FIELD 2000

REPORTS OF RESEARCH ON
CLIMATE AND NATURAL RESOURCES
LIVESTOCK PRODUCTION
FORAGE PRODUCTION

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
GRAZINGLANDS RESEARCH LABORATORY
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OCTOBER 12, 2000

USDA-ARS
Grazinglands Research Laboratory Field Day
October 12, 2000

Reports of Research Projects and Research in Progress on

Climate and Natural Resources
Livestock Production
Forage Production

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Cover: Brangus research herd on tallgrass prairie rangeland at Grazinglands Research Laboratory, El Reno, OK. Photo provided by M.A. Brown.

United States Department of Agriculture

Research, Education and Economics
Agricultural Research Service

WELCOME TO ALL

On behalf of the staff of the Grazinglands Research Laboratory and our cooperating institutions, we welcome you to Field Day 2000. We hope that today proves to be exciting and informative.

The name of the Laboratory reflects our mission. We conduct research across a broad range of scientific disciplines, but each facet of the program is directed at increasing profits and reducing risks by providing new technology and management strategies for livestock production that is based on grazing. Over recent years we increasingly focused much of the research on the stocker calf component of the Nation's beef production system, and increased our scientific capability to conduct forage production research in support of stocker production. At the same time, with the help of our supporters, our Congressional delegation, and the Agency's leadership, we added projects which address the management and conservation of soil and water, and the impacts of a widely varying climate, which relate to all agriculture in the Great Plains and elsewhere.

Our last field day occurred on October 18, 1995. We postponed field days for a few years, primarily to focus intensively on planning and re-organization of the research program and to incorporate new research projects into the overall mission. At the time of the last field day, the Laboratory's research program was conducted by five scientists (two of those positions were vacant) and a support staff of 12. The staff now consists of 17 scientists and 33 capable support personnel. Two of those scientists and two technicians are permanently stationed at Langston University, Langston, OK, and another of our employees is stationed at Tuskegee University in Alabama. Those personnel conduct the Laboratory's research directed at the unique problems associated with low-input forage and livestock production on small land-holdings. Recent years have also seen dramatic improvements in our research facilities, with significant investments in both renovations and new construction.

While the Grazinglands Research Laboratory is a research facility staffed and operated by USDA's Agricultural Research Service, we are fortunate to have many partners who help us achieve our goals. Cooperators with Oklahoma State University, the Oklahoma State Experiment Station and Oklahoma Cooperative Extension Service, have been members of the research team at El Reno for over 50 years. Other institutions, such as the University of Oklahoma's Health Sciences Center, the University of Central Oklahoma, Langston University, the Noble Foundation, and Redlands Community College, participate with the Laboratory staff in a variety of research projects. We place a high value on these partnerships.

We express our gratitude to the employees of the Grazinglands Research Laboratory for their hard work in preparing for this event and to the planning committee for organizing the field day.

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GRAZINGLANDS RESEARCH LABORATORY
Research Program

USDA, ARS has operated the Grazinglands Research Laboratory on the 6,700 acres of Fort Reno lands since 1948. The **laboratory's mission** is to provide new technology and management strategies which increase the profitability of forage and livestock production while reducing economic risk and environmental impacts. Emphasis is placed on development of more efficient forage/livestock production systems for the stocker calf component of the U.S. beef cattle industry, based on grazing winter wheat. Research conducted at the laboratory has contributed to the solution of a variety of problems confronted by farmers and ranchers.

Currently, the primary research objectives are to:

- minimize periods during the year when high-quality forage is unavailable, requiring producers to import purchased feeds at high cost, by developing new varieties of forage grasses and better management techniques for existing forages;
- increase the profitability of beef cattle production by resolving constraints to rapid weight gain by stocker cattle and developing beef cattle finishing systems that utilize more forages in the diet;
- evaluate and adapt seasonal climate forecasts developed by NOAA's Climate Prediction Center for agricultural applications and incorporate them with other information about variability in climate and weather into risk-based decision and management tools;
- utilize long-term climatic and hydrological data bases to assure availability and efficient use of water;
- develop new technology to monitor soil water content and forage characteristics, using remote sensing (satellite imaging technology);
- define and mitigate any adverse effects of livestock grazing on soil and water quality; and
- address problems unique to small, marginal farms, with emphasis on low-input forage and livestock production and natural resource conservation (at Langston University).

The research is conducted by 17 scientists and 33 support personnel, divided into five teams:

- Forage Genetics and Management
- Livestock Genetics and Nutrition
- Climate Variability and Seasonal Forecasts
- Water Resources and Remote Sensing
- Small Farms Research (conducted at Langston University, Langston, OK)

In addition to state-of-the-art livestock handling facilities and laboratories for chemical analyses, scientists at this research facility use experimental herds of between 300 and 1,000 cattle and about 600 sheep to conduct farm-scale research projects. The land resource includes 200 acres of irrigated alfalfa, 900 acres of wheat, 2,000 acres of improved grass varieties, and almost 3,000 acres of native tallgrass prairie, which is also grazed.

Additional information about the Grazingland Research Laboratory can be accessed through the Internet address http:\\grl.ars.usda.gov.

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EROSION STUDIES FROM EXPERIMENTAL WATERSHEDS IMPACTED BY GRAZING LIVESTOCK

John A. Daniel

RATIONALE

Native rangeland of central and western Oklahoma in the Southern Great Plains (SGP) is an important region for stocker cattle production because it is located between the cow/calf production area in the southeastern United States and the feedlots of the Texas and Oklahoma panhandles. Because of the plentiful supply of forage, stocker calves are shipped to the SGP to graze a variety of warm and cool season forages before final shipment to regional feedlots for finishing. However, there is concern that this activity from livestock grazing, such as trampling, defoliation, defecation, and urination, may increase the potential for surface runoff and sediment losses.

Previous research has shown that livestock grazing on pastures has an impact on compaction, bulk density and infiltration, which can ultimately increase erosion potential. While the impact of livestock grazing on sediment movement and erosion is well documented, a commonality exists in the conclusions - the impact of heavy stock densities, particularly in combination with rotational grazing systems, are found to increase sediment production. In addition, the detrimental impacts from grazing may become more significant during periods of a drought or winter dormancy.

OBJECTIVE

The overall objective of this study was to estimate the soil erosion potential on native rangeland under different climate conditions and stocking densities. This was done by using historical watershed runoff and sediment yield information to calculate linear regression equations for each stocking density. These equations were incorporated with 40 years of simulated precipitation data generated in a computer simulation. The five driest and five wettest years of the simulation allowed calculation of the potential sediment yield for drought and wet periods.

RESULTS

Based on regression equations calculated from surface runoff and sediment yield on established experimental watersheds that have undergone three stocking densities, estimates of sediment movement for periods of drought and wet periods were determined.

The driest years have the smallest amounts of estimated sediment yield from the watersheds, and reflect an increase in soil loss with increasing grazing activity. The lightly grazed treatment has the smallest sediment amount with 13 lbs/ac. The moderately-grazed watershed has the next highest at 14 lbs/ac, and the heavily grazed watershed experienced 16 lbs/ac of sediment loss.

For the wet years, the same relationship of increasing sediment yield with higher stocking density occurs. The lightly-grazed treatment displaying the smallest total sediment movement with 16 lbs/ac, followed by the moderately-grazed treatment with 18 lbs/ac, and the heavily grazed treatment with 20 lbs/ac.

A watershed with no grazing was available to use as a control. Sediment yields were calculated from the years when no grazing occurred between 1980 and 1991 on the watersheds were used as a control. Results show that more sediment moved off the watersheds during the rest periods than when grazing occurred. When no grazing occurred on the watershed the total sediment was estimated at 29 lbs/ac and 36 lbs/ac during dry and wet years, respectively. The reason for this is not clearly understood, but it may be associated with the surface roughness of the ground. Hoof imprints formed during grazing tend to increase the surface roughness and can possibly pond water on the watershed. Another possible explanation may be that surface crusting of the ground and increased soil cohesion during grazing may prevent the sediment from moving except for intense storms. The results suggest that conservative grazing practices have a minimal effect on the erosion potential of native rangelands in this region.

