CHAIRS' SUMMARY PAPER: Grazing Management

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A wide diversity in both subject matter and resesarch approach was presented in the Grazing Management session. Two invited papers and 75 volunteered paper/poster offerings from 23 countries provided an impressive glimpse into the depth and breadth of grazing management research programs around the globe.

Dr. Alistair M. Nichol, a Senior Lecturer in the Animal and Veterinary Science Group at Lincoln University, NZ, gave an imaginative and informative presentation on the application of mixed grazing of diverse classes of livestock in temperate pastures. Following a review of basic principles, the following key applications were emphasized:

The overall outcome of mixed grazing, whether of similar animals (e.g. weaned lambs and dry ewes) or dissimilar animals (e.g. cattle and sheep) reflects both complementary and competitive effects.

The potential for complementarity, in which mixed grazing is able to utilize more nutritional resources than grazing by either species alone, increases as species preferences differ and as the heterogeneity of the sward increases. The combination of a browsing with a grazing animal is more likely to produce complementary resource use than combining two browsers or two grazers (see also Pinares et al. on co-grazing of alpaca with sheep). Similarly, greater diversity in sward composition in time and space provides greater opportunity for complementarity.

Design and analysis of mixed grazing studies are hampered by difficulties in evaluating or substituting animals. For example, on what basis is one to replace cattle with sheep, or weaned lambs with dry ewes to avoid confounding the effect of mixed grazing with that of stocking rate per se?

Differences in grazing strategy are not readily discernible in steady state swards. Changes in sward state must be given time to occur in to see responses to the different grazing strategies of the various classes of livestock.

The balance between competitive and complementary interaction is complex but can be affected by managerial decisions, including grazing jointly or sequentially, under continuous or rotational sward management, or changing species ratios.

Dr. Raymond Jones and his co-author Dr. R.M. Jones of the CSIRO in Australia addressed the subject of Grazing Management in the Tropics, emphasizing the pre-eminent role of stocking rate. Their findings may be summed up as follows:

Stocking rate is the overriding factor determining both individual animal and per hectare productivity as well as the sustainability of the grazing resource. The SR that provides maximum profitability will be significantly lower than the SR which produces maximum gain per ha and significantly greater than the SR which produces maximum gain per head. Maximum profitability may occur at a SR that is also environmentally sustainable. In societies where wealth is determined by animal number, target SR's may be well above the threshold where environmental degradation will occur.

The dominance of stocking rate, relative to all other managerial decisions, may be generalized over all grazing systems, although the slope of the relationship will vary with environment, forage species, management and class of livestock.

Grazing management - apart from stocking rate - is the fine tuning used to achieve specific objectives. Maintenance of key species, deferring grazing for dormant season use, or managing spatial grazing distribution may be specific objectives of a chosen stocking method.

Future trends for grazing strategies in the tropics may include management to accomplish very specific sward or animal responses. Environmental concerns will continue to increase in all parts of the world. Multiple attribute decision support models will replace simple component models as management tools.

A total of 75 volunteered paper/poster offerings provided a rich and varied complement to the two invited presentations. For the purpose of this review, contributions were divided into four categories: Genetics, Physiology/Ecology, Management/Production, and systems/Farmer Participatory, although some papers pertained to more than one category.

Genetics. Comparison of species and cultivars within species has shifted in recent years from simply reporting yield and quality to more integrative parameters. The choice of response parameters - animal performance (Cardosa et al.; Fraser et al.; Kopp et al.; Tudsri et al.), species composition/weed encroachment (Elgersma and Schlepers; Enrique and Minon), wool production (Hyder et al.), anthelminthic properties, meat flavor, and odor (Fraser et al.), and environmental responses (Clifton et al.; Pritchard et al.) - reflects a broadening awareness of the potential for grassland species and management practices to contribute to contemporary agriculture. Another novel feature was a revealing assessment of site-to-site variability in genetic responses to management practices (Avery and Graham; Thompson and Avery; Graham et al.). The potential for study of interactions was provided when genetic effects were compared at different levels of grazing management or supplemental feeding (e.g. Mislevy et al.).

