to production. Improved fecundity for higher prolificacy must be met with greater management skills to ensure a higher rearing percentage through reduced losses. With the correct management a much greater output per ewe from the resources available

can be achieved. Increasing current production from a reduced number of ewes would better match the seasonal availability of pasture, with more lambs produced to utilise peak production whilst a smaller ewe base needed to be fed through the winter shortage in growth. This massively reduces methane emissions per kg produced and reduces the risk of environmental damage, with less of the poaching, soil damage and run-off normally associated with high winter stocking rates. In producing a commodity for a global market there is little scope for adding value on a commercial scale. But increasing production through better use of the resources available will maximise the potential returns because of reduced production costs. Rearing more lambs per ewe will not just improve production efficiency but, through a reduction in variable costs, improve economic efficiency.

With the correct management a much greater output per ewe from the resources available can be achieved.

With the right genetics for maternal ability in place, specialist pastures available to increase the nutritional quality plus improved grassland management to augment usable yield, higher rearing systems would be well suited to pastoral-based sheep production. I've seen 4000 triplet-bearing ewes rear at 270% and 500 quads at 320% on pasture. There need not be a stigma with high multiple births if there is a system in place to meet the nutritional requirement plus genetics focused on improving survival. With the growth rates achievable on specialist pastures to fully express the genetic potential in place, finishing time for high multiples could surpass that for many single lambs on current systems. In cases of high multiples concentrate supplementation proves very cost effective. Research at Teagasc on triplet rearing systems supplemented an additional 18kg to the ewe in late pregnancy and into lactation, with 300g/day per triplet lamb fed from 2-12 weeks at a total cost of £18.30. This ensured the lambs were weaned at over a kg heavier than lambs from ewes rearing twins, and finishing time was not extended. With labour included the cost of supplementing represented a 3:1 benefit-to-cost ratio.

Adapting the principles laid out in this report will help progress the breeding objectives and productivity of current sheep production systems to optimise performance. Looking forward can these principles be implemented to better utilise the resources we have available and greatly increase the industry's productive ability in the future?

7. Conclusions

1. The maternal genetics in place are vital to improve ewe efficiency, reduce management requirement and increase productivity. They hold the key to increased output and reduced losses.

2. Improving grassland management to increase usable yield is essential to increase the productive capacity of pastoral livestock systems.

3. Economic efficiency in a commercial sheep enterprise is fundamental, derived from efficiencies in production and enabling the maximum profit achievable through an increased output per hectare whilst reducing production costs per kg sold.

4. Meeting nutritional requirement is essential for genetic potential to be fulfilled. The ability to manage nutrition to provide the required quantity and quality, along with correctly developed genetics, will increase the performance achievable on pasture.

5. Maximising production from improved genetics to target ewe efficiency, increased stocking density per labour unit, and output per hectare incorporated into grazing strategies to maximise usable yield from a pasture/forage based system, will enable the greatest output per hectare from a reduced cost base to be achieved, and best improve economic efficiency.

8. Recommendations

1. As the essence of sheep production comes down to nature verses nurture, the ability to integrate improved genetics, nutrition and management will improve the productive capability and profitability of a sheep enterprise.

2. Nature - genetics, and nurture - nutrition and health, inevitably come down to management decisions.

3. The ability to maximise the usable yield of pasture will increase both the nutrition available and the output achievable from a reduced production cost. To progress pasture-based sheep production it is essential the stock is able to perform on the system.

4. Ensuring incoming genetics have been developed on a system similar to the one you require them to perform on will make sure they are able to perform in your environment.

5. Objective measuring of traits required to progress your system will enable the selection of replacements from superior stock, and assist the removal of underperforming individuals to aid the development of the flock. Even with low heritability in certain traits, progression can be made on farm. Sourcing genetics developed for desired traits will shorten the time it takes to improve these traits in your own flock.

6. Implementing simple systems to identify poor performing individuals will facilitate the adoption of new data collection. Whilst EID technology improves the ability to integrate recording of traits across every animal, simply ear notching or spray marking those that underperform (and their progeny) for traits such as poor lamb vigour, poor lambing ease or low MBS, will ensure they can be identified at a later date.

7. Whilst some proposed changes may seem daunting, incorporating them as simply as possible will inevitably aid the likelihood of the practice being incorporated long term, and greatly increase productivity, management ease and labour requirement in the future.

