The Farmers Club Charitable Trust

Educators Award 2013

Grassland Science: Education, Research and Knowledge exchange as practiced in New Zealand Dairy Industry.

And

22nd International Grassland Congress, Sydney, Australia: Review

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10. Summary

1. Introduction

1.1 Background

Grass based livestock systems are central to the UK farming systems with grass being the primary source of nutrition for the ruminants. Grass and forages can account for a minimum of 50% of a dairy cow's diet and up to 95% of a sheep's diet. Grassland accounts for 70% of agricultural land in the UK and Ireland therefore it is the major resource for farmers. The western locations within the British Isle are ideally suited in climate to provide a long growing season with good rainfall during April-September to allow accumulation of 10-12 t DM/ha. Whilst we have the climate the complex interactions of grass with livestock and the environment often results in less than optimal utilisation.

It is to this end that much research and advisory/knowledge exchange activity attempts to raise this awareness and assist in offering the farmer the knowledge and confidence to fully utilise the potential of grass in livestock systems within the UK.

1.2 Reasons for applying

As programme leader and lecturer at Scotland's Rural College (SRUC) Ayr (formerly SAC), my main area of specialism is grassland. I have gained plant breeding and other experience commercially prior to my job within research and education.

I was able to carry out a PhD on the effect of grazing management on the heterogeneity of an intensively managed sward, which was a wonderful experience and allowed me to meet many researchers over those years. My job moved focus and I am currently managing and delivering within the land based education. I strive to inspire my students on grassland and botany as my lecturers did me!

Scotland's ability to grow grass and produce high quality produce from it is one of our strengths. However it is not always realised by our farmers for various reasons, one of these being the lack of confidence to manage their grassland effectively. I would like to try and address this by enhancing the education and training of farmers in grassland management through our education and consultancy services.

Having attended the International Grassland Congress (Dublin) in 2005 I felt this was an excellent platform not only to gain knowledge in a very efficient manner but also to be able to network with the grassland community on a world wide basis and an opportunity not to be missed. The attraction to the congress in Australia was also enhanced by the possibility of getting a greater insight into the pasture management in countries which are in the forefront of grassland agronomy. I constantly teach about the NZ based systems and the 3 leaf system form Australia and hear from local farmers who have travelled to NZ to gain valuable insight and give them confidence to base their systems on grass. I wanted to experience the NZ system and investigate their methods to educate their students and farmers on grassland management which may be incorporated into SRUC knowledge exchange and allow our grass based farming systems to be more competitive.

I wanted to visit the land based Lincoln university and Massey University in NZ to investigate their education programmes and pursue the potential for Scottish students to undertake part of their studies in NZ. Many of our students complete after 3 years with an ordinary degree, wishing to travel rather than do an honours year. I believe there would be a good incentive to students to continue to honours if during their third year they got the opportunity to travel and learn oversees. I wanted to investigate the opportunities and develop contacts at these renowned agricultural Universities.

1.3 Objectives

The objectives of my study trip were:

- To increase my technical expertise in grassland science
- Investigate techniques to exchange knowledge and advice on farm within intensive grass based systems used in NZ.
- Develop links with Universities which may allow SRUC agricultural students to participate in studies overseas during their degree.

1.4 The study tour

I departed Glasgow on 1st September arriving in Auckland on 3rd. From there I travelled to Palmerston North and spent 3 days in the area, at Massey University, AgResearch centre and with Dairy NZ consultants. I flew to the south Island and repeated the exercise based at Lincoln visiting Lincoln University, Dairy NZ office, dairy farmer near Ashburton and PGG Wrightson commercial plant breeding company. From here I flew to Australia to attend the International Grassland Congress in Sydney on 15th Sept. Funding from the SWSGS allowed me to attend a 2 day post congress tour around NSW University farms and a number of commercial farms as a flavour of the farming and knowledge exchange in the area.

In total I was in NZ and Australia for 3 weeks meeting numerous grassland specialists involved with research, education or advisory and the following report highlights the main findings in these areas.

2. Overview of Agriculture in New Zealand

The productivity of the agricultural sector in New Zealand has increased dramatically over the last 20 years. Currently there are 6.6 million dairy cows, 31.2 million sheep, 4 million beef cattle, 34,000 ha grapes and 12,800 ha kiwifruit. The agri-food exports for 2011 were $24 billion and the goal is to increase this to $62 billion by 2025.

The dairy sector production has increased by 77% in last 20 years with stocking rates increasing from 2 cows/ha to 2.8 cows/ha on average or higher using home grown cereals. Herd size has tripled to an average of 400 cows. The area of land associated with dairying increased by 200,000 ha over last 10 years. Much of this increase has been seen in the South Island and lower North Island with the use of both irrigation and high fertiliser nitrogen rates achieving yields for Perennial ryegrass of 18 t DM/ha.

Fig 1. Irrigated perennial ryegrass pasture in NZ

Fronterra (the largest co-operative dealing with 89% of NZ milk) has been very successful in achieving a secure and growing market for milk powder to China and the whole dairy industry is much focussed, pulling together to the same end point. Milk contracts are paid on milk solids and the average yield of milk solid per cow has increased to 330kg (equates to 3,710 litres of milk with 184kg milk fat and 139kg protein) which is an increase of 35% over the last 20 years, with milk solid per hectare nearly quadrupling in that time. To this end the, Jersey Friesian crossbred (42%), Holstein Friesian (37%) and Jersey (12%) breeds are in favour of use. Milk prices has risen three fold in 20 years, currently around $(NZ)7 per kg, equivalent to 30p/l.

Sixty five percent of New Zealand dairy farms are owner operator with the majority of the rest being run as share milking. Share milking involves someone operating the farm on behalf of the owner with an agreement of usually 50% return of farm income. This can also involve owning of cows etc. and allows new entrants to accumulate equity in order to purchase land in their own right. This structure in a profitable industry has allowed for young, new entrants to get established farms quickly and has led to a vast increase in land prices, especially in the Canterbury plains where much land has been converted to dairying.

Grass is the basis of the dairy production systems within New Zealand. The systems can be divided into 5: S1-all grass self contained, S2 – <15% feed imported for supplementing dry cows of the grazing platform, S3 –20% feed imported to extend the lactation usually as a winter feed, S4 – 30-40% feed imported to extend the lactation at either end and S5 – 50% + imported feed all year round for whole lactation. Fig 2 shows the proportions within each system classification and how this has changed over the last decade with a doubling of farmers who have increased imported feed for winter or extending lactations. There is less than 10% in either of the extreme categories..

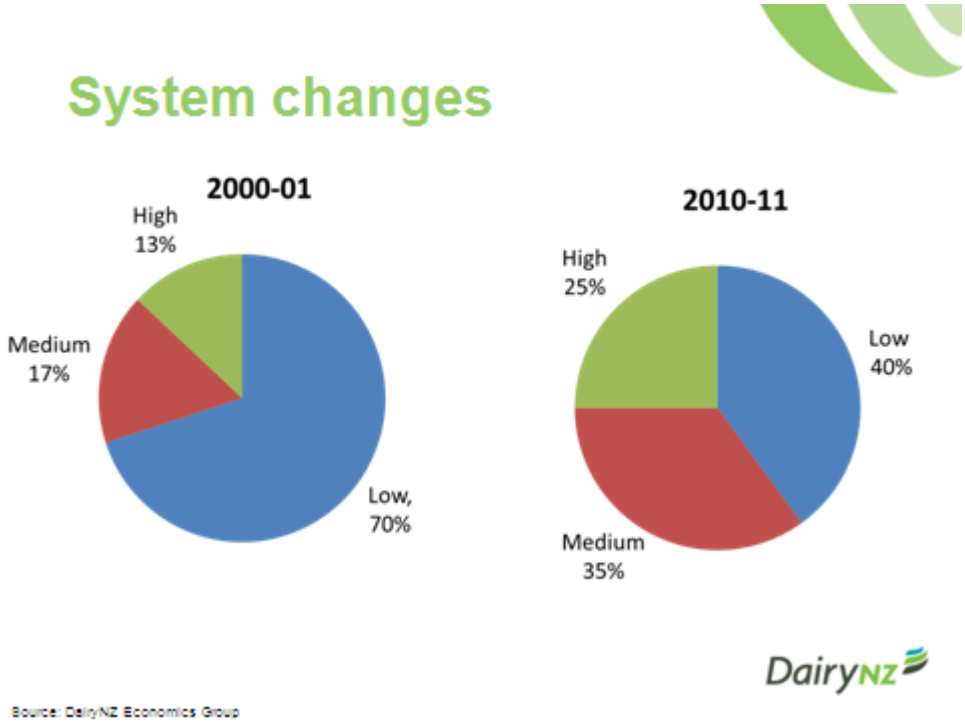

Fig 2: The proportion of NZ dairy farmers within the five S systems (Low =S1 and S2, Medium = S3 and high S4 andS5) and the change of this between 2000 and 2010

There is a move to the Perennial ryegrass is the main component of pastures within NZ, for much the same reasons as it is in the UK, establishing quickly, responsive to fertiliser, good nutritive value and high dry matter production. It does however show weakness in persistence and drought tolerance. Pests are much more aggressive and the Argentine stem weevil can cause devastation. It is to this end that endophytes have become essential in order to allow perennial ryegrass to maintain persistent. These endophytes although essential to allow pest resistance by the plant the animals can suffer causing health issues and poor performance. Much research has allowed for endophyte strains which are less harmful to livestock while retaining the pest resistance to the plant. Alternatively other grass species can be used such as Cocksfoot, Tall fescue and Brome grasses which have resistance to pest and persistent, however not always as easy to establish.
Legumes are also important, such as white clover, red clover and Lucerne. High fertiliser N use in some systems has resulted in reduced white clover in grazing pastures for dairying.