IMPACT OF GRAZING STRATEGIES ON SOIL COMPACTION

John A. Daniel and William A. Phillips

RATIONALE

The Southern Great Plains (SGP) is an important part of the U.S. beef production system. Stocker calves from across the southern U.S. are shipped to the SGP in the fall and summer to graze a variety of warm and cool-season forages before shipment to regional feedlots for finishing. Stocker producers have to manage a variety of resources in a very dynamic system. While striving to maintain peak stocker growth, they must also be aware of the impact of grazing on soil, water and plant resources. Grazing livestock can lead to soil compaction, which in turn can affect soil structure and water infiltration rate. Stocker producers that utilize winter wheat in their grazing system may also use these wheat fields in the summer to grow summer annuals to extend the grazing season and to provide high quality forage to augment warm season grasses. These types of systems are aggressive users of soil moisture and increase the time stockers spend on these fields. Because water is a limiting resource and the impact of grazing on water quality is becoming more of an issue, the impact of grazing on soil surface characteristics needs to be defined.

OBJECTIVE

The overall objective of this study was to determine the impact of winter and summer grazing of winter wheat fields on soil compaction.

RESULTS

Results of the study indicated that stocker grazing caused some soil compaction as measured by the resistance of the soil surface to penetration. Penetration readings taken in June 1999 at the end of the winter wheat grazing season and prior to the initiation of any summer grazing indicated that some soil compaction had already occurred. However, there were no differences in penetration measurements between winter wheat fields that were either left fallow and ungrazed in the summer or were over seeded with a summer legume and grazed during late summer. Our results show that the impact of grazing was in the top 6 inches of the soil surface with the maximum impact being in the top 2 inches.

Increasing the number of grazing days on winter wheat fields does not have a cumulative effect on soil compaction, but these data are from only two years of grazing. The impact of continually grazing wheat fields during the winter and summer has yet to be determined.

PRECIPITATION VARIATIONS IN CENTRAL OKLAHOMA AND IN THE GREAT PLAINS

Jurgen D. Garbrecht and Jeanne M. Schneider

RATIONALE

Annual precipitation at a location generally varies from year to year. Sometimes ten or more consecutive years will have mostly above or below average precipitation. Such variations in precipitation are natural occurrences and, at different times, have contributed to the prosperity or hardship of farmers and ranchers. Variations in precipitation that last ten or more years may have serious consequences for dry-land agriculture, long-term irrigation water needs, and water conservation strategies.

The Dust Bowl of the 1930's is a typical example of a decade-long variation in precipitation that contributed to economic and social hardship for people in the Great Plains of the United States. A seven-year drought occurred at the same time that grasslands were being overgrazed or converted to wheatland. This led to destructive dust storms that wrecked the agricultural economy of the Great Plains and resulted in mass migration of thousands of farm families. Other examples of droughts, though smaller in scale, include the 1976-1977 and 1987-1992 droughts in California that slowly depleted state water reserves, affecting irrigated agriculture, urban water supply, reservoirs operations and aquatic recreation. An oversupply of water can be damaging as well. The 1980's rise of the Great Salt Lake, the 1993 Upper Mississippi River basin flood, and the rise of North Dakota's Devils Lake in the late 20th century have caused substantial damage to urban and rural areas.

The broad and far reaching economic and societal consequences of decade-long precipitation variations requires that subtle, yet sustained variations in precipitation be identified early. With early identification adaptive and mitigating strategies may be developed, opportunities exploited, and policies and investments made to ensure a secure water supply and a responsive and competitive agricultural economy.

OBJECTIVES

The objective of this study was to identify the magnitude, duration and extent of recent decade-long precipitation changes in the Great Plains, and to quantify these changes on a regional basis. The purpose for conducting this study was to illustrate the size of and encourage consideration of precipitation variations which last many years in practical agricultural applications, such as agronomic planning, irrigation operations, and water conservation strategies.

RESULTS

Variations in annual precipitation that last for decades have been analyzed for the Great Plains between the Rocky Mountains and the Mississippi River for the 105 year interval between 1895-1999. The study revealed that many regions in the Central and Southern Great Plains experienced mostly above average precipitation conditions over the last two decades of the 20th century (Fig. 1). This 1980-1999 wet period was found to be the longest and most intense of the entire 1895-1999 period of analysis. This is illustrated for the Central Oklahoma climate division (Fig. 2) and for the entire Region 5 which includes Kansa, Nebraska, Iowa and Missouri (Fig. 3). In Fig. 3 the annual precipitation is expressed as a standard precipitation index that allows the direct comparison of precipitation values between climate divisions and across the entire region. The precipitation increase in the Great Plains in 1980-1999 ranges from about 6% to 12% of the average annual precipitation, and from about 25% to 60% of the year-to-year variability of annual precipitation depending on the region (Table 1). The 20-year precipitation increase was primarily the result of a reduction in the number of dry years, as opposed to an increase in the amount of precipitation during wet years. This can be shown as a change in the likelihood of a year being dry, average or wet. Dry, average and wet years have been defined in a way that one third of all years between 1895-1999 are dry, one third average and one third wet. For the 1980-1999 period and for all regions, this likelihood of a year being dry, average or wet shifted to about 20%, 33% and 47%, respectively (Table 1). On a seasonal basis, most of the precipitation increase occurred during late spring, early summer and autumn months. For some regions a slight decrease in precipitation during summer months was also observed. The northern and northwestern Great Plains also experienced a precipitation increase, but only over the last decade of the 20th century. Again, there were fewer and less severe drought years over the last 10 years, as opposed to an increase in the precipitation amount during very wet years. Seasonally, a large portion of the precipitation increase occurred during months in early summer and in autumn.

The finding that the majority of the Great Plains has experienced a precipitation increase over the last one or two decades of the 20th century, has immediate implications for practical agricultural applications that deal with water resources planning, management and utilization. Though it is not possible to predict what will happen in coming years from this analysis, the recent above average precipitation conditions provide opportunities to exploit favorable conditions to insure a responsive and competitive agricultural economy. This is particularly true for agriculture in the Great Plains of the U.S. that relies mainly on dry-land farming and natural precipitation to support a forage, grain and livestock industry. Above average precipitation in the Southern and Central Great Plains may provide opportunities for diversification and double cropping that directly benefit farmers and ranchers. However, in the Northern Great Plains, persistent above average precipitation can lead to excessive moisture that can be detrimental to agriculture.

On the other hand, should the above average precipitation conditions of the last two decades come to an end, adaptive measures and water conservation strategies will be needed to deal with the potential water shortfall compared to the recent ample precipitation. This study identified the magnitude and geographic extent that could be impacted if current annual precipitation patterns return to normal conditions.

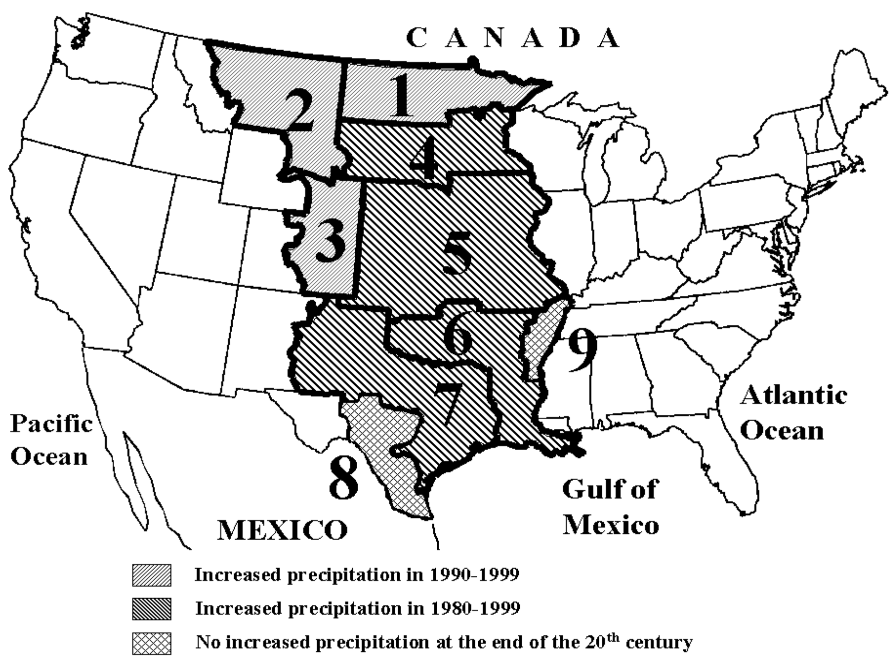

Fig. 1. Identification of regions that show increased precipitation at the end of the 20th century.

