Session 16: Pastures I

Chair: Derryn Harris

Pasture plant breeding in South Africa: lessons from the past and future needs

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Pasture breeding in South Africa dates back to 1910 with the first research stations being established in South Africa specifically for the purpose of pasture breeding. The specific objectives for grass breeding were however only defined at a meeting in April 1959. From there on substantial programmes were developed especially at Cedara and Roodeplaat. Various tropical, sub-tropical and temperate species were worked on. Later, in 1992, the pasture breeding function was transferred to the ARC. The main species in that programme were at Roodeplaat *Medicago sativa, Vigna unguiculata* and *Digitaria eriantha* while at Cedara work was done on *Lolium multiflorum, Lolium perenne, Festuca arundinacea, Secale cereale, Raphanus sativus, Eragrostis tef* and *Trifolium repens*. For each of the species there was a specific set of improvement objectives. For the *L. multiflorum* for instance the initial work focused on seasonal yield improvement and developing varieties that are of the type Westerwolds and Italian as well as genetic mixtures. The flowering behaviour and the seasonal yield are linked. The yield increases that were achieved were significant. Later that programme expanded substantially to improve forage quality in terms of dry matter content and total non-structural carbohydrate content. This proved to be a very successful objective which resulted in increased animal production from these varieties. The next step was to combine the high forage quality characteristics with an extended growth duration to develop Italian ryegrass that would be able to compete with perennial ryegrass in terms of summer production. The *E. tef* programme resulted in changing the use of teff as a commodity to that of an improved seed and expanded the use of teff from improved hay pastures with a better leaf-to-stem ratio in the new varieties to also being used for grazing. The *F. arundinacea* programme had the objective of producing varieties with a lower leaf tensile strength (softer leaves) than the varieties that were available at that stage and to retain good persistence at the same time. Currently pasture breeding in South Africa is taking place only on a very limited scale due to lack of capacity. It is not a healthy situation for the future to have to rely on imported germplasm only. The value of locally adapted varieties should not be underestimated. It is important to combine local climatic and soil requirements with local farming system requirements in developing varieties. Together with pasture breeding comes the need for a strong capacity of variety evaluation trials in all the different climatic zones where these varieties are to be used to determine adaptability. Again this capacity has severely diminished.

Keywords: ryegrass, total non-structural carbohydrates, teff, rye, fodder radish, tall fescue

Illustration 8: Hygrotech

Could 'mosaic' irrigation and strategic feeding be a better economic option than broad-scale pasture or infrastructure development for livestock production in semi-arid environments? A case study from northern Australia

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The beef industry dominates the northern Australian rangelands, but is in poor financial shape and few enterprises generate positive returns. Most fail to achieve productivity gains required to offset an ongoing cost-price squeeze (~2% pa). A major limit to productivity is the lack of high quality forages at critical times. Despite longstanding research to intensify production systems, the development of improved pastures, including irrigated pastures, remains limited compared to other major options (e.g. genetics, supplements, and infrastructure). There is a resurgent interest in tapping the high annual rainfall runoff, extensive land area and proximity to Asian markets for irrigation development. However, beyond a few large scale developments (e.g. Ord River, Douglas-Daly, Mitchell and lower Burdekin), there has been little development of irrigation for integrating sown forages into extensive beef production systems. There is scope for sufficient irrigation water to exploit 60 000 − 120 000 ha of rangeland which represents a 200-400% increase over the present irrigated area (NALWT 2009). Mosaic irrigation, small scale dispersed developments based on suitable soils and extraction sites, has been suggested as a technically attractive option to exploit the available water resources; especially by individual enterprises. Mosaic irrigation is largely untested and indications of economic benefits are scarce. The paper uses three regional case studies (Kimberley, Barkly Tableland, and Charters Towers) and simulation modelling to explore the scope for small scale irrigation developments to raise productivity of northern enterprises and deliver economic benefits. It also compares that scope with other options that might offer productivity gains (e.g. broad-scale sowing of legumes, fencing and stock water infrastructure). The individual case studies examine options of changing market orientation (e.g. retaining store weaners for feedlotting or live export, changing from live export to heavy slaughter bullocks) or meeting existing market specifications more quickly (reaching heavy slaughter weights 12 months earlier); identify forage options to meet the revised market criteria (e.g. irrigated cereal, grain legumes or grasses); establish an irrigation type and scale for each option; select the relevant stock classes and feeding duration, and determine the production and economic outcomes for each scenario. The assessment is conducted using the North Australian Beef Systems Analyser (MacLeod et al. 2013) for simulation periods of 20 years (1990-2010). The projected benefits from mosaic irrigation vary across regions and enterprise types and are typically higher and more reliable than for the dryland grazing baseline. However, the returns to the capital investment required for the irrigation infrastructure and pasture establishment are relatively small and generally below the threshold of acceptability (~30% return on capital outlays). Moreover, the projected returns from mosaic irrigation are similar to or lower than for broad-scale pasture development and provision of additional watering points and stock handling infrastructure.