However it's not all good news, together with increased intensity of production there is an environmental price. Water quality monitoring has shown a trend of degradation of quality between the 80's and present day with an increase in Nitrogen, Phosphorus and faecal bacterial. Much research is looking at methods to reduce nitrate lose from the pasture and models are being developed to be used on farm to determine nitrate lose and set levels of acceptance at farm level. Waterway fencing and plantings of riparian boundaries are being introduced to counteract livestock access to waterways. Many considerations are being taken to reduce the contribution of grazing livestock to excessive nitrogen leaching. Urine patches are considered to be the highest risk to nitrate leaching, particularly in the wet autumn season. Wintering cows off the grazing platform, fertiliser timing and precision application together with housing of animals to retain and better manage nutrients are all seriously being considered to allow better nutrient managed at the farm level.

3. Agricultural Education

There are two universities within NZ which offer Agriculture degrees, Massey University in the North Island and Lincoln University in the South Island.

3.1 Massey University:
This is the largest agricultural university in NZ which also delivers veterinary science.

All BAgriScience students take a selection of compulsory subjects throughout the degree, most of which are in the 1st year and include introductory science, economics and agribusiness. This provides students with a broad knowledge and skill set which will equip them to go on to more advanced papers in the 2nd and 3rd years.

The agriculture major also has a set of compulsory papers spread across all years in subject areas such as agricultural systems and management, agribusiness, animal science, agricultural engineering, plant pests and diseases, plant science and soil science

There is also a practical work requirement for the BAgriScience degree. It consists of at least 26 weeks full-time work in an area relevant to Agriculture.. Practical work is normally carried out during summer vacations throughout the degree.

Currently approximately 60 students are enrolled each year with around 40 choosing agriculture as their major (as apposed to horticulture or equine major). Massey has an exchange programme set up with RAC, however in practice few take up this opportunity. The majority of students exit after 3 years with a general BSc with only a few continuing on to the honours year. This is primarily due to the industry's demand for graduates is greater than the supply therefore good opportunities exist for graduates without the need for an honours degree.
Resources at Massey are excellent with 40 PhD students working on Agri food related topics and 2000 Ha of farmland split between 5 farms, ranging from 3 dairy, upland sheep, upland beef, lowland beef, deer and dry stock. The pasture and crop

department have a block of land which is used as farmlets. Undergraduate students in groups are given 1ha of pasture with which they manage 20 sheep in a grazing and lambing system of their choice. The aim is to produce as much live weight of lamb per hectare.

One of Massey's Dairy Farms (No 1) has recently started the Future Farms project. This has a research vision together with the integration of undergraduate teaching and post graduate research. The focus is on low input precision farming on a simple once a day milking system which is environmentally sustainable with a slogan of "Simple is the new sophisticated"

Modeling work has shown No1 Dairy Farm has Nitrogen leaching of 48kgN/Ha/yr. The target set by authorities is likely to be 20kgN/Ha/yr. The farm has 120ha with land running for 3 km along a main river and carries 360 Holstein/Friesian cows. The farm is also on the suburbs of Palmerston North town and part of the vision is to involve the community by including walkways and cycle routes. Community groups have been involved in conservation initiatives and they plan to invite schools to learn about food production.

It is planned to reduce the stocking rate to 240 cows together with 18 ha of trees along the river banks, 37 ha of cropping (Lucerne for silage, chicory and plantain for grazing) leaving 102ha of grazing platform. The cows will become spring calving with no winter milk and the introduction of Jersey to crossbreed. The aim is to reduce to once a day milking but retain the milk yield of 365kg milk solid/cow/yr while reducing Nitrate leaching to 20kg/ha/yr.

Overall the research farm will deliver on 4 variables: Profit, People, Environment and Social Connection with a desire to work with students, researchers, consultants and farmers not only in NZ but also internationally and is an ideal opportunity for SRUC to get involved, especially in the light of the comparison with some of these aims and that of Crichton Royal Farm in Dumfries.

Massey Dairy Farm No 4. has 650 cows on heavy land liable to winter poaching. This farm is looking at an alternative strategy to reduce leaching in autumn/winter. No. 4 is looking at investing in infrastructure rather than changing the complete system as with Dairy Farm No.1. A shed is being constructed to allow 300 cows to be housed during the winter with limited grazing to compare this with 350 cows outdoors all year round. This will allow for a comparison of nitrate leaching from these two systems together with how variable strategies affect nitrate leaching.

Although the farm facilities and resources at Massey university are extensive I do feel however these are not fully integrated into the undergraduate agriculture teaching and students do not get as many opportunities to be involved as they might do at a practical or data collection level.

3.2 Lincoln University:

Fig 3. Lincoln University Campus

Lincoln University refers itself as the only specialist university in NZ. It is much smaller than Massey with 4500 student body offering courses in Agriculture, Horticulture, Environment, Tourism, Commerce. Lincoln has recently merged with Telford Rural Polytechnic who run lower level one year practical courses for 15 yr olds in dairy, sheep and deer (similar to our FE colleges) which makes Lincoln University very comparable to SRUC in both course provision and level.

Agriculture provision is at the diploma level (HND equivalent) and B.Ag. AgSci, Masters and PhD. Yearly Degree intake is 80-100 with a further 50 students doing the ag commerce degree. Unlike Massey the majority of these undergraduates are retained through to the fourth year programme to achieve the B.AgSc. Students who leave after the third year achieve B.Ag. The retention into fourth year is thought to

be due to their recruitment activity outwith the farming communities and have attracted students without farming experience who do see an honours degree as useful and also get extra practical work between year 3 and 4 to help complement their studies. The drop off is at the masters level where they struggle to retain home students gaining international students at this level.

Lincoln University Dairy farm has 186 ha irrigated pasture, of which 160 hectares is the milking platform. Previously this was University sheep farm until converted to dairying in 2001. The different soil types on the farm represent most of the common soil types in Canterbury. It is part of large project- South Island Dairying Development Centre involving 7 partners including commercial, research and Dairy NZ with among many objectives include the following:

- To develop and demonstrate world-best practice pasture based dairy farming systems and to transfer them to dairy farms throughout the South Island.
- To consider the farms full environmental footprint, land requirement, resource use and efficiency in system decision making and reporting
- To use the best environmental monitoring and irrigation management systems in the development and implementation of practices, that achieves sustainable growth in profit from productivity and protection of the wider environment.
- To ensure optimal use of all nutrients on farm, including effluent, fertiliser, nutrients imported from supplements and atmospheric nitrogen; through storage where necessary, distribution according to plant needs and retention in the root zone.
- To manage pastures and grazing so per hectare energy production is optimised and milkers consume as much metabolisable energy [ME] as practicable.
- To optimize the use of the farm automation systems and demonstrate / document improved efficiencies and subsequent effect on the business.
- To assist Lincoln University to attract top quality domestic and international students into the New Zealand dairy industry.

This is only one of 2 farms. The other farm of 56ha irrigated pasrture,190 Friesian cows, high technology parlour and cow identification is used for research projects for staff, undergraduate and postgraduate students. Much of the research is within the

government P21 research programme looking at dairy system studies to reduce nitrate leaching and effect on the production.

Fig 4. Fistulated cows on pasture research at Lincoln University Dairy Farm

Two systems are being compared, each of 30 cows but one at high stocking rate (HSE) at 5 cows/ha and one at low stocking equivalent (LSE) at 3.5cows/ha. Both systems off winter with HSE using fodder beet while LSE using kale and a cereal rotation. The objective is to reduce the nitrate leaching by 40% for LSE while maintaining milk solids. The HSE will use higher fertiliser N together with denitrifying inhibitors but overall 35% increase in nitrate leaching during grazing but milk solids increase of 45%. Much of the undergraduate work is looking at some aspect of this overall system study e.g. honours projects looking at gibberellins to boost early season production without the increase of fertiliser N, Lucerne for grazing, high genetic vs low genetic merit cows within systems.

Generally the farms were being used in a multifunctional way with many collaborative partners but most importantly these farms were being utilised by the undergraduate students for both data collection and practical experience.