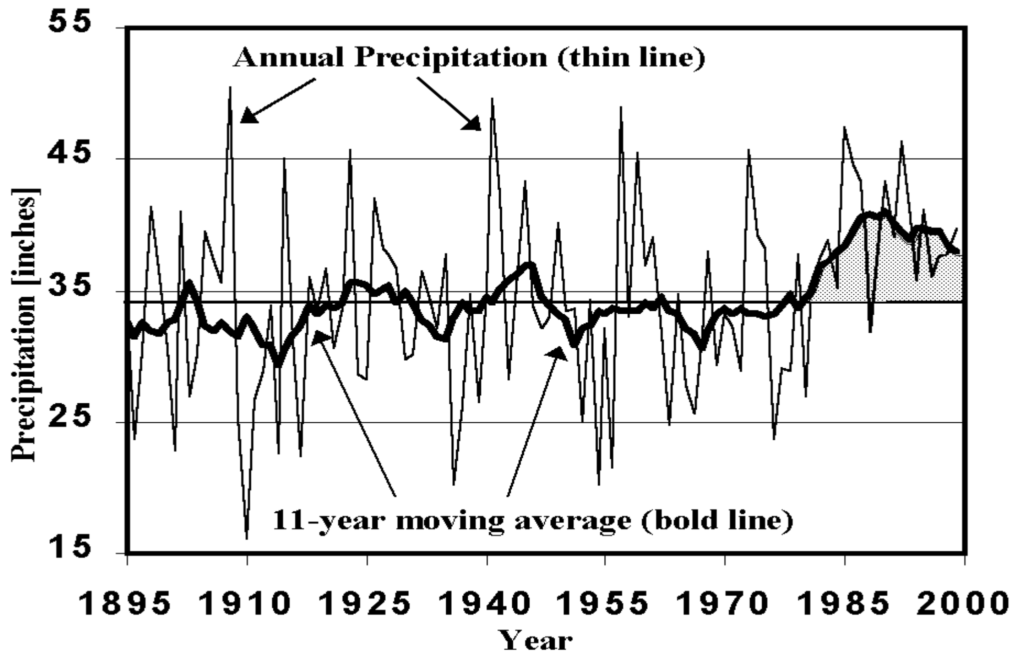

Fig. 2. Example of annual precipitation and increase in precipitation (shaded) in the last two decades of the 20th century for the Central Oklahoma Climate Division in Region 6.

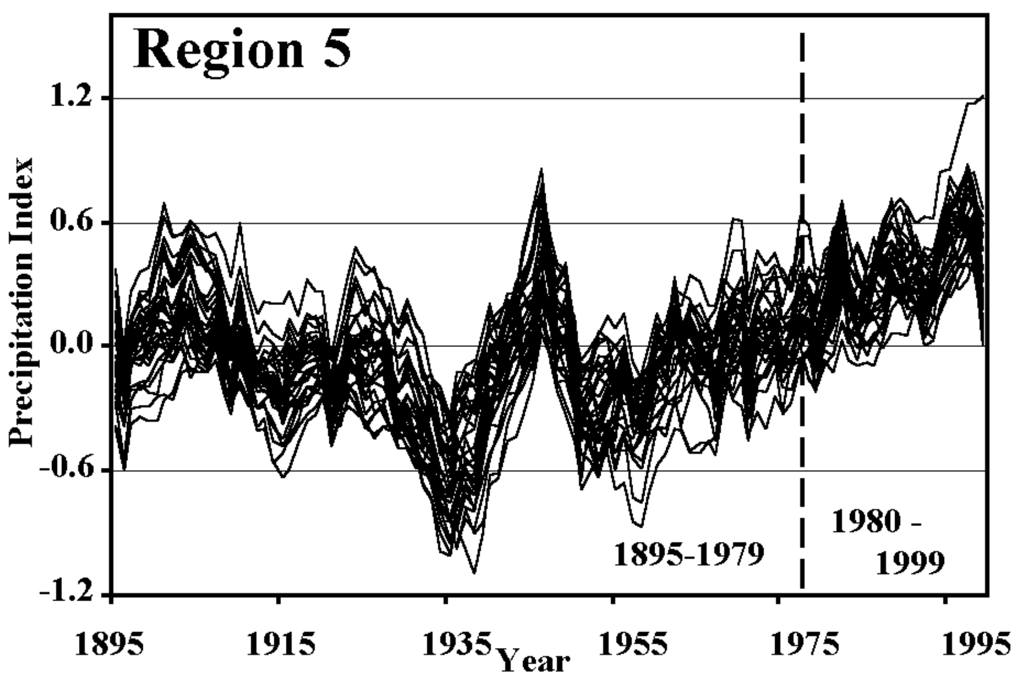

Fig. 3. 11-year moving average of the precipitation index for the 32 climate divisions in Region 5.

Table 1. Percentage increase in precipitation by region and likelihood (probability) of being dry, average and wet conditions.

	Precipitation increase		Probability		
Region	Inter-annual variability	Long term mean	Dry	Average	Wet
	--------------- % ---------------		---------------- % ----------------		
1	47	8	20	31	49
2	20	4	28	34	38
3	44	8	18	33	41
4	60	12	18	29	53
5	35	6	18	33	49
6	37	7	19	33	48
7	25	6	21	37	42

REMOTE SENSING OF SOIL WATER CONTENT

Patrick J. Starks

RATIONALE

Knowledge of soil water content is important in agriculture, hydrology, meteorology and many other disciplines because the amount of water in the soil supports agricultural enterprises, partitions rainfall into infiltration and runoff, and divides solar radiation into energy used to warm the air and evaporate water. Rangelands comprise more than 60% of the land area of the 48 contiguous states, and agricultural, industrial, recreational and municipal water supplies in many areas of the U.S. are directly linked to rangeland watershed management. Increased competition for available water supplies requires that tools and techniques be developed to monitor soil water content over large land areas as an aid in management of water resources. Remote sensing is the only technique that offers the possibility of providing these measurements over large land areas in a timely and cost-effective manner. However, at present, remote sensing can only provide a measurement of soil water content in the top one inch of the soil profile.

OBJECTIVE

The objective of this study was to examine the feasibility of determining root zone soil water content by combining remotely sensed estimates of surface (top 1 inch) soil water content, field measurements, and modeling techniques.

RESULTS

A simple two-layer water budget model was selected for this study due to its ease of use, minimal input requirements and its potential to be applied in large, spatially diverse regions. First, the ability of the model to predict both surface and root zone water soil water content was tested using data from measurement stations located in four tall grass prairie sites located in central and south central Oklahoma. In general, the model adequately simulated both the surface and root zone soil water contents at the four sites when the model was initialized using field data (Table 1). However, it was observed that the model performed better in fine textured soils (sites 1 and 4) than in coarse textured soils (sites 2 and 3). The model was then initialized using remotely sensed estimates of surface soil water content obtained from a passive microwave sensor mounted on board a NASA P3 aircraft. The aircraft was flown over the study sites between June 18 - July 16, 1997. Two sites (1 and 4) were characterized by either a heavy litter layer on the soil surface or had trees in the vicinity that caused an underestimation of remotely sensed soil water content. When these remotely sensed data were used in the model, the model output did not compare well to measured values. Sites 2 and 3 did not have these vegetation problems, and output from the model compared well to measured data (Table 1). Fig. 1 is a plot of both measured and modeled surface and root zone soil water content at site 4 as it varies over the 30-day study period.

The research suggests that accurate values of surface soil water content from remotely sensed data can be combined with field measurements and modeling to provide reasonable estimates of root zone soil water content. Weather forecasts and/or climate outlooks could be integrated into such a remote sensing/modeling approach to project future soil water supplies, as well as assessing current status of soil water content. Such assessments and predictions could be used by water resources managers, agricultural producers and others as a tool to better manage watersheds, schedule irrigation, predict crop or forage production rates or as a tool for water resources management.