9. After my study tour

9a. On my farm

On returning from the research trips for my Nuffield Farming Scholarship I have implemented a number of changes on farm. The main change has been in the nutrition provided to the ewe lambs pre mating, during gestation and whilst rearing.

9a.i. Nutrition

Two plantain-based pasture mixes are currently being trialled to assess the benefits they bring to our hogget rearing system and also how they match up as a specialist finishing pasture. One mix containing plantain along with red and white clovers is currently being used as a finishing block for the tail end of our finished lambs with late season growth in both the stock and the pasture itself being very pleasing. The other mix - plantain, lucerne and white clovers - is being used to rear and mate ewe lambs on, and both mixes will be rested from early winter until lambing when they will be used to rear hoggets and their lambs until weaning.

Once lambs are weaned both mixes will be used as finishing blocks throughout the summer. Both blocks have been subdivided using an Australian fencing system called Clipex which gives us the ability to subdivide the pasture for the length of the ley without the need for electric, and can be removed and used again on the next block once the ley goes back into grass, brassica or arable. With all stock EID-recorded at birth, performance on the two mixes can be compared to that of other specialist leys on farm and to the performance of our grass-based leys. As a finishing mix it will have to match up to our red clover/high sugar grass block which produces up to 20kg liveweight a hectare per day; but the ability to improve performance in hoggets' lambs up until weaning remains one of the main reasons for establishing the plantain-based leys so I am excited to see how well it can perform compared to data from previous years regarding the rearing of these lambs on grass leys.

Another main driver in adopting plantain was to assess its ability to overcome deficiencies on farm, in particular selenium and cobalt. Next year, once the mixes are fully established with a good tap root in the plantain, forage and blood samples will be used to see if an improved uptake of trace elements has been possible. It would be nice if the improved mineral composition of plantain meant we could overcome our deficiency from pasture but, as may well be the case, there may simply not be sufficient quantities in the soil for any improvement to be noticed. If this is the case fertiliser containing selenium and cobalt will be spread and the uptake between the plantain and grass leys will be monitored.

Along with the plantain I have now established more brassicas for winter grazing. Ewes graze a kale/turnip mix in mid-late gestation, then move to swedes as ME requirement rises in late gestation, before returning to grass. A larger area of the kale/turnip mix has now been planted with the aim of improving nutrition for our ewe lambs throughout gestation. Whilst previously I viewed mating ewe lambs as a way to improve ewe efficiency through reducing the mature weight of our ewes, I now want to see if improving the nutrition provided to the ewe lambs throughout that first winter and during rearing has an impact on *future* rearing ability as an aged ewe. Providing the new system of nutrition for our ewe lambs, I feel, will inevitably result in increasing their mature weight compared to our previous system so a noticeable improvement in their future progeny's weaning

weights will be required. If this new system of nutrition for our ewe lambs can improve their offspring's growth throughout their adult life, reducing finishing time in their lambs will mean a reduction in stocking capacity will not be the result of a slightly higher mature weight as, with their lambs off the system sooner we can preserve more grazing for the ewes themselves. As ever time will tell and data will be compared on lifetime performance as a ewe from the new system, compared to that collected on the previous system.


Figs 22 and 23: Finishing lambs (left) and ewe lamb replacements (right) on the plantain-based pastures currently being trialled on farm, sown with a forage rape nursery crop to increase yield during establishment.

9a.ii. Genetics

Undertaking this report has confirmed a decision I made during the beginning of my Scholarship - to become a breeding partner with Innovis. We are two years into a three-year embryo transfer programme and this week implanted 700 more embryos into recipient ewes on farm. Although a major financial undertaking, this decision will help improve the business in the long term. A nucleus flock of pure Aberfields on farm has enabled tremendous selection pressure for the maternal rams we use on our commercial flock. The nucleus is heavily recorded and, as well as selecting potential sires from breeding data collected in the same environment as the commercial flock is run, we can now start selecting for more specific traits to help develop our commercial ewes. Ram lambs have received one dose this year, 12 weeks ago and, having challenged these lambs in our own environment, FECs[2] have now been taken to determine those with best natural resistance to worm burden. Monitoring of growth rates also enabled us to identify animals with greater resilience and this data will be fed into our sire selection to help develop these traits in our breeding ewes and their future progeny. This, along with dag and breech scoring, should enable us to develop a lower management requirement from our stock in the future.