Agricultural education in NZ is well structured with degrees based on science and including a broad range of subject areas covered. Crop and pasture science is

covered in year one and two as soil science and plant science which makes up a ¼ of the year. Year 3 is more flexible with pasture agronomy, crop science and advanced soil management all available for selection. This gives a strong pasture content within the three year programme which indicates the reliance and importance of grass in their livestock systems. A comparison to pasture/crop/soil science content within the BSc Agriculture with SRUC would be ¼ in year 1 followed by $^{1}/_{8}$ in year 2, 3 and 4. Perhaps this would need to be increased in order to give our next generation more knowledge and understanding of grassland and soil science and allow better reliance on grass in our livestock systems within Scotland.

4.0 Grassland Research

AgResearch is a Government-owned Crown Research Institute (CRI) focused on supporting the pastoral sector through scientific research and development. Core funding comes from government and this is enhanced through commercial funded projects and industry levy funding e.g. DairyNZ. Research grouping covers Animal Productivity, Nutrition and Health, Forage improvement, Land and Environment, Food and Bio based products and Innovated farm systems.

Pasture based research is multidisciplinary with a concentration of scientist working from the Palmerston North research station, Grasslands on areas ranging from plant physiology, plant breeding (both conventional and bio-technology techniques) and microbiological investigations and improvement for both grass and clover. Many of the strategic aims, as outlined in Table 1 are very production driven looking for increased forage quantity and quality.

Table 1: Strategic aims covering pasture research in Agreserach

Outcome area	Sector outcome goals	Priority impacts
Dairy On-Farm	***Outcome 1:*** Increasing farm profitability ***Outcome 2:*** Internationally competitive milk supply which maximises returns to farmers	**Impact 1:** ***Improved production from home-grown feed*** ***Impact 2:*** Improved rate of genetic gain in the national herd ***Impact 3:*** Improved animal health and milk quality ***Impact 4:*** Adoption of new farm management practices which improve productivity ***Impact 5:*** Control targets met for nationally monitored diseases ***Impact 6:*** Improved animal welfare
Meat & Fibre On-Farm	***Outcome 3:*** Improved productivity and profitability of sheep and beef farms	**Impact 7:** ***Improved productivity from forage*** ***Impact 8:*** Improved productivity from meat animals ***Impact 9:*** Improved animal health status of meat animals ***Impact 10:*** Continuous improvement in farm management practices

During my visit I was hosted by a number of scientist who took time to show and explain their research:

4.1 Greg Bryan- Genetic markers and plant physiological processes

This group have identified mutant Arabidopsis lines and through genetic engineering have produced lines that produce a protein, cysteine–oleosin which encapsulates the fatty acid and stabilises it allowing accumulation within the endoplasmic reticulum of the cell of up to 5 fold increase. The photorespiration was also reduced which results in up to 50% increase in leaf biomass production. These genes have know been transferred to other grasses and they are looking to get international involvement to further develop this scientific advancement. This has potential benefit for the biofuel industry and animal feed as energy dense biomass can be produced.

4.2 John Ford - Forage Improvement through conventional plant breeding

Grasses and Clovers are being bred with a commercial end point as the focus. Such breeding is sponsored by PGG Wrigtsons for grasses and Barenbrug for clovers. Germplasm selection for root biomass using hydroponics and digital analysis to select material which will be more drought tolerant and also absorb nitrate better from soil reserves is a major objective for perennial ryegrass. Red clovers ecotypes which have shown much improved persistency are being released.
There is no regulated seed sales in NZ which results in an open market competing for price, In order to try and give guidance to farmers Dairy NZ have commissioned a project through AgResearch to develop the Forage Value Index (FVI). DairyNZ in conjunction with the New Zealand Plant Breeding and Research Association (NZPBRA) have developed a forage evaluation system to provide an estimated profit index, called the DairyNZ Forage Value Index ($/ha), for perennial ryegrass cultivars in different regions of New Zealand, Table 2 shows such an example.

The Forage Value Index ranking for perennial ryegrass cultivars is calculated from information on dry matter yield obtained from the National Forage Variety Trial

(NFVT) system. Trials have been conducted in numerous locations throughout New Zealand, since 1994. Each trial has generally included between 10 and 20 different cultivars tested at several sites using a standard set of research protocols.

However, there are limitations of the NFVT data:

- The trials are conducted using pure ryegrass swards, clover and other species are absent, or present at only very low levels
- Each trial runs for only three years, so the persistence of the different cultivars is not measured
- No information on feed quality is collected
- Some trials are grazed (by sheep, beef cattle, or dairy cows), however many are managed under mowing only
- The trials are managed to a high standard with regard to fertiliser inputs, minimal damage due to over-grazing/pugging and good weed control, but are not usually managed to the same high level on farms.

To ensure that FVI rankings represent the expected performance of different cultivars on farms, new supporting research projects are being conducted to address information gaps.

Table 2: FVI for upper South Island

Perennial Ryegrass Forage Value List

Note: Perennial ryegrass FVI is currently a combination of seasonal dry matter performance values and economic values only

Dairynz® Forage Value Index

Evaluation date: 1 Dec 2013

Cultivar	FVI[1] (Star Rating)	FVI Star Band ($/ha)	Conf[2]	Performance Values[3] (1 to 5 Rating[1])					Endo[4]	PI[5]	HD[6]	Marketer
				WIN	ES	LS	SUM	AUT				
One50 AR37	★★★★★	$346 to $470	8.0	5	2	3	4	5	AR37	D	L	Agricom
Base AR37	★★★★★		4.3	5	3	5	5	3	AR37	T	VL	PGG Wrightson Seeds
Arrow AR1	★★★★	$222 to $345	10+	3	5	5	4	3	AR1	D	M	Agriseeds
Ultra AR1	★★★★		10+	4	3	4	4	4	AR1	D	L	Cropmark Seeds
Matrix SE	★★★★		9.7	3	4	3	3	3	SE	D	VL	Cropmark Seeds
Alto AR37	★★★★		5.0	5	4	5	4	3	AR37	D	L	Agriseeds
Bealey NEA2	★★★	$99 to $221	10+	3	1	2	3	2	NEA2	T	VL	Agriseeds
Alto AR1	★★★		10+	3	2	4	3	2	AR1	D	L	Agriseeds
One50 AR1	★★★		10+	3	1	3	4	3	AR1	D	L	Agricom
Halo AR37	★★★		9.7	4	1	2	4	4	AR37	T	VL	Agricom
Expo AR1	★★★		8.7	3	3	3	3	2	AR1	D	L	PGG Wrightson Seeds
Extreme AR37	★★★		7.3	4	5	2	1	3	AR37	D	M	PGG Wrightson Seeds
Bronsyn AR1	★★	-$25 to $98	10+	1	3	4	2	2	AR1	D	M	Agriseeds
Banquet II Endo5	★★		9.0	3	1	1	3	2	Endo5	T	L	PGG Wrightson Seeds
Samson AR37	★★		3.3	3	5	2	1	1	AR37	D	M	Agricom
Nui SE	★	-$149 to -$26	10+	1	2	1	1	1	SE	D	M	Common

[1] 5 = top 20%, 1 = bottom 20%, [2] Confidence (higher is better), [3] WIN = winter dry matter production (June, July), ES = early spring dry matter production (Aug, Sept), LS = late spring dry matter production (Oct, Nov), SUM = summer dry matter production (Dec-Feb), AUT = autumn dry matter production (March-May), [4] Endophyte, [5] Ploidy (D=Diploid, T=Tetraploid). [6] Heading date (M=Mid, L=Late, VL=Very late). For more information visit www.dairynzfvi.co.nz

This information is providing framers with realistic and appropriate information at a regional level to allow for beneficial cultivar selection. Everything is related to profit within NZ dairy farms and the grass cultivar is treated no differently. Just as a farmer would consider the cost of a piece of machinery or the profit realised from a purchased feed, so too is the profit potential of the grass cultivar sown in the field. I think this can only reinforce the importance of grass in the NZ system and how it is consider crucial in the whole farm profitability, not only in its management but

starting from the cultivar chosen. Seed mixtures sold are very simple or indeed straights, unlike that in the UK. The DairyNZ levy is being used effectively at the farm level.

4.3 David Hume and Linda Johnson – Endophyte evaluation, improvement, agronomy and knowledge exchange with farmers.

Endophytes are fungal microbes that live in the tissues of many groups of plants, including grasses. The endophytic association are responsible for some debilitating animal diseases. However, it has also been shown that they are critical for plants' protection against insect pests.