Table 1. Average absolute difference between measured and modeled soil water content for the two model initialization scenarios.

Site	Soil texture	Layer	Initialization scenario: Field data	Initialization scenario: Remote sensing
			--------- $ft^3\,ft^{-3}$	---------
1	Fine	Surface	0.03	0.07
		Root zone	0.01	0.11
2	Coarse	Surface	0.04	0.04
		Root zone	0.05	0.05
3	Coarse	Surface	0.06	0.05
		Root zone	0.03	0.04
4	Fine	Surface	0.02	0.08
		Root zone	0.01	0.12

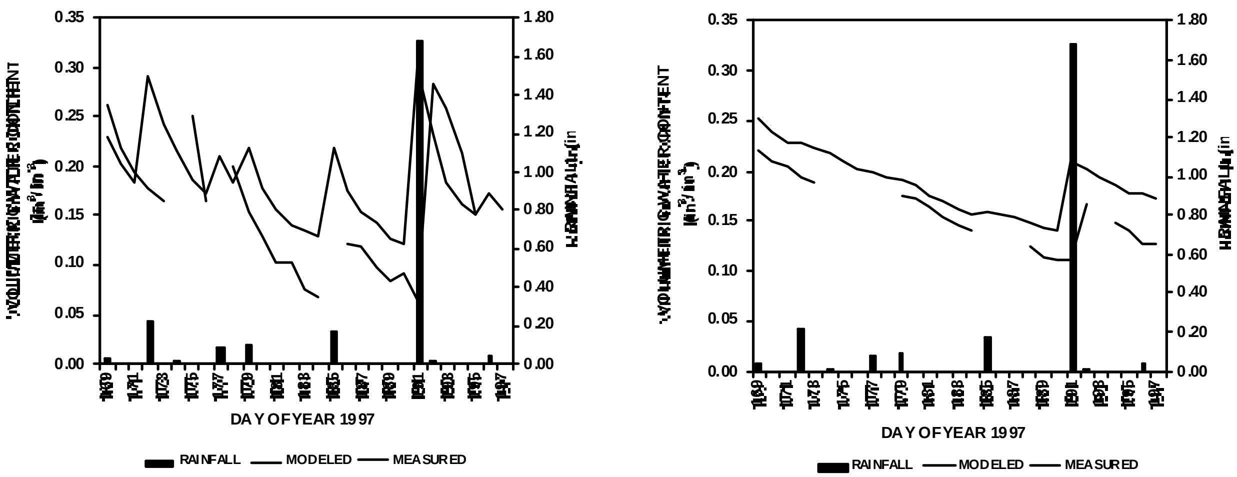

Fig. 1. Comparison of measured and modeled soil water content at the surface and in the root zone at site 4. The model was initialized using remotely sensed data.

ADAPTATION OF DORSET, ST. CROIX AND CROSSBRED LAMBS TO WHEAT PASTURE

M.A. Brown, W.A. Phillips, and L.A. Richards

RATIONALE

Wheat pasture plays a major role in the stocker industry in the Southern Great Plains. In most stocker operations, animals are purchased rather than raised and placed on wheat pasture with the intent of producing weight gain at costs below market value of the gain. Stocker operators have observed and research has substantiated a period of adaptation when gains are minimal or negative after animals are first placed on wheat pasture. Shortening the adaptation period could result in substantial increases in net income for stocker operators. However, little is known about factors that may influence this adaptation period, and these factors must be identified before strategies can be developed to mitigate problems with initial animal performance on wheat.

OBJECTIVE

The objective of this research was to evaluate the period of adaptation to wheat pasture in lambs and to determine if breed differences in adaptation times or magnitudes are important.

RESULTS

Four breed groups of fall-born lambs (Dorset x Dorset, St. Croix x St. Croix, Dorset x St. Croix, St. Croix x Dorset; sire breed listed first) were weaned in December and one-half of each breed group was placed in drylot or on wheat pasture in January. Dorset are medium-frame wool sheep while St. Croix are small-framed tropically adapted hair sheep. Lambs in drylot were fed a high roughage ration balanced to approximate expected animal gains on wheat pasture (Table 1.) Weight gains in drylot and wheat pasture lambs were measured from January 18 to February 28 after which all lambs were place on wheat pasture. Gains were again measured from February 28 to March 28 to observe the adaptation of the drylot treatment to wheat pasture.

Weekly average daily gains (ADG) for each postweaning treatment are given in Fig. 1. Averaged over breed group, lamb gains on wheat pasture were less than contemporaries in drylot for the first three weeks of the trial. For the next three weeks, gains were similar between postweaning treatments, indicating adaptation had occurred. Consequently, it appears a 3-week adaptation period is required for lambs. For the last four weeks of the study, lambs assigned to the wheat pasture treatment remained on wheat pasture and lambs in the drylot treatment were placed on wheat pasture. Similar to observations for the wheat pasture lambs in the first three weeks of the study, there was a significant adaptation period for the drylot lambs after being moved to wheat pasture.

Data were categorized and summarized into three time periods for purposes of breed group comparisons (Table 2). The initial period of 21 days was the first time period and corresponded to time when the wheat pasture lambs were adapting. The second time period consisted of the subsequent 21 days and corresponded to time when the wheat pasture lambs were adapted to wheat pasture. The third time period of 28 days following the previous periods was associated with the adaptation of drylot lambs to wheat pasture. While there were obvious breed groups differences in the drylot during period 1, there was little evidence of breed group differences in the wheat pasture treatment. If the difference between drylot and wheat pasture can be interpreted as a measure of magnitude of adaptation, Dorset x St. Croix and purebred St. Croix appeared to adapt more readily than St. Croix x Dorset and purebred Dorset. The same trend is evident in period 3, where losses in gain due to adaptation are less in Dorset x St. Croix lambs and purebred St. Croix lambs.

From these preliminary data, we can conclude that approximately three weeks are required in lambs to adapt to wheat forage. There may be genetic differences in magnitude of adaptation which relate to rate of gain within a period, but time/extent of adaptation may be less influenced by animal genetics. Additional research will be required to more conclusively evaluate genetic influences on wheat pasture adaptation.

Table 1. Ration for drylot treatment lambs.

Ingredient	Fraction of ration	Crude protein	Total digestible nutrients
	----------------	%	----------------
Molasses	5.0	0.2	4.0
Limestone	0.5	--	--
Dical phosphate	0.5	--	--
Corn	35.5	3.6	31.6
Alfalfa hay	50.5	8.6	28.3
CSM	8.0	3.5	6.2
Total	100.0	15.9	70.1