Undertaking a lot of recording at point of lambing, particularly in the nucleus flock, but also now in our commercial flock, has meant the requirement to update some of the technology on farm. Although it is an added investment, aiding the ease of data capture saves time and the increase in physical performance of our commercial flock will more than pay for any upgraded equipment. Birth weight, lambing ease, lamb vigour, MBS, entropium and cover score are all recorded at birth to feed

[2] Faecal egg count

into our breeding values, as well as aiding sire selection to improve maternal ability and survival in our flock. Investment in a Racewell handling system four years ago has proved extremely valuable in the ability to monitor performance and, whilst previously using weaning weight and dlwg for replacement selection, this year 8-week weights were taken from all lambs to ensure we are selecting replacements from ewes with greater maternal ability to help develop this trait further in the future.

9a.iii. Management

To improve the maternal ability and performance of our flock we want higher selection pressure for our breeding replacements and, contrary to popular recommendations, are now mating a much higher percentage of our flock to maternal sires. We have no hesitation in doing this and in fact are questioning whether the use of terminal sires is necessary at all! Lambs sired from our maternal rams graded at 65%-R's, 25%-U's and 10%-E's with only one lamb this year falling out of specification at U1, proving to us the ability to easily hit market requirements from a maternal sire. The potentially killer blow for our terminal sires (all within top 10% of their respected breed) is the fact that lambs sired from our maternal rams weaned on average 1.8kg heavier from lighter ewes on poorer pasture. With our desire to increase selection criteria for our breeding replacements, the fact that growth from our maternal sires is outperforming that of our terminal sires means we are more than happy to put more to a maternal ram. This, along with the selection pressure we now have on the maternal sires used, should help increase future performance of the flock.

Figure 24: At back fat and muscle scanning we were able to collect data at a rate of 80 animals/hour with ease and there was no need to handle the stock during scanning, thus reducing stress and labour requirement.

Where traditionally the farm has been producing finished lambs, we have now developed a market for selling ewe lambs. This also influenced the decision to mate more ewes to maternal sires and gives the ability to add value to the output from our commercial flock. This combined with the increased revenue from large scale ram production should help improve the economic efficiency of our sheep enterprise.

Having returned from my studies I now want to implement changes to our infrastructure to aid grassland management on farm. A lot of time is spent working with electric fencing and investment is now to be made in more permanent fencing to decrease the workload associate with sub division. Plans for more lanes to be put in place around the farm will aid our grazing rotation and mean access will not be limited when certain areas are used for growing brassicas or arable crops – as can sometimes be the case. This I hope will enable us to increase our stocking capacity further and decrease the management required by our current grazing strategy. With value added to what we are producing I look forward to the development of our flock into the future.