Assessment and or comparison of native with sown swards was the focus of studies by Coleman et al., Kanneganti et al., and Maraschin et al. (288). Annual pastures were featured in studies by Freddi et al. on oats in Argentina, and by Mundy et al. on grazing corn in Nebraska. Perennial kikuyu-based pasture was found to support growing season sheep gains comparable to those from annual pastures, while providing off-season feed in Western Australia (Sanford et al.).

Several studies emphasized the beneficial effect of alfalfa (Kopp et al.), white clover (Harris and Clark; O'Riordan (543) Sung Seo et al.), and other legumes (Tudsri et al.) on animal performance. Kopp et al. noted that beef calves gained 11% better on alfalfa- than on grass-based pastures, but that blood urea nitrogen (BUN) levels were at the top of the normal range for cows grazing alfalfa, while those of cows grazing fertilized and unfertilized grass-based pastures were in the middle and lower end of the normal range, respectively. Elevated BUN level has been associated with depressed cow fertility in other studies.

Physiology/Ecology. Species-specific responses to grazing management, and hence, on sward composition over time, were the subject of studies by Lardner et al. on rate of leaf appearance in dryland C3 grasses and by Agnusdeil et al. on C4 grasses plus tall fescue. Maraschin et al. (286) assessed the effect of varying herbage on-offer in dwarf elephantgrass swards on canopy and root characteristics, animal performance, and sustainability. Matthes et al (1422 and 1423) reported on the use of grazing by pigs or sheep and goats to modify trends in natural succession.

Two innovative Australian contributions to this session showed that soil moisture deficit could be varied with grazing management

(Clifton et al.) and that the balance between pestiferous and beneficial invertebrates could also be varied with grazing management (Michael et al.).

Management/Production. Sward height and structure were related to species composition, herbage on-offer, intake, and/or quality in papers by Mosque-Losada and Gonzalez-Rodriguez, Pavlu and Velich, Prigge et al., and Singh et al.. Changing species composition or herbage availability during seasonal deficit intervals by varying timing and/or intensity of defoliation was the focus of studies by Crosse and Dillon, Harris et al., Johnston, and O'Riordan (544). Other studies sought to identify management strategies to retain valued species, such as white clover (Harris et al.), perennial ryegrass (Graham et al.), Phalaris aquatica (Avery and Graham), and orchardgrass (Thompson and Avery) or to improve the persistance and reliability of new species, such as birdsfoot trefoil (Blumenthal et al.) and sandplain lupins (Croker et al.).

Grazing behavior was contrasted between biotypes of beef cattle (Cid et al.), and between fistulated and intact sheep (Gong et al.), as well as in response to sward application of slurry and dirty water (Danby et al.). Gong et al. found that most bite attributes did not differ between sheep grazed indoors or outside or between intact and fistulated sheep. However, bite rate was higher in intact than in fistulated sheep, and in outdoors than in indoors grazing by fistulated sheep.

Mineral nutrition and nutrient cycling were the object of several papers, including that by Matthews et al. on redistribution of nutrients attributable to shade and watering resources, and that by Kawas et al. who studied trace mineral concentrations of soil, plant, and animal tissues in cattle grazing in northeastern Mexico. Use of fertilizer, and especially N, to promote growth of warm season pasture species and animal performance was assessed by Euclides et al., Morrison et al., and Sollenberger et al. O'Riordan (543) found that carcass weights were higher from steers grazed on grass-clover mixtures than on grass mixtures fertilized with up to 220 kg N/ha.

