Forages and Pastures Symposium: Forage Systems Adaptable to Dry Conditions

355 Between droughts and floods—Climatic effects on forage and livestock production systems. D. Niyogi*, *Purdue University, West Lafayette, IN.*

The record drought of 2012 brought the issue of climatic vulnerability to the agricultural enterprise front and center. The swings in the temperature patterns associated with higher frost and freeze risks, as well as the midseason heat stress and heavy rain/severe weather risks have brought about potentially newer climatic regimens to light. Several associated shifts are apparent in regional growing season length, cropping patterns and irrigation demands. Nonclimatic forcings such as regional landuse/cover patterns due to urbanization and regional policies have also contributed to newer vulnerabilities to the agricultural enterprise. This presentation will review the various climatic / weather processes and trends that have been observed and are expected in the coming decades. The potential effects from the traditional sensitivity approaches will be discussed, followed by a bottom-up vulnerability approach for understanding the climatic (and non-climatic) stresses on production systems. Efforts underway to link the different indices for identifying triggers and regimen shifts, societal issues, and decision making process with several data intensive /computational efforts will also be presented. The largest vulnerability appears to be in the availability of water resources within the regional setup. A clear need for adapting a newer mode of operation leaving the traditional "business as usual" view is starting to emerge.

Key Words: climate, drought, vulnerability assessment

356 Foraging through the dry times: Novel approaches to improving drought tolerance in forage crops. M. J. Oliver*[1], A. Yobi[1], and J. C. Cushman[2], [1]*USDA-ARS-PGRU, Columbia, MO,* [2]*University of Nevada, Reno.*

Increasing global uncertainty about food security, expanding desires for animal protein, intensifying extremity of weather events, and growing demands on the world's supply of fresh water all drive the need for forage crops that require less water to maintain productivity and that tolerate episodes of drought. The development of low-water-input forages useful for current livestock production enterprises in semi-arid and arid regions can be promoted by understanding cellular processes that are adaptive for drought tolerance in grasses and by evaluating novel forage grasses for use in arid areas. New strategies for improvement of drought tolerance in forage crops have focused on *Sporobolus*, a genus of grasses used historically as forage in stressful arid or saline environments. A sister-group contrast has been used to compare the response of the transcriptomes, proteomes (in progress), and metabolomes of the desiccation-tolerant (DT) species, *Sporobolus stapfianus*, and the desiccation-sensitive (DS) species, *S. pyramidalis*, to various degrees of shoot dehydration. Genes, gene networks, and metabolic processes with adaptive value for the establishment of cellular dehydration tolerance have been identified as strategically important for forage crop improvement. An important link between dehydration tolerance, oxidative metabolism, and nitrogen storage and remobilization has been identified that is the focus of on-going targeted metabolomics studies. Forage potential (under variable irrigation) has been evaluated for 3 *Sporobolus* species that could be suitable for both feed supplementation and rangeland reclamation. Data indicate that these good-quality forage grasses can be produced using considerably less water than currently devoted to arid-land beef cattle production using conventional forage species. The powerful combination of genomic resources, novel gene discovery, and successful field tests validates these *Sporobolus* species as attractive models for further improvement.

Key Words: drought tolerance, forage grass, water use

357 Field experience with drought-tolerant maize. S. Soderlund*, F. N. Owens, and C. Fagan, *DuPont Pioneer, LaSalle, CO.*

Drought-tolerant maize hybrids are being marketed by several seed companies. Such hybrids were developed by phenotypic and marker-assisted selection with various degrees of irrigation water restriction or through genetic modification. Crop productivity and survival are progressively reduced as drought intensifies. Water needs differ due to differences in root structure, evaporative loss, capacity to store water or enter temporary dormancy, and plant genetics. Availability of water differs widely not only with rainfall and irrigation but also with numerous soil and agronomic factors (soil type, slope, seeding rates, and tillage practices). Reduced weed competition, enhanced pollen shed and silk production, and deep, robust root growth reduce the negative effects of drought. Genetically selected drought-tolerant maize hybrids yield more grain even when drought conditions are not apparent due either to reduced water extraction or greater tolerance of intermittent water shortages. In Pioneer trials, whole plant NDF digestibility of maize increased with water restriction, perhaps due to an increased leaf to stem ratio. Efficiency of water use, measured as dry matter or potential milk yield per acre per unit of available water, responded quadratically to water restriction, first increasing and then decreasing as water restriction increased. For grain production, water restriction has its greatest negative effect during silking or post-silking through reducing kernel number or kernel fill. For silage production, water restriction during the vegetative growth stage negatively affects terminal plant height and biomass yield. Earlier relative maturity maize hybrids, through earlier pollination, may help avoid mid-summer heat stress at this most critical growth period and reduce the number of irrigation events needed. Although drought tolerance of maize hybrids has been improved due to genetic selection or biotech approaches, selecting locally adapted hybrids or crops, adjusting seeding rates, and modifying tillage practices are key considerations for optimal water utilization for grain and forage production.

Key Words: water, drought, maize

358 Using mixtures of summer forages for improved forage yields in dry conditions. C. Teutsch*, *Virginia Tech's Southern Piedmont AREC, Blackstone.*

Corn silage is grown on more than 76,000 ha in Virginia and North Carolina and is the primary component of dairy rations throughout the southeastern United States. Although the yield potential of corn grown for silage is high, it is also sensitive to environmental stress. Dry conditions during any stage of corn growth can significantly reduce corn silage yields. In contrast to corn, forage sorghum possesses a much higher level of drought tolerance and increased water use efficiency. Planting mixtures of corn and forage sorghum may reduce the risk of low yields during years with below average rainfall and above average temperatures. A study to evaluate the effect of planting corn alone or in

mixtures with forage sorghum was conducted at Virginia Tech's Southern Piedmont AREC, located near Blackstone, VA. The experimental design was a randomized complete block with 4 replications. Corn and forage sorghum were planted alone or as a mixture consisting of corn (28,000 kernels/ha) and 4 rates of forage sorghum (2.25 to 9 kg/ha) in late May 2010 and 2011, approximately a month after the optimal corn planting date. The yield and nutritive value were evaluated when the forage sorghum reached the soft dough stage. Adding as little as 4.5 kg/ha of forage sorghum to late planted corn doubled (11.0 to 26.0 Mg/ha) and tripled (12.1 to 32.0 Mg/ha) the adjusted silage yield (35% DM) in 2010 and 2011, respectively. These data indicate that forage sorghum grown either in mixtures with corn or alone could help to mitigate the effects of drought and high temperatures in silage production systems in southeastern United States, especially on soils that are marginal for corn silage production.

Key Words: drought, forage, mixture