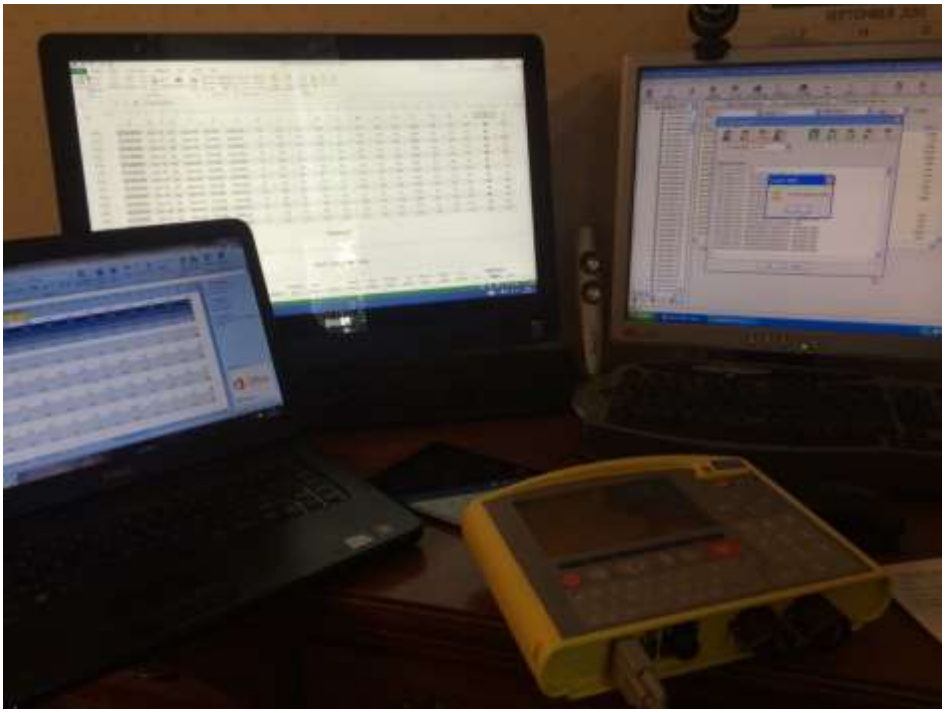

Figure 25: All data collected is fed into our software programmes and selection can now be aided with insight from performance recording, both through analysing physical performance and breed values

9b. The wider farming community

Having finished my Nuffield Farming report, attention is now focused on finalising my paper for the Moredun Foundation: 'On Farm Methods to Reduce Anthelmintic use in Sheep Production'. I hope this, alongside my Nuffield report, can help benefit sheep farms' physical performance and profitability.

My stint as the North of England representative on the National Sheep Association's Ambassador Group has come to an end and I look forward to continuing my work with the NSA into the future.

Meetings held on farm are increasing in frequency year on year, particularly now as we host open days with our breeding partner, and this proves a great way to give insight into our system and the changes that are being implemented since completing my Nuffield Farming study tour. Dewi Jones, the CEO of our breeding partner Innovis, is also a past Scholar and we make special reference to the tremendous opportunities undertaking a Nuffield Farming Scholarship can present. We encourage attendees at both our on farm events and those we host around the country to consider undertaking a Scholarship themselves.

Several trials are run on farm ranging from DUP supplementation to disinfectant products to assessing benefits both physical and financial that can aid sheep production throughout the industry. My father and I have worked alongside the likes of AHDB, SAC and Newcastle University to aid research and demonstrate best practice to farmers at various events on farm. This gives us a chance to assist in knowledge transfer but also the ability to trial new technology to ascertain the practical benefits of improving data capture.

Figure 26: Pasture meter and various canopy sensors being trialled on farm in conjunction with Newcastle University to assess pasture quantity and quality: turns out it's a lot more expensive than a sward stick!

10. Executive Summary

Sheep production in the UK, on the whole, is heavily reliant on subsides with many enterprises unable to make a profit from farming sheep. Where sheep production is the sole income stream economic margins in many enterprises would be insufficient to sustain the business without the support of the Common Agricultural Policy. Whilst market patterns are influenced by global factors there are huge opportunities for UK sheep producers to adopt measures which can significantly influence profitability through increasing physical performance and reducing production costs.

The main objective of my report was to determine measures producers could integrate into existing production systems resulting in improved profitability. Increases in production efficiency through improved ewe productivity, grassland management to increase usable yield enabling a higher stocking capacity, and targeted input costs can greatly improve profit per kg produced, profit per hectare, and the economic efficiency of a business. Current systems were examined throughout the UK, Ireland, Australia and New Zealand alongside meeting a vast quantity of industry consultants, research organisations, genetics companies and extension providers to study methods that could progress productivity and profitability in the UK sheep sector. Whilst technology advances can aid breeding and management decisions, it is ultimately the management of the business that will determine the direction the producer chooses to progress the enterprise.

Needlessly recommending radical changes to sheep production methods would ultimately reduce adoption of new practice. Instead, implementing procedures which can simply integrate into current practice will provide cumulative and permanent effects to be incorporated into a farming strategy. Simply put, sheep farming comes down to Nature verses Nurture, and targeting the key aspects that govern these: genetics, nutrition and management, will determine the productivity, management ease and profitability of sheep production. Reducing the management requirements of the system will allow an increase in stocking density per labour unit, and improved pasture management to increase utilisation and yield will enable stocking capacity to be increased.

The maternal genetics in place are the overwhelming aspect governing both labour requirement and productivity. Incorporating improvements to the genetics currently in use - through objective measurements and selection - will progress the stock's ability to improve production targets. Sourcing any incoming genetics to develop ewe efficiency is vital to increase the productive ability of the flock. Ensuring any incoming stock has been developed in an environment similar to that under which one's own system is run is paramount, and gives much greater relevance to breed values. As influential as the genetics integrated into the system is their ability to perform. Careful appraisal of the source of these genetics is critical to ensure the ability to achieve their potential.

James Drummond

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