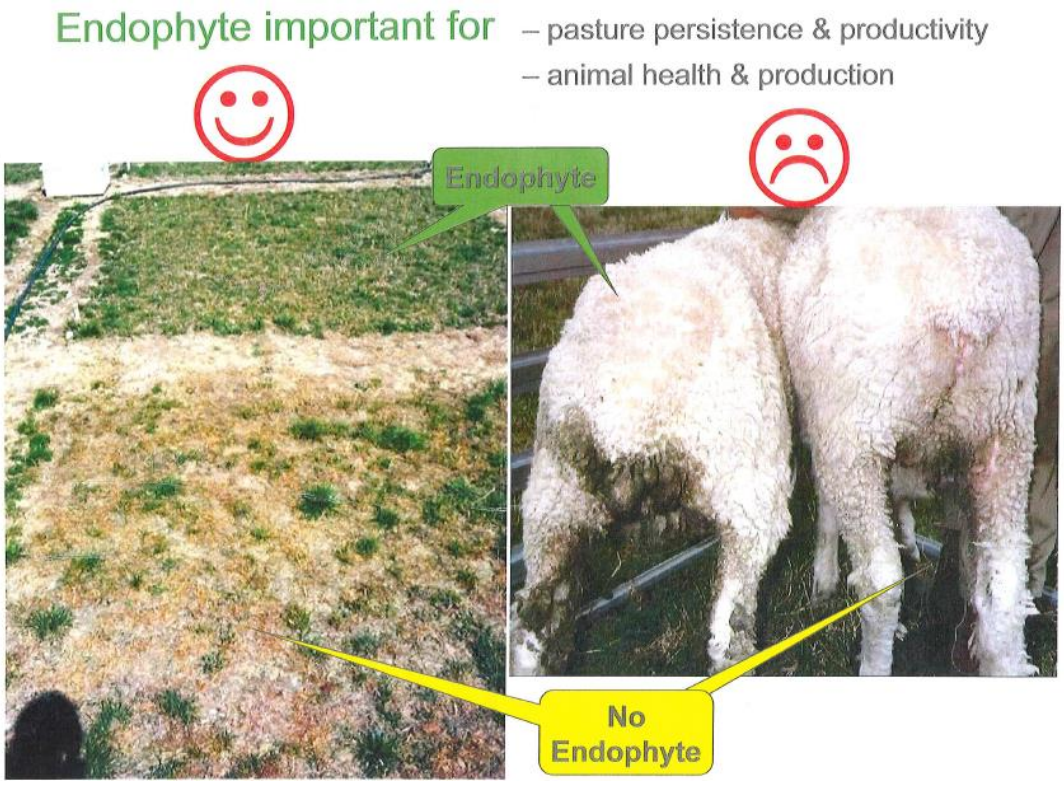

Fig 5. The effect of endophytes on ryegrass pasture and sheep

Differences amongst endophyte strains can actually make a greater difference to grass properties than genetic variation of the grass host itself and therefore they have huge impacts on livestock productivity. To this end much resources are allocated to research into the endophyte pasture relationship, looking to improve the

strains of endophytes to reduce the secondary metabolites which cause poor live weight gain and retain those secondary metabolites which give the host protection against many pest found in the hotter, drier climates e.g. Argentinian stem weevil, black beetle and root aphid to name a few. A new strain AR37, released in 2004 has proved to allow ryegrass to be persistent and high yielding without too much side effect on livestock grazing it. They haven't yet produced the ideal strain and so work continues however there has been much improvement in the endophyte ryegrass relationship in many ways: strains, agronomy, biochemistry of the metabolites, transmission between generations and storage of seed to retain endophyte content.

Endophytes are very important in many climates of the Mediterranean and America, unlike the more temperate cooler climates of UK, however endophytes are present but due to climate do not produce metabolites to cause adverse effect on livestock. The lack of pests means endophytes are not a requirement within seed sold in UK, however climate change may in the future mean the southern parts of the UK find the need to rely on endophytes and therefore the excellent work of AgResearch may be transferable to our conditions.

Much work within the AgResearch endophyte team is knowledge exchange and education of the farming industry. There are still many farmers within NZ unaware of endophytes and how the improved strains can be beneficial compared to the wild strains.

4.4 Dr Margaret Brown researches people in agriculture and has been studying how farmers learn and how knowledge exchange and understanding of science and technology could be improved at the end user level.

Of particular interest to AgReserach are:

- Farmers' decision-making processes in the context of their social, economic and bio-physical environments
- How farmers learn about and respond to new technologies and systems
- The construction and implementation of innovation systems that encourage the use of new knowledge.

Much of the research is embedded within the science projects, however one which was very relevant to me was e-learning and how it can be developed to deliver learning to the farming community. There is currently much emphasis within tertiary education within Scotland, due to the diverse geographical spread and a willingness to allow access for all to develop and offer qualifications by e learning. This project within New Zealand is taking this e learning delivery to another level - the more practical workshop type training required by farmers.
Their project aims were:

1. An investigation of the viability and feasibility of using eLearning as a learning approach for members of the agricultural community;
2. An opportunity to determine whether it was possible to successfully translate an interactive, participatory, face-to-face workshop format into a distance format based on video-conferencing supported by other technologies; and
3. An investigation of the use of different technologies to support and enrich the video-conferencing learning sessions.

This small-scale exploratory study demonstrated that it was possible to deliver an eLearning programme which truly reflects the adult learning principles of participatory, interactive, small group learning based on goals and expectations that are both important to and set by the learners. It also demonstrated that eLearning based on video-conferencing supported by other technologies, can successfully deliver a learning programme that caters directly for farmer learning style preferences. The trial demonstrated that it is possible to successfully translate the hands-on content of face-to-face workshops into distance formats using such technologies as document cameras, video cameras and digital cameras. This project is ongoing to further develop the methodology in a wider range of training areas.

One area that was worked on in the small scale study was the budgeting and management of grass. The use of a video camera on a few host farms over a period of time to produce a video diary allowed for all participants to be able to view pastures and discuss issues in a workshop format, perhaps arguably better than on farm at one snap shot of time. It required video conference facilities on 3 or 4 sites over a region and rooms with circular table layout of small discussion groups. The

facilitator on one site had assistance from suitable consultant colleagues at each site to enable good break-out discussion times.

The use of video conference is crucial to the delivery model of UHI (University of the Highland and Islands) in Scotland and indeed used within SRUC multi campus site delivery with some negative feedback from both staff and students who are involved. The work by AgResearch if further developed could be so worthwhile within Scotland and UK for knowledge exchange at the farm level where farmer's time and geographical spread of expertise is often the prevention of it.

5.0 Commercial Grass and Forage Plant Breeding

With a background in plant breeding myself I was very interested to get the opportunity to visit NZ largest agricultural company, PGG Wrightson Seeds (PGGWS) who have a strong focus on research and work collaboratively with DairyNZ, Universities and AgResearch. I met with Dr Alan Stewart, Chief Scientific Officer for PGGWS. PGGWS have approx. 60% of the forage market in NZ. The company's vision is to provide science based innovation with their collaborative working central to the science. There is no regulation of sales of crop cultivars in NZ unlike the EU and therefore free market with companies competing for market sales to farmers with price. Cultivars are marketed to farmers not mixtures which again is very different to that within the UK.

Forage grass breeding concentrates on diploid Perennial Ryegrass and to a lesser extent Timothy and Cocksfoot. Perennial ryegrass objectives are for high yielding, cultivars with excellent (95% +) endophyte transmission between generations. High sugar types (HSG) have not always shown improved animal performance unlike in UK trials, which is likely due to higher sunshine levels in NZ provide much greater sugar levels in all grass cultivars and so the increase of HSG is not as obvious. A competitor has introduced these cultivars so trials and marketing are looking at the benefits. PGGWS uses the grazing animal within their breeding programmes to ensure productivity and profitability are the end point. There are multidisciplinary teams involving ruminant nutritionists, plant physiologists, microbiologists and plant breeders.

Nitrogen use efficiency is also an objective where by cultivars with deeper rooting may allow for better use of nitrogen within the soil. Nitrogen usage within NZ dairying is high at an average of 300 kg/ha. Clover is still being bred with cultivars which can be more competitive under higher fertiliser rates, however insect attack has caused a widespread loss of white clover in NZ. To this end work with biotech research and markers has allowed tannin production pathway from other legumes to be inserted into white clover to allow higher tannins within the seed and allows for protection against pests. It is believed that the future need for Nitrogen leaching reduction by dairy farming will result in resurgence for the use of white clover in swards in NZ, which is not unlike the trend in the UK due to the rise in cost of fertiliser rather than the environmental influence.