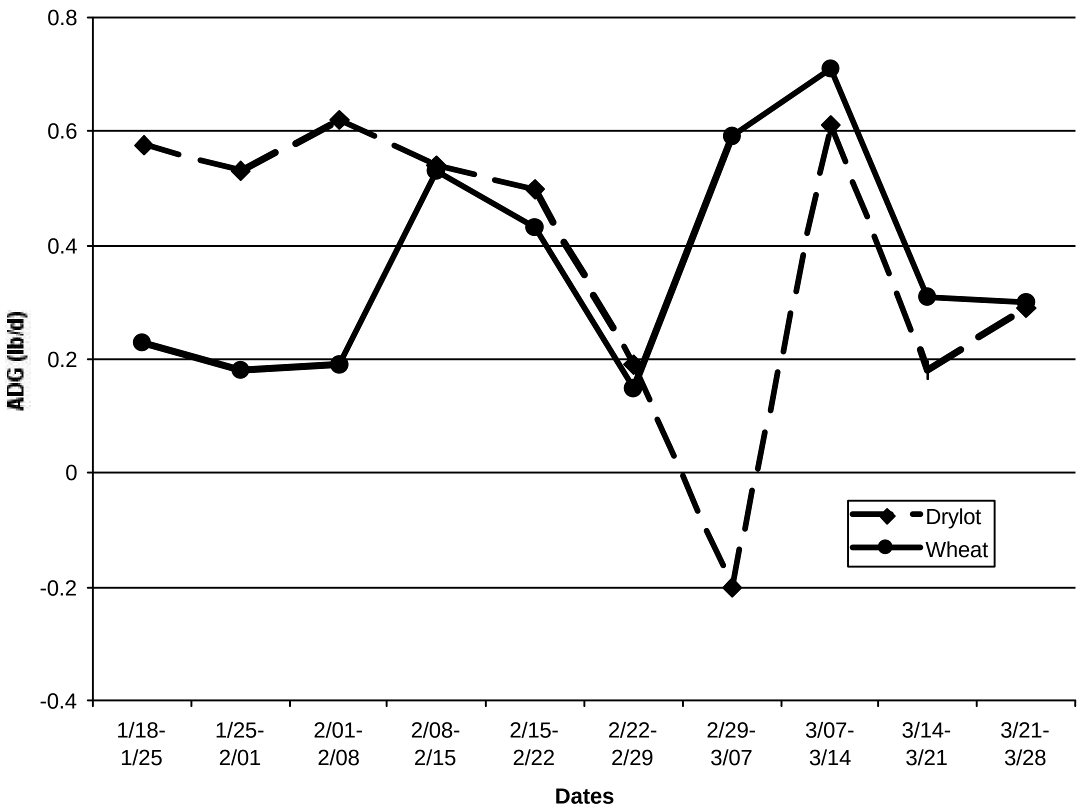

Fig. 1. Weekly average daily gains for drylot and wheat pature postweaning treatments.

Table 2. Average daily gains for three periods for each breed group and postweaning treatment.

Breed[†]	Postweaning treatment	Jan 18 - Feb 8[‡]	Feb 8 - Feb 29	Feb 29 - Mar 28
		---------------------------- lb per day ----------------------------		
D x D	Drylot	0.76	0.50	0.34
	Wheat pasture	0.1 (0.59)[§]	0.43 (0.07)	0.62 (-0.28)
D x S	Drylot	0.39	0.34	0.25
	Wheat pasture	0.21 (0.18)	0.36 (-0.02)	0.45 (-0.20)
S x D	Drylot	0.71	0.40	0.10
	Wheat pasture	0.21 (0.50)	0.33 (0.07)	0.56 (-0.46)
S x S	Drylot	0.43	0.33	0.19
	Wheat pasture	0.18 (0.25)	0.32 (0.01)	0.29 (-0.10)

[†]D x D=Dorset, D x S=Dorset x St. Croix, S x D=St. Croix x Dorset, S x S=St. Croix, sire breed listed first.

[‡]Jan 18 –Feb 8, Period 1, initial adaptation period; Feb 8 – Feb 29, [c]Period 2, lambs maintained on wheat pasture or in drylot; Feb 29 – Mar 28, [d]Period 3, adaptation period for drylot lambs to wheat pasture.

[§]Numbers in parentheses are drylot-wheat pasture ADG.

MILK YIELD AND QUALITY IN BRANGUS COWS

M.A. Brown, W.A. Phillips, and L.A. Richards

RATIONALE

Stocker cattle are traditionally under 12 months of age and have spent a significant portion of their life on the cow when transported to the Southern Great Plains for grazing. The preweaning environment of calves can influence postweaning performance as stockers. Factors such as climate in which calves were raised, preweaning forage type, preweaning exposure to microorganisms, preweaning management, and preweaning maternal environment can all impact postweaning growth. The preweaning maternal environment includes the amount and quality of milk produced by cows. While milk production levels consistent with production environment are desirable for weaned calf production, the effects of higher levels of production and/or quality on postweaning growth in calves are less well understood.

OBJECTIVE

The objective of this research is to evaluate the effects of level and quality of milk production on preweaning and postweaning growth in Brangus and Brangus-cross calves, and to associate actual levels of milk production with estimated genetic potential for maternal performance.

RESULTS

Fifty Brangus cows were selected from a herd of 125 to estimate milk yield and quality in the spring of 2000. Cows were selected to include a wide range of sire estimated progeny differences for milk EPD's. Sire milk EPD's in this sample of cows ranged from -13.8 lb to 17.5 lb. The difference in sire milk EPD's can be interpreted as the expected difference in weaning weight of calves from daughters of the sires, due to differences in mothering ability. In this sample of cows, the expected weaning weight difference would be 31.3 lb between cows with the lowest and highest sire milk EPD. Milk yield was estimated by milking cows after a 12-hour separation from calves using a single-cow milking machine. Milk quality was estimated by a commercial laboratory from samples taking at milking. Milk production estimates were conducted at an average 58, 86, 114, 142, and 177 days post-calving. Averages for milk yield and quality and calf weight for each milk production date are presented in Table 1. Milk yields were relatively consistent for the first four estimates but declined somewhat by day 177 (August 2000). This decline coincides with the typical decline in forage quality in late summer and also reflects the lack of rainfall received in July and August, 2000. Estimates of milk fat were lower at 58 days than on other days, but generally reflected the higher milk fat expected in Brahman-cross cattle. Milk protein was lower on 86 and 114 days post-calving, while solids-not-fat (SNF) was slightly higher on day 58. Lactose declined over the summer, starting at 5.08 % on day 58 and declining to 4.78 % by day 177. Somatic cell count was unexplicably high on days 58, 86, and 142, indicating the potential for subclinical mastitis in some of the Brangus cows in the study. Average daily gain (ADG) of calves from birth to 177 days past calving averaged 2.20 lb/d. The simple correlation of total milk yield to ADG was .52, indicating the importance of milk yield to calf preweaning growth.

Future work will determine the relationships of sire EPD for milk to actual milk yield and quality in daughters (the Brangus cows in this study), as well as relationships to calf preweaning and postweaning growth.

Table 1. Milk yield and quality for Brangus cows and calf weights and gains.

	Days after calving					
Milk Trait[†]	58	86	114	142	177	Average
Yield (lb)	9.6	10.0	9.8	10.2	8.4	9.6
Fat (%)	3.25	3.79	3.71	3.90	3.68	3.67
Protein (%)	3.31	3.07	3.05	3.22	3.18	3.16
SNF[a] (%)	9.29	8.99	8.86	8.97	8.85	8.99
Lactose (%)	5.08	4.98	4.88	4.86	4.78	4.92
SCC[b]	429	313	79	631	178	326
Calf wt. (lb)	198	253	311	379	473	--
ADG[c] (lb/d)	--	--	--	--	--	2.20

[†]SNF, solids-not-fat; SCC, somatic cell count (thousands of cells), ADG, calf preweaning average daily gain from birth to 177 days of lactation.

FINISHING HEAVY STOCKERS ON OLD WORLD BLUESTEM PASTURES WITH AD LIBITUM ACCESS TO A HIGH CONCENTRATE DIET

W.A. Phillips, M.A. Brown, and S.W. Coleman

RATIONALE

Due to good genetics, beef producers are weaning calves at heavier weights which increases both initial and final weights of these calves when used as stockers. Heavy stockers are usually discounted in the market, because of the small difference between the purchase weight and the final finished weight coming out of the feedlot. Stocker operators could increase the returns from heavy stockers if the stockers were finished on the farm and marketed as finished cattle rather than selling them at a discount.

OBJECTIVE

The objective of this experiment was to compare the performance of heavy stockers fed under a conventional confinement finishing system with stockers fed on grass with ad libitum access to a high concentrate diet.

RESULTS

Crossbred steers (year 1 and year 2) and heifers (year 1 only) were wintered under two different systems, placed on cool-season grasses for the spring then assigned to one of two finishing systems. Half of the stockers were fed in a total confinement system, while the other half were fed on grass pastures with ad libitum access to a self-feeder containing the same high concentrate diet fed to the stockers in the confinement system. Old world bluestem pastures were used each year with a stocking rate of 4 stocker/acre. The self feeder was not introduced into the pasture until most of the forage had been consumed, usually 3 to 4 weeks after the initiation of grazing.