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Keywords: North Australia, beef cattle, mosaic irrigation, sown forages, modelling, economics

The seasonal and annual dry matter production of *Festulolium* hybrids compared to *Festuca* spp. and *Lolium* spp. in the southern Cape

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The main focus within a pasture based dairy system is the production of sufficient high quality palatable fodder which can fulfil the nutritional requirements of animals. In the southern Cape of South Africa, annual and perennial ryegrass form an important part of fodder-flow program due its high palatability and nutritive value. Ryegrass shows a lower persistence in production over years compared to other species such as tall fescue. Plant breeders have bred hybrids between ryegrass (*Lolium* spp.) and Fescue (*Festuca* spp.) in an attempt to combine the high forage quality of ryegrass with the stress tolerance of Fescue. The resultant hybrids include *Festulolium pabulare* which is a cross between tall fescue (*Festuca arundinacea*) and Italian ryegrass (*Lolium multiflorum* var. *italicum*) and *Festulolium braunii* which is a cross between meadow fescue (*Festuca pratensis*) and Italian ryegrass. Both these crosses are back-crossed with their fescue or ryegrass parent species to obtain, respectively, festucoid and loloid varieties. The aim of this study was to determine the dry matter production potential of *Festuca* spp., *Lolium* spp. and *Festulolium* spp. The study was a small plot cutting trial conducted under irrigation on the Outeniqua Research Farm. The production potential of festulolium hybrids, tall fescue, meadow fescue, Italian ryegrass and perennial ryegrass cultivars was compared in terms of total seasonal and annual dry matter (DM) production over a three year period. Treatments were cut to a height of 50 mm approximately every 28 days or when the majority of treatments were ready for harvest to determine DM production and growth rate.

Table 1. The mean total annual dry matter production (t DM ha^{-1}) of *Festuca* spp., *Lolium* spp. and *Festulolium* hybrids (LSD at p≤.05 compares within column. Means with no superscript did not differ significantly).

Species	Year 1	Year 2	Year 3
Tall fescue	14.7^{bc}	13.3^{a}	9.76^{a}
Meadow fescue	13.6^{c}	9.84^{bc}	7.54^{b}
Festulolium pabulare festucoid	13.7^{c}	11.9^{ab}	9.11^{a}
Festulolium pabulare loloid	14.4^{bc}	9.92^{bc}	-
Festulolium braunii loloid	15.3^{ab}	10.1^{bc}	7.82^{b}
Perennial ryegrass	16.2^{a}	9.58^{c}	7.21^{b}
Italian ryegrass	16.0^{a}	10.7^{bc}	-
LSD (p≤.05)	1.057	2.234	1.267

Italian and perennial ryegrass had a similar total annual production to *Festulolium braunii* loloid, but higher than the rest in year 1. Tall fescue and *Festulolium pabulare* festucoid had maintained the highest and similar to the highest total annual DM production from year 2 to year 3. *Festulolium pabulare* loloid and Italian ryegrass did not persist in to a third year of production. If the aim, within a fodder flow programme, is annual seasonal production specifically focused on winter production, Italian ryegrass or perennial is the recommended selection. If the species is to be included as part of a perennial pasture system, Tall Fescue and *Festulolium pabulare* festucoid is recommended based on production and persistence.