Forage brassica, chicory and plantain are used throughout NZ to enhance nutritive value and also provide winter forage when grass growth slows dramatically. PGGWS through mutation breeding have produced kale cultivars resistant to herbicides. Plantain germplasm is being evaluated and has shown great variation in winter dormant types. Fig 5 shows evaluation rows of plantain with varying growth during the winter

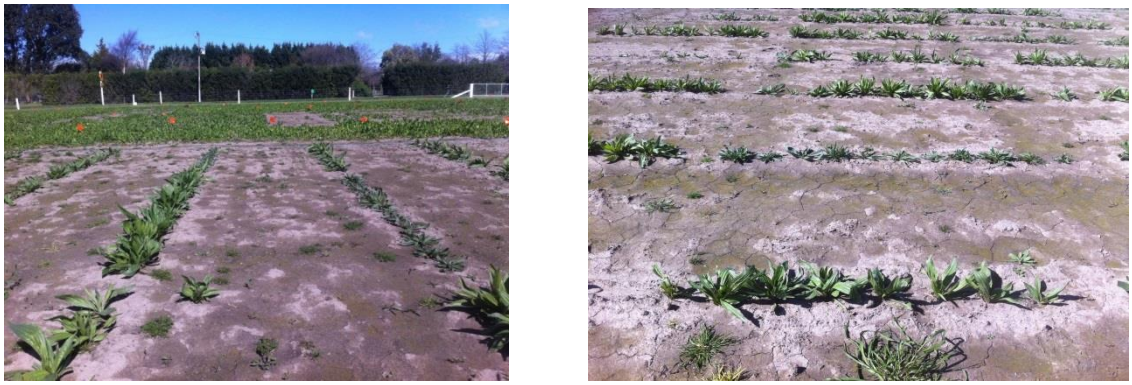

Fig 6: Plantain germplasm evaluation rows

The NZ white clover, plantain and grass cultivars do migrate to the european continent through collaboration with european plant breeders and agents, however the main emphasis for PGGWS is their home market, Australia, Uraquay, Brazil and

China. Southern England, Spain and France with a similar climate to that in NZ therefore allows some genetic material to be transferable. Endophyte requirement within NZ and the hotter meditteranean climates, not essential within the UK does mean some NZ material does not reach its full potential within the UK climatic conditions.

There appears to be excellent collaboration between the commercial plant breeders, government researchers, Universities and the farmer through DairyNZ. There has been a commitment to get the independent Forage Value Index (FVI) developed in order to start to give advise/guidance to farmers since regulation of cultivar selling is non existant. PGGWS are fully committed to enhancing NZ agriculture through improvment of forage but realise it is only possibly though working with the vast knowledge, resource and science based Agreseach. This is a good example of the industry working together while still relaising its own commercial objectives and vision.

6.0 Dairy NZ Consultancy

240 staff covering research, development and extension officers on production, marketing, policy and environment. The largest expansion has been in the South Island where there are now 40 staff with a hub based in Lincoln. I spent 2 days with Dairy NZ, one in the North Iisland based at Palmerston North and also at Lincoln. I was able to visit 2 farms, however there was a reluctance to go onto farm in September as this was Calving season and most farmers are too busy. DairyNZ have calving update meetings at this time of year which are off farm in a evening in a social setting and more informal just to keep in contact and facilitate social interaction during a very stressful period.

I was able to spend some time with an extension offcier on a young stock farm. It was very interetsing to see calf rearing at pasture outdoors using a tractor mounted bucket feeder when calves are a few weeks old. Discussions with the farmer and the extension officer indicated that farmers value on farm facilitated discussion groups where by a farm and its particular system are thoroughly reviewed. The extension officers select farms/farmers who are innovative and often trying out a product or

technique which other farmers would benefit from. Grassland consultancy is very much incorporated into all aspects of discussion groups. The farms are categorised into 5 S systems. Farmers from similar systems would be grouped together in discussion groups to get maximum benefit.

Much of DairyNZ work is at a general group level and although they do give some one to one consultancy the majority is more general with much research backed technical information exchanged to farmers through facilitated discussion. Much funded work at a farm demonstration level is carried out at Massey farms in North and Lincoln University Farm in South. Open days are held 4 times a year, themed depending on the season. The issues being investigated are all based around the ban of nitrification inhibitor, dicyandiamide (dcd), resulting in the change of management to reduce nitrogen leaching from urine patches. The future drive on grassland consultancy on farm will be influenced by the statutory requirement of reducing nitrate leaching on a farm level. The One plan devised by environmental agencies at regional levels using the Overseer model, to determine nitrate leaching targets and maintain water quality in major catchment areas, is currently being introduced to farms. DairyNZ are committed to assist farmers in making management strategy changes to significantly reduce the leaching possibilities. It is to this end that individual farm tailored consultancy will be in demand and may not be serviceable by the current DairyNZ structure. Sheds and conserved forages are being considered in order to reduce stocking rates, winter grazing and therefore nitrate leaching. This seems ironic when we consider NZ to be the champions of grazed grass! Perhaps the UK can offer consultant exchange program with expertise in systems to the benefit of both countries.

One observation is the business acumen of the farmers and consultants, which isn't an attempt to be insulting to the UK. The NZ farmer is very aware of every aspect on a profit level with no sentiment for a historical system. Change is not an obstacle if it has a positive effect on profit. The share farming structure also promotes profitability whereby young enthusiastic entrants are very focused at increasing profit of the whole farm as they gain the potential to ecru assets for themselves. This has proved very influential in moving the industry forward and in the fast expansion of dairying in NZ.

The future and current times are forcing change at an environmental level which the challenge for DairyNZ is to retain farm profit while changing the system to address statutory needs. To this end it is crucial for demonstration farms at the Universities.

Overall the main consultants with the dairy industry comes across as very well focused, influential, but very much integrated with researchers, educational institutes and farmers. DairyNZ appear very well structured, resourced, managed and respected which has brought the whole industry together very successfully. This has been the result of hard work but also open attitudes of all parties within the industry.

7.0 22ND International Grassland Congress, Sydney September 2013

Revitalising grassland to sustain our communities.

“The International Grassland Congress promotes interchange of information on all aspects of natural and cultivated grasslands and forage crops for the benefit of mankind, including sustained development, food production and the maintenance of biodiversity. It is the major international forum for scientists involved in grassland and livestock R&D and for people managing one of the world’s largest natural resources.”

Grasslands occupy 54% of the world’s ice free land area. They are the dominant ecosystem of many countries providing biomass for grazing as well as biodiversity. It could be stated that humankind depends on understanding, managing and sustaining grasslands in both developed and developing countries. However despite this grasslands are often poorly recognised by Governments and results in a reduction of support in the grassland research,

Delegates from all over the world, with only 6 from the UK met over 4 days to discuss wide aspects of grassland: There were 3 main themes with many subsections within. The main themes were:

- Theme 1 Improving production efficiency: forage improvement, livestock production and quality improvement, managing seasonality of grassland quality and quantity.
- Theme 2 Improving grassland environment and resources: ecology of grassland, plant-animal interactions, climate change impacts, management of nitrogen and other nutrients and biodiversity and conservation of grasslands.
- Theme 3 Grassland People, policies and processes: drivers for change, policy issues, tools to aid uptake of technology and innovated methods in grassland research and education.

I attended a wide range of lectures and spoke with lots of people from different parts of the world. I was reminded of much and learnt more. The diversity of grassland and the proportion of rangelands and extensive grassland reminds me of the relatively insignificance of UK temperate intensive pasture when considering grass on a worldwide platform!

The plenary sessions saw a number of prominent speakers renowned for their area of specialism. I have chosen a few to report on here which I found particularly engaging.

1. Feeding the world in 2050: trade offs, synergies, and tough choices for the livestock sector- Dr Jimmy Smith, Director General, International Livestock Research Institute, Kenya.

The emphasis has shifted for food production to feed the world, this no longer is sufficient and now we need to feed the rapid expansion with food produced sustainably taking into account social and economical aspects. Countries which are the poorest and hungriest are also those with least agricultural investment. Government play a major role in supporting the development of farming communities and in particular women through investment in large scale public goods. Small scale producers fundamentally produce in very different ways to the intensive large scale producer. While the intensive producer use cereals and food sources useful for human consumption the smallholder uses forage and wastes not suitable for humans on land less likely to produce alternative crops other than grass. Developing countries produce 50% of world's beef, 41% of the milk and 72% of lamb. For livestock based on grazing some 7% of milk and 37% of global beef and lamb is from such systems Strong growth in the smallholders and rangelands of the world are best position to produce within sustainable intensification and would not always conflict with the consumption of food for humans.

Livestock production and its connection with greenhouse gas emissions cannot be ignored. Poor efficiencies within the milk in Africa shows twice the gas emission per kg milk compared to the world average and a four fold increase over the intensified US systems. This would suggest increasing efficiencies within sustainable

intensification of the smallholders will have much to add to the mitigation potential and carbon off sets of agriculture. Carbon sequestration through rangelands grazing has great potential but equally need much research on these more fragile habitats.

Livestock undoubtedly has a significant contribution to make to the challenge of feeding the world in 2050. The complexities of this sector and great variation of the systems worldwide is a challenge in its own to retain production while considering environmental, economical, social and political influences.

2. Does intensification of grassland and forage use lead to efficient, profitable and sustainable ecosystems. Oene Oenema *et al* Wageningen University,

Case studies form Netherlands, Chile and New Zealand show intensification to increase the output per unit area and labour showing globally the outcome is the same with winners achieving high return on investment.

The relationship between intensification and environmental impact is complex. Intensification leads to increased emissions per unit surface area, but to decreased emissions when expressed per unit of produce. Intensification may lead to sustainable grasslands through their efficiency and profitability.