In year 1, 74 steers and 67 heifers with a initial weight of 820 lbs. were used (Table 1). Stockers fed on pasture had a slight higher average daily gain (ADG) than those fed in confinement and needed less feed to reach the same endpoint. Stockers fed in confinement consumed 173 1bs more feed than those fed on pasture. With a stocking rate of 4 stockers/acre, an acre of pasture was worth 692 lbs of feed/acre (4 steers/acre x 173 lbs of feed/steer = 692 lbs/acre). If the feedlot ration was valued at $100/ton, then the Old World Bluestem pastures were worth $34.60/acre (692 lb/acre x $0.05/lb of feed = $34.60).

In year 2, 72 steers were used, but the initial weight was lower (769 lbs.). Steers fed on grass gained weight faster than steers fed in the feedlot and consumed 496 lbs less feed during the feeding period. Using the same calculations as in year 1, the pasture was worth $99.20/acre (4 stockers/acre x 496 lbs/stocker x $0.05/lb = $99.20).

Carcass characteristics (yield grade, quality grade, etc) were similar among the two finishing systems, so return per pound of carcass would be equal. The amount of capital investment in facilities to implement this system is relatively small, which reduces the risk to the producer. Under this system stocker operators can market summer grass pastures through another source and also more efficiently market heavy stockers coming off of winter wheat pasture.

Table 1. Initial and final body weights, ADG, days on feed and feed intake of stockers finished under either a conventional feeding system or on pasture with ad libitum access to a high concentrate diet.

	Year 1		Year 2	
Trait	Feedlot	Pasture	Feedlot	Pasture
Start weight, lb	817	824	740	798
Final weight, lb	1148	1177	1208	1243
ADG, lb	2.74	2.88	2.72	2.89
Days on feed	121	123	173	155
Feed intake, lbs/stocker	2845	2670	3560	3064

LIMITING GRAZING OF LESPEDEZA TO INCREASE THE PERFORMANCE OF SUMMER STOCKERS

W.A. Phillips

RATIONALE

Stockers grazing warm season grasses have lower average daily gains (ADG) during the last half of the summer as compared to the first half. This is due primarily to a decline in the protein content of the grasses during the later part of the summer. Providing small amounts of supplemental protein can increase ADG, but these supplements are usually based on oil meals, such as cottonseed meal, and can be volatile in price.

Inter-cropping of annual lespedeza in winter wheat has been shown to provide high quality forage in late summer with a protein content of 18 to 20%. Annual lespedeza could be used to provide supplemental protein to summer stockers.

OBJECTIVE

The objective of this experiment was to compare ADG of stockers receiving supplemental protein from either a commercial all plant protein supplement or from limit grazed annual lespedeza.

RESULTS

One hundred and seventy two stockers were randomly assigned to one of three warm season grass pastures in the summer of 1999. Pastures were either tall grass native prairie, bermudagrass, or old world bluestem. These pastures were subdivided into six paddocks. The grazing season began in early June and ended in September for about 100 days of grazing. About half way through the grazing season, the stockers in two paddocks within each pasture were fed a 20% protein supplement. The weekly allotment of supplement (17.5 lbs/stocker) was fed in two meals each week. Stockers in two other paddocks were allowed to graze ‘Korean’ lespedeza for a 24-hour period twice a week. The lespedeza had been broadcasted into a standing crop of winter wheat or spring oats in March and the cereal crop was grazed or cut for hay in May. We allowed 0.35 acres of lespedeza per stocker. Grazing of the lespedeza began in mid-July at the same time that feeding of the commercial supplement was begun. The remaining two groups of stockers in each pasture served as the control group and received no supplemental protein.

The average weight of the stockers at the beginning of the experiment was 572 lbs. The ADG within each of the three treatment groups and source of grass are shown in Table 1. Providing supplemental protein in the form of a commercial 20% protein pellet or by limit grazing lespedeza during the second half of the summer increased average daily gain by about 0.2 lbs. This response was about half of the response observed in previous experiments at this location. In those experiments molasses blocks or liquid supplements were used. Year to year variations in stocker performance and the response to supplemental protein was probably due to variation in climatic conditions, which can greatly influence the seasonal distribution of forage production, infestation of cool-season annual grasses in the spring, and the composition of the forage on offer.

Although this was the first year of a 3-year study, we did conclude that supplemental protein needed to maintain summer stocker performance during the last half of the season could be provided by limit graze of annual lespedeza inter-cropped with small grains.

Table 1. Performance of summer stockers grazing either tall grass native prairie, bermudagrass, or old world bluestem pastures with supplemental protein provided by a commercial protein supplement† (pellet) or by limit grazing annual lespedeza (lespedeza).

Pasture	Treatment group[‡]		
	Control	Pellet	Lespedeza.
	------- ADG first half of summer (lbs) --------		
Native prairie	1.68	1.51	1.57
Bermudagrass	1.02	1.60	1.05
Old World Bluestem	2.31	1.67	1.56
Average	1.66	1.59	1.39
	------ ADG second half of summer (lbs) ------		
Native prairie	1.46	1.70	1.68
Bermudagrass	1.66	1.59	1.44
Old world Bluestem	1.22	1.73	1.71
Average	1.45	1.67	1.61

[†]The commercial supplement (pellet) contained no ionophore and a complete mineral mix was provided to all stockers.

[‡]No protein supplement was provided during the first half of the summer. During the second half, steers in the pellet group were fed 3.5 lb of protein/week in two meals. During the second half of the summer, the lespedeza group was allowed to graze a lespedeza pasture twice a week for 24 h each visit.

FEEDING VALUE OF PIGEONPEAS AS A PROTEIN SUPPLEMENT

W.A. Phillips and S.R. Rao

RATIONALE

Pigeonpeas (*Cajanus cajan* (L.) Miller) is a new crop that winter wheat producers in the Southern Great Plains could use to increase flexibility and economic stability to their cropping-livestock operations. Pigeonpeas can be grown during the summer in a double cropping system with winter wheat. Mature peas contain about 20% protein and could be used to replace more traditional protein sources in supplements for grazing livestock. The value of pigeonpeas as a protein supplement will depend upon its feed value in relationship to established protein supplements.

OBJECTIVE

The objective of this experiment was to determine the feeding value of pigeonpeas when fed to young ruminants.

RESULTS

Twenty-four crossbred wether lambs were placed in metabolism stalls and fed (2% of body weight) one of four diets that varied in the source of supplemental protein. All diets were formulated to provide similar amount of protein and energy (Table 1). The four sources of protein evaluated were cottonseed meal, soybean meal, alfalfa pellets and whole pigeonpeas. Cottonseed hulls were used as the roughage source, except in the alfalfa diet. The pigeonpeas were grown at the Grazinglands Research Laboratory in small plots. After harvesting and drying, peas were passed through a small hammer mill at a low speed so that most of the seed were cracked. Feeding whole peas without processing would probably lower the dry matter digestibility of the peas. The peas used in this study had a protein content of 19.4%, which was similar to previous published values of 20.6%.

Lambs readily consumed each of the four diets, but the amount of feed provided was limited to 2% of body weight, which was about half of what these lambs were capable of eating. We limited the amount of feed offered to control protein intake and to eliminate any feed refusals. The dry matter digestibility of the cottonseed, alfalfa and pigeonpea diets was similar and averaged 79%. Digestibility of these diets was lower than the 88% observed for the soybean meal diet. Replacing the protein provided by either alfalfa pellets or cottonseed meal with pigeonpeas did not affect protein digestibility, but all of these diets had a lower protein digestibility than the diet contain soybean meal.

We concluded that in a diet formulated to contain 11% protein, whole cracked pigeonpeas can be used as the protein source to replace ether cottonseed meal or alfalfa pellets without affecting dry matter or protein digestibility. The protein concentration in pigeonpeas is similar to that found in alfalfa pellets, but pigeonpeas are more digestible than alfalfa pellets. Based on current prices of the feedstuffs used in this experiment, pigeonpeas had an estimated value of $100/ton.

Table 1. Ingredient composition of the four experimental diets.

	Diet			
Ingredient (% of DM)†	Cottonseed	Soybean	Alfalfa	Pigeonpea
Cottonseed hulls	10	10	--	10
Cracked corn	75	76	70	54
Cottonseed meal	14	--	--	--
Soybean meal	--	13	--	--
Alfalfa pellets	--	--	30	--
Cracked Pigeonpeas	--	--	--	35
Limestone	1	1	--	1

†10 grams of salt were added to each diet daily.