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Keywords: tall fescue, ryegrass, growth rate, pasture

Methane yield from pregnant heifers grazing natural veld and forage sorghum as measured with a Laser Methane Detector

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Agriculture is responsible for 5% − 10% of global methane production, of which 80% - 90% comes from livestock. Enteric methane is produced by methanogenesis or biomethanation due to anaerobic fermentation of feed in the rumen and large intestine. Different methods used to measure methane production in ruminants in the past included: Respiration calorimetry chambers, Sulfur hexafluoride (SF6) tracer techniques, mass balance/micro-meteorological techniques and prediction equations based on fermentation balance or feed characteristics. The use of the recently developed, proprietary, Laser Methane Detector (LMD) to detect methane emission in dairy cows was first suggested and explored by Dr Chagunda in Scotland (Chagunda et al, 2008). Chagunda and Yan (2011) tested the level of agreement between the LMD and the indirect open-circuit respiration calorimetric chamber and found a high level of agreement between measurements of the LMD and the calorimeter chamber with a high (r=0.8) correlation coefficient. The ARC acquired a LMD and an experiment was done to measure the enteric methane emission from different breeds of pregnant heifers grazing either forage sorghum under irrigation, and natural veld (sour mixed bushveld) at the Roodeplaat experimental farm of the ARC-Animal Production Institute. Four pregnant heifers of the Bonsmara-, Brahman-, Jersey-, Nguni- and Red Poll breed were individually measured with the LMD while grazing natural sour veld and forage sorghum under irrigation respectively. The animals were adapted for 14 days on the specific grazing before the measurements were taken. Gas column density within 3 m was measured on individual animals by directing the auxiliary LMD targeting laser beam at the nostrils of the heifers. All measurements were taken late afternoon (18:00) as it proved to be difficult to see the laser beam in direct sunlight and no or very little wind is experienced this time of day. The measurements for each individual heifer were taken every 5 seconds over a period of 60 seconds to include different stages of the respiratory tidal cycle. Four 60 second repeated measurements were taken on 8 consecutive days on both natural veld and forage sorghum. Enteric methane production is reported in gram per day. As expected significantly less methane was produced when the animals were grazing on the forage sorghum under irrigation compared to the natural veld ($p<.0001$).

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Keywords: methane emission, laser methane detector, Bonsmara, Brahman, Jersey, Nguni, Red Poll, veld, sorghum

Direct anthelmintic effects of feeding *Lespedeza cuneata* hay (leaf material) on gastrointestinal parasites in sheep: *In vivo* studies