3. New fronteirs and perspectives in grassland technology, Jurgen Schellberg

Grassland scientists and farmers are increasingly faced with emerging new technologies and in-formation systems developed by scientist to include among others, precision agriculture, remote sensing and biotechnology. Compared to new technologies applied to arable land, that on grassland has been only partial and with delay.

Remote sensing (RS)

Conventional methodology of identification of type and state of grassland vegetation through sampling, analyses and visual assessment can in principle be replaced by application of RS technology, either satellite based or at close range near the object. However, RS technology is still limited by method deficiencies (*e.g*. spatial versus radiometric resolution, cloud cover and number of observations available).

Precision Agriculture

Many application processes are monitored spatially according to site specific information in order to minimise input using natural resources while sustaining optimal yield. Much success within the arable sector has not immediately been transferred to the pasture management. The complexity of animal interactions together with the problem of yield estimation may partially be to blame.

Yield estimation is likely to be solved with the rapid pasture meter (Farmworks ®, http://www.farmworkssystems.co.nz). Readings of an optical sensor are converted into dry mass per unit area via regression equations derived from calibration. The readings are transmitted via Bluetooth to an on-board data analyser which creates digital maps of dry mass of the paddock. This system has been developed to support grazing management based on the temporal change of the amount of residual biomass.

Modelling

N cycling models have been developed to integrate forage intake, excretion, volatilization, atmospheric deposition and leaching. However, the complexity of the dairy production system with its biotic and abiotic elements, such as animals, grassland, crops, soil and climate influencing each other in space and time, is not well understood.

Models developed are further enhanced using expert knowledge and converted into Decision support systems (DSS). These complex tools collect and analyse data to support decision making and the development of strategies. One example of a successful DSS is NGAUGE which simulates the flow of N on farms and works out recommendations for policy makers and researchers by taking into account optimization procedures that reduce environmental impact while maximizing N use efficiency

The success in the uptake of technology onto farms is through investment in time by not only the end user, the farmer but also researchers, advisors and educators. The pay off is long term and much effort is needed to transfer the knowledge and encourage the uptake. Systems which are low input and focused on optimising grass based system are among those who show a drive to use technology to a

greater extent in order to achieve their returns, e.g. New Zealand, Ireland and Switzerland.

There were many papers delivered by auditorium and poster covering a wide variety of subjects within the themes of the conference. A small selection to follow indicates the range selected for their relevance to temperate pasture based systems.

Assessing resilience of pasture production to climate change: Brendan Cullen *et al* (University of Melbourne)

Their results for SE regions of Australia showed in cooler climates the rise of temperature will reduce the low temperature limitation to growth and production. It also showed that in C3/C4 mix of species it will increase the C4 proportion in the Mediterranean/Western climates. At all climate zones reduction in rainfall will reduce production. The model shows how increments of temperature and rainfall change affect the pasture system and its resilience to future climate change.

Impacts of climate change on livestock systems: What we know and what we don't know: M Howden *et al* CSIRO Canberra.

Grassland based livestock systems cover climates of the world from the hottest to the coolest, wettest to the driest and low to high altitudes which are more extreme than any other agricultural system. For this reason the complexity of climate change and possibilities too numerous to review in detail. A general approach is considered

The main changes of temperature increase with greater frequency of temperature extremes. Rainfall seasonality and intensity with increasing average rainfall in cool temperate regions and lower in sub tropical. Solar radiation will increase as climates become drier and reduce under wetter climates. These changes are likely to cause heat stress of livestock increasing water requirements reducing productivity in some climates. Pasture production could rise in cooler climates through temperature increase however under the hotter climates this could lead to lower quality through

desiccation. CO_2 increase in regions with moderate rainfall (500-1000mm/yr) could enhance production.

There will be issues with soil degradation (erosion and salinity') and spread of livestock disease. Careful management of grazing will be essential to maintain preferred plant species and these management practices may need adjusting in accordance with the climate change. Grass breeding may improve quality through higher non structural carbohydrate and those which are adapted better to raised temperature and CO_2.

The short term adaptions, over the next 20 years will probably require operational modifications such as hardier livestock breeds, feed supplements during drought and legumes to improve digestibility etc. which are within the normal management parameters. Over the longer term, 20-100 years government intervention may be needed to encourage adoption of management. Most importantly any policies should be flexible and promote independence not one-size-fits-all approach!

Efficient beef production from temperate grasslands in North- Western Europe: Edward O'Riordan *et al* Teagasc, Ireland

Five main dairy calf to beef systems within Ireland were described and compared; Early maturing beef sire at 24 month finishing, Late maturing beef sires at either 24 or 21 month finishing, Holstein/Friesian sire finishing over 24 months and an intensive 24month finish with Late maturing sires. Carcass output kg/ha ranged from 580-750 (Holstein-Friesian least and 21 month Late maturing greatest) compared to the 1000 kg carcass output of the intensive late maturing system where by the stocking rate was nearly twice that of the extensive systems. Well managed pasture based extensive systems can produce excellent output while remaining within European Union Nitrate Directive.

Do different breeds of dairy cow differ in their ability to digest perennial ryegrass? Marion Beecher *et al* Teagasc, Ireland:

Jerseys have been shown to produce more milk solids per kg bodyweight compared to Holstein Friesian however this study tried to determine if Jerseys , Holsteins and crossbreds of Jersey x Holsteins differ in their ability to digest grass. Their studies showed Jerseys significantly has higher digestibility of grass. This was potentially explained because of the greater rate and number of mastications which would have reduced the particle size and hence digestion improved.

Cultivar influences milk production of grazing dairy cows. Mary McEvoy *et al* Teagasc, Ireland:

This paper tries to address the effect cultivars have on milk production properties rather than the cutting system under which they are trialled by government testing. Two tetraploid and two diploids were grazed in spring and summer with cows blocked and randomised over the plots. All cos were offered 17Kg DM/day > 4cm. Results showed that milk yield (kg/day) and milk solids (g/Kg) were 5% and 6% respectively greater for tetraploids compared to the diploid cultivars. This difference was thought to be due to the greater leaf and lower stem content of the tetraploid swards compared to the diploids of this study. It concludes that choosing cultivars can assist in making grass based systems more profitable.

Grassland Management- The PROGRAZE approach. RP Grahame et al, Dept Primary Industries, NSW Australia.

Prograze workshop and training course was introduced to farmers in 1990s. The idea was to increase the skills and knowledge of the grassland farmer in a wide range of grass and livestock principles. The package was delivered via groups of around 15 farmers and had a structured approach together with a flexibility to consider existing experience etc. Assessment and learning was encouraged through on farm action to solve problems. This programme of education and knowledge

transfer was evaluated in many ways and was found to generally have improved knowledge and understanding which built confidence among farmers to be able to help solve the continual challenges within grass based livestock systems. PROGRAZE PLUS was introduced in 1998 to address on farm budgeting and allow farmers to be able to determine fed deficits and surplus ahead of real time. Further programme to help farmers deal with drought decisions called STOCKPLAN was developed and launched in 2007. These decision support systems allow farmers to solve problems.

All three of the programmes on offer, PROGRAZE, PROGRAZE PLUS and STOCKPLAN all use the same principle of increasing skills and knowledge to allow farmers to solve issues and build confidence in grass. These programmes are now being launched through e-learning reducing the need for personal contact and therefore opening up a much wider participation rate.

Will intergenerational succession and our current educational systems be sufficient to provide the next generation of farmers and researchers? Brian Revell, Harper Adams University, UK

Worldwide it would seem the age profile of people working in farming has deteriorated since 2000. The proportion of those over 55 rising while those under 35 have declined. The average age of the farmer in the UK is now 59, USA 57 and Australia 53. There is a tendency for farmers to work on past the traditional retirement age and family farms become a ‘way of life’. Succession and recruitment of young entrants is crucial to be able to meet the global challenge of feeding the world. Farms have become fewer but larger and more technologically advanced which may have led to a decline in the number of farmers. The younger farmer is more likely to be innovative with greater technological advancement for farm efficiency.

Intergenerational succession of family farms is the main route into the profession particularly in the UK but also in the EU, Canada and New Zealand. Family farms

attract approx. 35-50% of UK agricultural graduates. Graduate numbers have increased in the UK since 2008 however a trend not replicated in Australia, Canada or New Zealand until an increase in 2013.

We need to engage with the next generation in order to sustain our agricultural industry. In order to do this we need to engage with the schoolchildren, connect and better inform the school teachers and careers advisors. Graduate employment is highest for agriculture with rates of around 95% in the UK. The agriculture industry needs to catch up with other sectors in providing a structure, competitive salaries and benefits to attract young graduates.

Creating an International Forage and Grasslands Curriculum. Brianna Randow *et al*

A national forage curriculum has been developed by Oregon State University. This project is being widened to incorporate partners from Asia and China. The project will produce on line materials for 22 modules ranging from Grassland of the world, Legumes, Plant identification, Breeding forages, Weed control, Grazing, Environmental issues and Economics. All modules would have both teacher and student materials and assessments. It would allow for a comprehensive information source to raise awareness of the world's greatest resource.