The effects of varying stocking rate, herbage allowance, and level of supplementation on animal performance were the subject of 9 dairy, 4 beef, and 1 sheep studies. The papers in this session which compared multiple stocking rates supported the thesis of the invited paper by Dr. Jones that the decline in individual performance due to increased stocking rate is linear. Stosiek et al. reported the relative efficiency of metabolizable energy conversion to animal product at multiple stocking rates. This approach is a very useful tool for assessing biological efficiency. A number of papers addressed grazing dairy cows either at different SR's or with supplement levels which effectively altered grazing pressure (Okubo et al., Togamura et al., Dhiman et al., and Kolver and Muller)

SYSTEMS/FARMER-PARTICIPATORY SURVEYS

A more systematic, comprehensive, and often producer-based approach to grassland management was evident in several papers. Water use efficiency from irrigated dairying was reported from a 180 farm survey in Australia (Pritchard et al.). Planning strategies for grass-based livestock systems were reviewed for China (Matthews et al.) and for the Falkland Islands (Kerr). Systematic experimental studies to develop and/or validate grass-based farming systems were reported from France (Chabosseau), and by Bryan et al, Dalrymple et al., DeRamus et al., Hill et al., and Phillips et al., all from the United States.

Producer experiences were reported for year-around beef and sheep grazing in Ohio (Bartholomew et al.) and for raising dairy heifers in Pennsylvania (Rodgers). Blumenthal et al. reported on the outcome of a participatory (co-learning) process by which Australian producers explored a variety of methods for maintaining birdsfoot trefoil in their swards.

The INFOGRAZ system for storing and releasing to the public detailed information on beef, sheep, and dairy grazing studies in tropical Australia was reported by Rickert et al. The GRAZEON model for pasture budgeting in native swards was discussed by Cobon et al.

A SYNTHETIC LOOK TO THE FUTURE

In the coming century, producers will face challenges which are more complex and contentious than those of their predecessors. Grazing management researchers of the future will have to reconcile societal demands not simply for productivity and profitability, but also for food security and environmental sustainability. As noted by Ann Moris Bayer, issues of stocking rate and productivity may be of lesser import to low income producers than issues of food security, family health, and continuance.

Likewise, consumer and environmental groups will demand a greater say in on-farm practice, requiring producers, researchers and policymakers to seek a more broadly defined "common ground". Awareness of environmental issues was evident in questions from Ken Ricket and Jim Scott relating to the need for predictive indices of environmental degradation and for methods of reducing weather-related risk of environmental degradation due to grazing. L'Mannetje emphasized the need to consider issues other than production - such as N emissions and pollution potential - when assessing stocking rates. In the same vein, Daniel Flaherty drew attention to the environmental implications of differences in nutrient cycling, distribution and retention in swards managed under continuous versus rotational grazing. In anticipation of this trend, the focus on multi-disciplinary and integrative research in many of the contributions to this Session was noteworthy and laudable.

Preconceived limits to the role of grasslands in contemporary agriculture are being challenged by the vision of innovative researchers. Differences within and among herbage species have been shown to influence not simply combining ability in mixtures, nutritional quality, and perenniation, but olfactory/taste attributes of the meat, anti-helminthic properties, and groundwater recharge. Future research may well identify other useful properties of herbage species and management regimes, including strategic grazing by mixtures of livestock as discussed in questions from Tom Nolan and Alistair Mail to provide new opportunities for balancing ruminant nutrition, producing more consistent meat, milk, and wool quality, reducing dependence on chemical pest control agents and growth stimulants, and enhancing sustainable land use.

Another future direction anticipated in this session is the generalizability of findings across environments. Nick Quirk and Ron Heitschmidt raised the issue of extrapolating findings from small paddock studies to large scale grazing ranges. On a wider scale, Jim Gerrish noted that the ability of stocking rate to largely account for productivity may be more discernable in extreme environments characterized by either slow (arid) or fast (very humid) ecological processes. The importance of stocking method may be more prominent in intermediate environments, such as that of the continental United States. Lack of robustness in the relative performance of a given treatment among years (Kanneganti et al.; Martin et al.) and among sites (Bartholemew et al.; Blumenthal et al.; Graham et al.) underscores the importance of site- and year-specific variables.

In the aggregate, these and other papers underscored the need to appreciate the limits of inference for a given body of information. Researchers and producers will also need to better acknowledge the propensity for cultivar rank order or management recommendations to interact with factors likely to vary in on-farm practice, such as the weather. Given the need to buffer against site-specific GxE interactions, the translation of research findings into objective guidelines, as sought by Ted Wolfe, may produce more flexible and less rigid recommendations than in the past.