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The existence of livestock is closely bound to that of parasites. Increased concentration of livestock and grazing on monoculture forages has enhanced parasite populations to such a level that livestock production, to a large extent, has become dependent on anthelmintic chemotherapy. Increased public awareness of chemical drug residues in agricultural products, together with the increasing development of resistant strains of parasites to chemical anthelmintics, has required the search for sustainable alternative methods to complement or replace anthelmintics. Many calls are made for a more holistic management solution. Recent studies on the use of bioactive forages, especially *Lespedeza cuneata*, highlighted the potential of these to contribute towards holistic parasite control. The aim of the study was to determine the effect of *Lespedeza cuneata* leaf hay on an established gastrointestinal parasite infection in Merino sheep. Different dried herbage diets were offered to confined Merino ewes, with confirmed established gastrointestinal parasite infection, for 35 days. The leaf portion of *Lespedeza cuneata* hay and *Medicago sativa* hay was offered ad libitum to these sheep. *Lespedeza cuneata* is a tannin rich legume, while *Medicago sativa*, known for its very low condensed tannin content and zero anthelmintic properties, was used as control. Faecal egg count (FEC), Famacha©, live weight changes and rectal temperatures were monitored. The FEC of the sheep showed a significant reduction on Day 35, ($p<.05$), with FEC levels constantly lower in the *Lespedeza* group, compared to the control. Rectal temperatures tended to correlate with the FEC, but need further investigation. Famacha© scoring showed no significant ($p>.05$) differences in the data. The results from this study, despite some values that were not significant, indicated that dried *L. cuneata* leaves can reduce the GIN infestation in sheep. *L. cuneata*, therefore, can play a major role in reducing the contamination of pastures with infective larvae, thereby reducing the need for anthelmintics. The possibility of using the hay as a dewormer offers exciting possibilities to sheep farmers.*L. cuneata* has a tremendous advantage over many other plants with anthelmintic properties, because it can be used on farm by grazing animals or in hay form, since it is already established as a planted pasture with commercially available seed. With its many other agronomic advantages, including that it is relatively drought resistant, the inclusion of *L. cuneata* as bioactive forage, can play an invaluable role in a holistic GIN control programme.

Keywords: *Lespedeza cuneata*, *Medicago sativa*, anthelmintic properties, faecal egg count, rectal temperatures

Session 16: Pastures I

Impact of fertilisation on the chemical quality of cultivated pasture soil

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Cultivated pastures improve animal production systems and contribute, amongst others to food security. Initially, annual pastures were established by conventional tillage methods, but from the 1990s permanent pastures were established on a minimum-tillage regime. Lime and fertiliser guidelines, which were developed for annual pastures established by conventional tillage methods, were followed on minimum tillage systems, despite changes in the soil physical properties and stratification of biological parameters. This study aimed to survey soil fertility of irrigated minimum-till kikuyu–ryegrass pastures in the southern Cape region and compare it to virgin soil. At least 20 soil subsamples taken at three depth increments of 100 mm from the surface were collected from every replicate. Standard procedures of the Non-Affiliated Soil Analysis Work Committee were followed to conduct a full range of soil chemical analyses. The soil fertility status of cultivated kikuyu–ryegrass pasture was affected, in many instances severely. Effects of lime application were visible through the higher concentration of calcium and magnesium. Organic carbon (34 to 56 $ton.ha^{-1}$), total nitrogen (2.1 to 4.9 $ton.ha^{-1}$) and cation exchange capacity (4.0 to 13.9 $cmol.kg^{-1}$) were related to each other and was improved in cultivated pasture soil. Potassium (0.11 to 0.45 $ton.ha^{-1}$), sodium (0.04 to 0.2 $ton.ha^{-1}$), copper (0.25 to 0.41 $kg.ha^{-1}$) and manganese (9.4 to 107 $kg.ha^{-1}$) registered higher concentrations in the cultivated pasture soil than in virgin soil. Boron (0.5 to 0.7 kg ha^{-1}) was not affected. Aforementioned nutrient concentrations were regarded as satisfactory from an agricultural and environmental viewpoint. However, phosphorus and zinc were drastically increased. The P concentration was 16 to 23 times higher in the 0 − 100 mm layer of the cultivated pasture than in virgin soil and Zn concentration between 26 and 53 times higher, depending on the district. Such high concentrations could cause deleterious effects on ecosystem health or sustainability of pasture production. This could be as a consequence of irresponsible sales-driven fertiliser advice to farmers, or the continued adherence to lime and fertiliser guidelines that were originally developed for conventionally tilled pasture systems. Prevention or mitigation of loading of soil with phosphorus and zinc in topsoil should be a priority. This study stresses the importance of adhering to fertiliser guidelines that fit the tillage system.

Keywords: kikuyu, nutrient cycling, phosphorus, ryegrass, soil fertility, zinc