Overall the conference was an excellent showcase for the grassland research throughout the world. There was some disappointment at the limited contribution from the temperate Western European area however a sign that research funding is unable to fund attendance at what was an expensive conference. It was eye opening to see the vast array of research from China and Africa. An interesting case study was delivered as a plenary paper by Professor Yang from China Agricultural University, Beijing which reviewed the drivers of change for grassland and forage systems. In China 90% of the grassland is degraded through overstocking, damage by insects and industrial development. Grazing intensity is thought to be the major cause and the prediction that this intensity is likely to increase by 50% globally then better grazing management is crucial to reduce further degradation. Grassland area

is reducing in China by 1.5 million ha per year with soil erosion, overstocking and expansion of urban areas. Government spending on ecological restoration and productivity of grassland has increased dramatically. A national grassland monitoring project which introduced grazing bans, rest and rotational grazing management through subsidising their farmers has proved to be the successful driver. The grassland in China belongs to the public with livestock being owned privately and up until the 1990s land was used freely by herds to graze without restriction. A contracted to household scheme was introduced in the 1990s which would allocate blocks of land to a household for 30 years. Some 80% of the grassland in China is now contracted to households. This alone has changed the attitude and control of grass management. This policy alone has been significant in the protection, change and improvement within the grasslands of China. Economics has also been a huge driver. The demand is increasing for livestock products due to the 37 % increase in population between 1980 and 2010. China is a net importer of dairy, beef and mutton therefore there are opportunities for increased domestic production which are likely to be met though increased efficiency of grassland systems. Beef and sheep productivity by herdsmen has increased significantly while the dairy production form grassland is less well developed. Social issues would be driver number 3 with the Chinese herdsmen realising wealth to be more monetary rather than related to livestock numbers. This in itself has revolutionised the goal for grassland farming. Food safety and quality has also created a demand for the beef and mutton form the 'green' grassland zone and as a result the price of this premium product tripled between 2001 and 2011. Both these social drivers have resulted in a great surge of development within grazing systems for livestock production.

Technology improvement is a strong driver throughout the world with China being no different. Remote sensing has been used in 1990s to map all grasslands and develop a classification system with 18 types. The continued use of GIS and GPS together with the grassland map has allowed monitoring and management of the grassland systems. The increasing resolution of satellites in later years has allowed for quite precise monitoring for biodiversity and precision management. Other technologies within plant breeding are improving forages for production and tolerance to environmental constraints. Irrigation technology, cultivation and harvesting machinery, new pesticides and forage additives and use of Infrared

technology to evaluate hay to measure Crude protein and an overall feed value are all examples of how technology is being improved and used within the grass based systems in China.

The final driver is environmental which has had a great influence throughout the world currently and thought to be even more important in the future. Grasslands in China are mainly located in the colder, dry regions which make them very vulnerable to increasing temperature and drought due to climate change. The need for carbon sequestration and the importance of grassland is a hot topic of research currently.

They conclude that although Policy and economical drivers are the most important within China to change grassland and forage systems the drivers of social, environmental and technical all play a role in the continued evolution and modification of the systems.

8.0 Post Congress Tour of NSW

I am indebted to the South West of Scotland Grassland Society who contributed to my finances and allowed me to participate in one of the post congress study tours – 'A taste of the NSW Southern Tablelands'. This 2 day tour took in University of Sydney Dairy research, a commercial dairy farm in Sydney's suburbs, a wool and meat producer, a grain and graze revolution farm and CSIRO alternative legume knowledge exchange project. This was a really enjoyable part of the conference experience which not only allowed me to see in practice a small part of the Australian farming systems and view the rural surroundings, but also to gain more valuable discussion and interaction with a relatively small group (35) of a mixture of researchers from Africa, China, Germany, USA together with 2 farmers from the UK!

The first farm we visited was Leppington Pastoral Company (LPC) situated at Bringelly on the suburbs of Sydney. LPC milk 2000 Holstein/Friesian cows producing on average 11000l per lactation on three times a day milking and providing approx. 7% of Sydney's drinking milk. The cows are housed all year round

on free stalls with climate control using fans and sprays when temperatures over 21^{o}c are reached. Exercise lots are available adjacent to the sheds and cows have access during dry weather. Dry cows get out to graze pasture. The farmed area is one with relatively high rainfall (750mm/annum) however to ensure maximum production of grass irrigation is also available. The farm grows all their grass silage, maize silage, barley, wheat and Lucerne over a total of 2500ha. Other feeds such as cotton seed, brewers grains, bread waste are purchased. Milk is marketed as A2 type which is a specific casein protein within the milk which has been shown to cause less allergies. 60% of the cows are the a2 genotype and by using bulls with a2 gene they are increasing their homogeneous a2 status in the herd.

Fig 7. LPC housing and exercise area and University of Sydney Dairy Unit grazing

University of Sydney's dairy farm near by is a contrast with 75ha grazing platform for 350 Holstein cows. The farm had just recently completed an industry-funded FutureDairy 2 project. The emphasis on the system was to maximise milk from grass and forages with minimal purchased feeds. Fig 6 shows the dairy feeding systems operating within Australia. Future Dairy project was covering the largest sector within dairy systems of Australia. 100 cows using 21ha (65% *Pennisetum clandestinum* or kikuyu pasture oversown annually with ryegrass and 35% other forage crops to complement the soil and the animal e.g. peas, oats, maize) and purchasing over 1t grain based concentrates/cow/yr on all year round calving. Over

26tDM/ha was utilised from whole systems. The kikuyu is a tropical grass with extremely high growth rates of up 200kgdm/ha/day in summer and autumn, however it must be kept tightly grazed otherwise the quality can be very poor. It is also susceptible to winter kill and it is for this reason that the annual ryegrass is oversown to maintain high quality and carry the pasture through the winter grazing. The use of home grown forages and feed with approx. 1t concentrate per head has allowed 28,000l/ha to be produced. This is a 25% increase in milk yield coupled with a 35% reduction in concentrate feed compared to the national average.

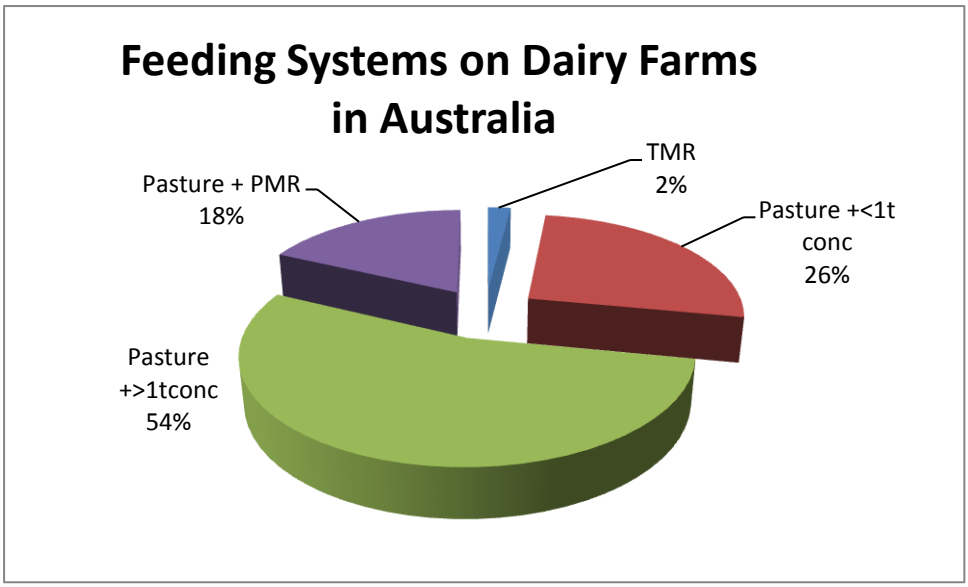

Fig 8, Dairy Systems operating in Australia

Other projects ongoing within the Dairy Science group at Sydney include technology use to reduce dependence on labour and allow greater time for farm management. Most Australian farms struggle to attract good stockmen and as a result farmers spend time on labour intensive tasks involved with milking. Researchers are currently planning to join with DeLaval to introduce a robotic rotary, of which there are only 5 operating in the world(3 Sweden, 1 Germany and 1 Tasmania). They are also looking at robot herdsman who can also carry out pasture recording and cow observations for heat detection! These are just prototypes currently and likely to be 3-4 years to commercialisation. Other technology being explored is electronic chips

which can detect rumination, calving, grazing times etc. and send a text to alert the farmer.

This was an interesting visit to see and hear about the challenges of Dairy farming and pasture management together with the forward thinking problem solving of low labour availability and time saving technology.

A visit to Evandale estate showed the difficulties of sheep production in this area for both meat and wool. Evandale is owned by a Sydney based businessman with a farm manager left on site to run the 600ha carrying 600 Merino cross ewes and 100 Angus cows crossed to Simmental Bull. Pastures are perennial comprising Cocksfoot (*Dactylis glomerata*), *Phalaris* sp and subterranean clover (*Trifolium subterraneum*). Approx. 40ha of other forage is planted to supplement spring grazing for freshly calved cows or lambing ewes. This could be Italian ryegrass or triticale.