STOCKER LAMB PREFERENCE OF COOL-SEASON HAYS HARVESTED IN THE MORNING OR AFTERNOON

Lisa A. Richards and M. A. Brown

RATIONALE

Recent research findings by USDA scientists suggest hay quality can be improved by cutting in the afternoon as opposed to morning (Mayland and Shewmaker, USDA-ARS-NWISRL-Note 99-01). This is due to accumulation of nutrients by plants during the day while photosynthesis is actively occurring, followed by nutrient use during the night. As a result, higher concentrations of sugars and nitrogen, but lower fiber components, may be found in forages later in the day. Cattle and sheep have been shown to prefer hays harvested in the afternoon, providing the potential for increased intake and performance. While investigated in the eastern and northern United States on fescue, legume, and ryegrass hays, no work has been done to evaluate differences among hay types and harvest times of cool-season grasses from the Southern Great Plains.

OBJECTIVE

This research was conducted to evaluate the effects of time of day for harvesting hay and hay type on stocker lamb preference of cool-season grasses and wheat produced on the Southern Great Plains.

RESULTS

In June 2000, thirty-two spring-born crossbred lambs (Gulf Coast, Rambouillet, Suffolk) were adjusted to individual pens and familiarized with test hays prior to the preference trial. To do this, twelve lambs were offered a meal of hay harvested in the morning or afternoon from plots of ‘Triumph’ fescue, ‘Jose’ tall wheatgrass, ‘Luna’ pubescent wheatgrass, and ‘Paiute’ orchardgrass (Table 1). The remaining twenty lambs were fed the afternoon cutting only of the four hays plus wheat. Hays were coarsely chopped and fed in two buckets to teach lambs to choose between two offerings. In the afternoon, lambs were supplemented with a cracked corn/cottonseed meal mix (19% crude protein) at .8% of initial body weight (average = 57 lbs) and fed oat grass hay.

During the selection trial, lambs were allowed to select between the morning and afternoon cuttings over 4 days or between each combination of grass and wheat hay over 10 days. Buckets and hays were weighed before feeding, at 30 minutes post-feeding, and at the meal end to calculate intake. Hay selection was terminated when a lamb finished one hay or when supplementation time was reached. Differences in intakes were calculated to compare hay types. Hays and refusals were dried at 60^{o}C to express results on a dry matter basis.

Intakes at all times were increased (P < .001) by feeding hay cut in the afternoon versus morning, regardless of hay type (Table 2). The most significant effects across the meal were found with ‘Jose,’ whereas the intake of ‘Paiute’ was least affected by time of hay cutting. Over all times, the consumption of wheat and ‘Luna’ hays were greater (P < .001) than other types of hays, whereas ‘Triumph’ was preferred the least (P < .001) (Table 3). Based on this data, lamb preference among hays was ranked as follows: Wheat = ‘Luna’ > ‘Paiute’ = ‘Jose’ > ‘Triumph’.

These results demonstrate that harvesting cool-season perennial grasses in the afternoon can improve the acceptability of forages grown in the Southern Great Plains. Differences in preference did not appear to be influenced by crude protein or fiber levels. The effects of forage sugar and starch level on lamb preference will be investigated through laboratory analyses. Future research will determine the impact of forage preference on stocker gain and nutrient use under confined and grazing conditions.

Table 1. Nutrient composition of hays (% as-fed basis).

Hay	Crude protein	NDF[†]	Calcium	Phosphorus
	------------------------- Morning harvested (%) -------------------------			
‘Triumph’ fescue	11.0	53.8	0.28	0.25
‘Jose’ tall wheatgrass	10.2	52.9	0.26	0.27
‘Luna’ pubescent wheatgrass	14.7	53.7	0.31	0.33
‘Paiute’ orchardgrass	16.2	54.4	0.26	0.32
Winter wheat	10.1	49.5	0.22	0.26
	------------------------ Afternoon harvested (%) ------------------------			
‘Triumph’ fescue	12.9	52.4	0.27	0.31
‘Jose’ tall wheatgrass	13.9	51.7	0.28	0.29
‘Luna’ pubescent wheatgrass	13.6	53.2	0.29	0.30
‘Paiute’ orchardgrass	14.9	50.8	0.27	0.32

[†]NDF = Neutral detergent fiber.

Table 2. Dry matter intake of hays harvested in morning versus afternoon.

	0 to 30 min		30 min to meal end		Overall	
Hay	Intake[†]	Contrast[‡]	Intake	Contrast	Intake	Contrast
	-- lbs --		-- lbs --		-- lbs --	

‘Triumph’ fescue						
Morning	0.08	0.001	0.23	0.12	0.31	0.001
Afternoon	0.34		0.31		0.65	
‘Jose’ tall wheatgrass						
Morning	0.14	0.02	0.11	0.001	0.24	0.001
Afternoon	0.32		0.32		0.64	
‘Luna’ pubescent wheatgrass						
Morning	0.20	0.09	0.22	0.07	0.41	0.02
Afternoon	0.32		0.31		0.63	
‘Paiute’ Orchardgrass						
Morning	0.20	0.06	0.28	0.60	0.48	0.06
Afternoon	0.33		0.30		0.64	

†SE of the mean: 30 minutes = 0.049 1b; 30 minutes to meal end = 0.037 1b; Overall = 0.060 1b.
‡Contrast: Significance level comparing lamb intake of morning versus afternoon cutting within hay.

Table 3. Differences in dry matter intake of cool-season hays harvested in the afternoon and wheat.

Hay	0 to 30 min		30 min to meal end		Overall	
	Difference†	Contrast‡	Difference	Contrast	Difference	Contrast
	-- lbs --		-- lbs --		-- lbs --	
‘Jose’ vs. ‘Triumph’	0.32	0.001	0.20	0.001	0.52	0.001
‘Luna’ vs. ‘Triumph’	0.39	0.001	0.23	0.001	0.60	0.001
‘Luna’ vs. ‘Jose’	0.14	0.04	0.12	0.02	0.26	0.007
‘Paiute’ vs. ‘Triumph’	0.24	0.001	0.15	0.005	0.39	0.001
‘Paiute’ vs. ‘Jose’	-0.07	0.31	-0.01	0.92	-0.07	0.44
‘Paiute’ vs. ‘Luna’	-0.24	0.001	-0.24	0.001	-0.47	0.001
Wheat vs. ‘Triumph’	0.37	0.001	0.21	0.001	0.56	0.001
Wheat vs. ‘Jose’	0.33	0.001	0.01	0.88	0.33	0.001
Wheat vs. ‘Luna’	0.04	0.59	0.05	0.31	0.09	0.35
Wheat vs. ‘Paiute’	0.22	0.002	0.07	0.18	0.29	0.003

†SE of the mean: 30 minutes = 0.068 lb; 30 minutes to meal end = 0.055 lb; Overall = 0.096 lb.
‡Contrast: Significance level comparing the difference in lamb intake between two hays.

WEED CONTROL IN A WHEAT-PIGEONPEA CROPPING SYSTEM

D. Shantz, E. Petersen, K. Jones, J.E. Bidlack, S.C. Rao and C.T. MacKown

RATIONALE

Pigeonpeas can produce additional forage, grain, nitrogen, and cover during the summer. These legumes have potential as part of wheat-legume cropping systems in the Southern Great Plains because of their ability to withstand hot, dry summers. However, when pigeonpeas are planted in the late Spring / early Summer, proliferation of pigweeds introduce an undesirable impediment to summer legume production. Because pigeonpeas are relatively new to the Southern Great Plains, limited information is available about weed control in this crop and subsequent effects on winter wheat.

OBJECTIVE

Pre- and post-emergence herbicides were evaluated in this experiment to determine the effect(s) of weed control on pigeonpea and wheat biomass production.

METHODS

Field plots were established as a randomized complete block design with three replications at the USDA-ARS Grazinglands Research Laboratory in El Reno, Oklahoma. 'Georgia-2' pigeon peas were evaluated in response to two rates of the following herbicides: Authority (pre-plant applied), Cadre (post-plant applied), Lexone DF (pre-plant applied), and Poast Plus (post-plant applied); plus hand-weeded and weedy-check control plots. Pigeonpeas were planted on 25 May 1999 and herbicides were applied, as PRE or POST, shortly thereafter. Pigeonpeas were harvested, along with weeds, on 22 September. Winter wheat was then established in the same field on 25 October and harvested on 25 May 2000.