Fig 9. A Merino ewe with her merinoxwhite suffolk lamb

The main problem faced at this farm, like many farms in NSW territory of Australia is the invasion of the weed grass, serrated tussock (*Nassella trichotoma*). This weed grass is highly adapted to droughted low fertile soils in coller climate and very prolific seed producer spreading far and wide by wind. The grass has poor feed value and

unpalatible to stock. Its control is made difficult as native species are susceptible to the chemical needed to irradicate the serrated tussock grass. Spot spraying to hep minimise its spread is time consuming, with Evandale stating 3 days per week and approximately £30000 annually for costs of sray and labour. Evandale has introduced a rotation of forage crops in order to allow those pastures with excessive serrated tussock to be blanket sprayed and cultivated to reduce the seed bank. Much work has been undertaken by Department of Primary Industries to help understand the effects of this grass and mechanisms to control it.

Fig 10. Serrated tussock grass (*Nassella trichotoma*) intrusion in a native pasture

The farm has also an issue with succession. The owner is looking to sell the estate however is keen to see it retained in active farming. Mining is a competitive industry for land in the southern tablelands in NSW and this has caused a socioeconomic issue within the area where lucrative mining companies out bid agricultural investors.

Tirranna was a fine wool Merino sheep and Devon cattle farm until about 10 years ago when he looked to incorporate other enterprises. He has now introduced arable

crop for ‘grain and graze’ or dual purpose crops. Prime lamb and beef together with wheat and canola are produced. This farm was used as a technology transfer experimental farm with CSIRO to help develop this system for southern Australia. In order to allow the wheat to be suitable for both grazing and grain it is sown 3 months earlier in March and allow grazing when suitable root formation to prevent sod pulling, which equates to 1.5tdm/ha. The animals need to be off the crop by GS31 (1st node appearing) to have no effect on grain yield. Canola double zero varieties are also grown as a break crop to wheat and sheep grazing. These crops have allowed 1700 extra sheep grazing days with winter wheat and 1560 with Canola. While the arable crops are grazing it allows for the accumulation of pasture which then allows for overall 30-40% extra sheep grazing than when pasture only was grown. The delay in the crop which would usually be too forward if sown in March means the late frosts don’t cause flower damage.

This development of grain and graze has revolutionised the traditional sheep and beef farm and has had a major effect on the profitability of the farm. They have invested in grain driers to allow for wetter harvests. A share farmer has allowed for arable expertise to be acquired without the need for the owner to invest in machines and skills. This farmer was very business driven and innovative which has turned the farm into a very profitable business.

The final visit was to the CSIRO and NSW DPI alternative legume experiments and the use of Phosphorus to manage soil fertility.

Soils in Australia are mostly deficient in P. The rock reserves to produce such fertilisers are a finite resource and equally have risen, doubling over the decade. This has a huge effect on farm profitability. There is a need to review ways to use Phosphate fertilisers more efficiently and still retain the productivity from pastures. The results of experiments at a farm level have shown the stock carry capacity is influenced directly with the soil P level to a critical point and thereafter there is little to no effect. It is therefore crucial for farms to be soil testing in order to determine the Phosphate fertiliser application to achieve the critical point and no more or less.

Other trials also looked at alternative Phosphate containing products and their affect on native pasture growth. Three trial sites across the district and 8 commercially available products were assessed over 4 years. Herbage spring growth together with soil chemical and biological activity was tested. The results showed there were a few fertiliser products which produced as much herbage as super phosphate at a similar cost e.g. semi dry pig manure and Agriash (burnt sewage ash with liming agent).

At third element of the trials was to evaluate alternative legumes with varying Phosphate applications. Perennial legumes were: Lucerne (*Medicago sativa* L.) Birdsfoot trefoil (*Lotus corniculatus*), Tedera (*Bituminaria bituminosa*), Caucasian Clover (*Trifolium ambiguum*) and annual Legumes: Subterranean clover (*Trifolium subterraneum*), Rose clover (*Trifolium hirtum*) and Yellow serradella (*Ornithopus compressus*)

Fig 11. Alternative legume trial

These trials had been sown in 2012 and the first harvest year had shown only 2 of the annual legumes, rose clover and subterranean clover to have produced greater dry matter than the rest and responding up to P application of 50kg/ha. These trials will continue for another 2 years to gather a complete set of data to be analysed further.

9. Conclusions

The image of New Zealand is very ‘green’ from its bountiful grass, forest and mountains, wildlife and the outdoor lifestyle of many of the population. Whilst I could certainly see the association of this with lush grass grown, that’s where the comparison ends. The expansion of the dairy industry and the influence which business decisions have on farming systems has resulted in a very intensive dairy industry in water catchment areas which have had negative impacts on the water quality. The future now needs to drastically change and regional authorities are starting to implement nitrate leaching control on dairy farms. There is some resilience to the enforcement as it will result in reduced intensification and possibly on some farms on light soils requiring to house livestock during the winter. Beef and sheep farms are not under nitrate control in the near future and so for some areas a neighboring farm within the same water catchment may have no restriction on nitrate leaching. The change to individual farms systems in order to achieve the nitrate levels is thought by DairyNZ to require more one to one consultancy than they are currently able to provide. This may lead to other consultancy services operating in the dairy industry which could be detrimental to the unity and strength of current consultancy, where using forage to the maximum while achieving maximum profitability is the aim of the majority of farms.

It is timely to see that Lincoln University has recently published the results of its public perception survey on the environment. This shows that the public in New Zealand would consider that air, forest and bush parks are in good quality while water was poor and half of the respondents perceive farms as a major cause of run off and effluent causing water pollution. The greatest disparity between perception and reality was that of biodiversity. The department of conservation would see native plants and animals to be under threat. The intensification and expansion of the dairy industry has reduced plant biodiversity. The results of the public perception survey have historically been influential in shaping policy. It would suggest dairy farmers and farmers in general can only look ahead with the need to change management just perhaps as our own farmers within he UK have had to do in the last 10 years.

As much as I respect the NZ farmers in their reliance, knowledge and commitment to the use of grazed grass it is disappointing that their business decisions have not been aligned to the awareness of their environment and that the perception of green is deceiving.

The advisory activity for the dairy Industry in NZ is extremely well organised and focused with some excellent examples of levy funding being used to the true benefit of its industry. It is apparent that farmers have a great respect for the consultants as do the research bodies and educational establishments and so there is a very positive joined up structure all working together to exchange knowledge for the benefit of the dairy industry.

NZ farmers are facing challenging times ahead and some will need to change their systems to achieve statutory requirements; however I am sure that grazed grass will be retained to its optimum and hopefully the open minded attitude of NZ farmers will not be changed. This very focused industry to date may well start to get pulled in different directions as environmental factors really start to become more controlling.

10.0 Summary

It was a relatively brief and hurried study of the grassland science within education, research and consultancy, however due to the importance given to grass within their livestock systems no matter who I spoke to they had a connection and involvement with grass. I did manage to get a very good review of a wide range of areas and over all would very much say I fulfilled the following objectives to various degrees.

- To increase my technical expertise in grassland science

The attendance at the International Grassland Conference allowed me to update and refresh my knowledge and understanding of grassland research on a worldwide basis.
I have already shared some of these findings with my students groups and colleagues within SRUC.

- Investigate techniques to exchange knowledge and advice on farm within intensive grass based systems used in NZ.

Knowledge exchange of grassland science starts within the university whereby grassland modules are delivered at all years. The university connection with knowledge exchange is continued with demonstration farms. DairyNZ also fund farm research and hold discussion groups. Unfortunately due to the calving period there was little farm contact or activities during the few days I was there. I did get onto a few farms but would have liked to have had a few more on farm visits and perhaps have participated in the discussion groups. It was very apparent any farmers I did have contact with they were very knowledgeable of grass management and also very interested in grass. It was perhaps the attitude of the farmer which was amazing. They appear very receptive to knowledge exchange and keen to make changes in an attempt to be more efficient and profitable. There is great respect for DairyNZ from the farming community and they seem to have a nationwide monopoly

on knowledge exchange. Consultancy is becoming more one to one and environmental specific so the future may be different.
In Australia again the Government funding within regions has been well supported in the past with many knowledge exchange/advisor positions. The trend currently as in most countries is a reduction in public funding. Industry levy funding remains strong and focuses research to farm level knowledge exchange or demonstration.

- Develop links with Universities which may allow SRUC agricultural students to participate in studies overseas during their degree.

I made excellent contacts with both Massey and Lincoln Universities and can see the great opportunity and experience it would be for our students to get a semester of studies and some work experience in NZ during their degree with SRUC and equally for NZ students to spend some time in Scotland. This needs to be pursued further through the University of Glasgow in order to get approval for credit from other institutes.