RESULTS

Among pre-emergence herbicide treatments, all rates of Authority and the high rate of Lexone DF were as effective in reducing the number of weeds as the hand-weeded treatments (Table 1). Both rates of the post-emergent herbicide, Cadre, were effective in controlling pigweed populations. Both rates of Cadre were just as effective in maintaining pigeonpea populations and total biomass as the hand-weeded plots (Table 2), although some damage to pigeonpeas was observed. High rates of Authority and Lexone DF were most effective in maintaining pigeonpea yields with minimal damage to the crop. Among treatments used, Authority and Lexone DF displayed greatest potential for weed control without substantial damage to pigeonpeas.

Table 1. Weed density and biomass responses to different types of weed control practices.

Treatment	Rate	Weed density	Weed biomass
		plants acre^{-1}	lb acre^{-1}
Hand weed	--	0	0
Weedy check	--	186,000	5,030
Authority	Low	40,500	6,090
Authority	High	24,300	2,940
Cadre	Low	0	0
Cadre	High	1,070	124
Lexone DF	Low	101,000	5,320
Lexone DF	High	32,400	5,900
Poast Plus	Low	194,000	6,370
Poast Plus	High	158,000	6,220
LSD (0.05)		81,000	1,380

Wheat following pigeonpeas subjected to hand weeding, as well as Authority and Lexone DF herbicides, had higher plant stand and biomass compared with weedy-check, Cadre, and Poast Plus herbicide treatments. These results were interesting, in that, Cadre, the most effective herbicide controlling pigweed in pigeonpeas, subsequently reduced plant stand and biomass of winter wheat. For this reason, Authority and Lexone DF may be the best for moderate weed control in pigeonpeas, because these herbicides provided weed control during the summer without substantial damage to winter wheat.

ACKNOWLEDGEMENTS

This project was funded by the Oklahoma Center for the Advancement of Science and Technology (OCAST), Oklahoma Applied Research Support Internship Program, and matched by the USDA-ARS Grazinglands Research Laboratory. Support, in the form of release time, was also provided by the University of Central Oklahoma Office of Sponsored Research and Grants to provide additional time for the project and supervision of Undergraduate Student Interns.

Table 2. Pigeonpea and wheat responses as a result of different types of weed control and hrebicide rate.

		Pigeonpea responses		Wheat responses	
Treatment	Rate	Plant density	Plant biomass	Plant density	Plant biomass
		plants acre^{-1}	lb acre^{-1}	plants acre^{-1}	lb acre^{-1}
Hand weed	--	28,400	4,054	883,000	2,970
Weedy check	--	16,200	1,430	405,000	1,550
Authority	Low	16,200	1,480	482,000	1,790
Authority	High	28,400	2,830	616,000	2,330
Cadre	Low	24,300	4,090	211,000	819
Cadre	High	24,300	3,960	68,900	261
Lexone DF	Low	20,300	1,590	450,000	1,710
Lexone DF	High	20,300	1,920	559,000	2,120
Poast Plus	Low	20,300	1520	441,000	1,580
Poast Plus	High	12,200	1,300	397,000	1,620
LSD (0.05)		12,200	922	231,000	649

PLANT AND GRAIN TRAITS OF DUAL-PURPOSE WINTER WHEAT

Charles T. MacKown, Brett F. Carver, and Eugene G. Krenzer, Jr.

RATIONALE

Growing winter wheat (*Triticum aestivum* L.) as a dual-purpose crop for both forage and grain is an important management tool for many producers in the Southern Great Plains. Often this system offers economic advantages not enjoyed by producers relying on wheat exclusively for forage or a grain crop.

The effects of grazing on wheat used as a dual-purpose crop can vary depending on cultivar, environmental factors, and management practices. Generally, when grazed wheat is managed to minimize losses in grain yield, shoot weight at heading is often less than that of grain-only wheat. The ratio of grain dry weight to total shoot dry weight (harvest index) of dual-purpose wheat grazed by cattle in the Southern Great Plains can exceed that of grain-only wheat by up to 29%. The increased harvest index of dual-purpose wheat occurs because the dry weight of the straw is often affected more than grain yields.

Environmental factors affecting the availability of soil N and the physiological processes of N uptake, assimilation, and redistribution can alter grain yield and protein concentration. Because up to 90% of the total nitrogen (N) present in wheat at harvest can be accumulated by heading, N uptake during grain filling can be insufficient to meet the N demands of the grain. Consequently, a considerable amount of N already accumulated is redistributed to the grain. Differences in N uptake patterns and N redistribution efficiency can affect grain protein concentration of small grains. Variations in N redistribution efficiency, however, appears to have less impact on grain protein concentrations than factors affecting N uptake. Harvest index of wheat is often negatively associated with grain protein concentration, so if total N uptake before grain filling, a function of plant dry weight at heading, is decreased by grazing, then grain N concentration of dual-purpose wheat should decrease. In addition, forage consumed by livestock early in the season removes N that could be redistributed during grain filling and could lead to lower grain protein concentration. Grain protein concentration directly affects many traits that determine the quality of hard red winter wheat used to make bread.

Recently at an Oklahoma wheat industry meeting, Gary Gilbert, the new Executive Director of the Oklahoma Wheat Commission, asked if there was any documentation of the effects of dual-purpose wheat production on grain quality. While much more is known about management effects of dual-purpose wheat on grain yield, documentation of the impacts of the dual-purpose system on grain quality and many physiological traits of wheat are unavailable. We began to address these issues in a 1997 preliminary investigation at the USDA-ARS Grazinglands Research Laboratory and then later with additional research at the Oklahoma State University Wheat Pasture Research Center in Marshall.

OBJECTIVE

The objective of this research was to compare grain and N use traits of winter wheat grown as a dual-purpose crop or as a grain-only crop.

RESULTS

In the preliminary experiment, hard red winter wheat '‘2163’ was planted early September 1996 at the Grazinglands Research Laboratory following production practices recommended for Oklahoma. Pastures were either grazed (1.9 acres per 615 lb steer) from October to early March or left ungrazed. At the end of grazing, the aboveground dry weight of grazed wheat was 60% less than that not grazed, but there were about 20% more tillers. This difference in total plant dry weight decreased slightly at heading, but was still nearly 47% less for the dual-purpose wheat at harvest (Fig. 1). The number of live tillers declined markedly in both production systems as the crop matured. At heading (and harvest), tiller density of grazed wheat was 75% of that of grain-only wheat. Because of the differences in total dry weight of the wheat, aboveground N accumulated by grazed wheat was less than that of grain-only wheat (Fig. 2).

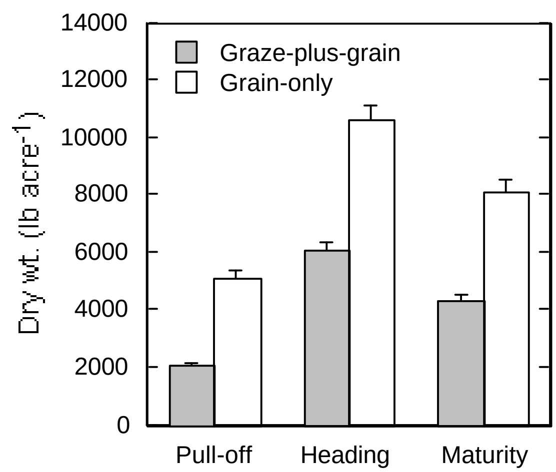

Fig. 1. Aboveground dry weight of genotype 2163 wheat managed as a graze-plus-grain or grain only crop. Dates were: pull-off 10 Mar 1997; heading 30 Apr 1997; harvest 6 June 1997. Small vertical bars represent 1 SE.

Grain yields of both systems were similar, but harvest index of dual-purpose wheat was much greater than that of grain-only wheat (Table 1), because straw dry weight of dual-purpose wheat was much less. Average kernel dry weight was the same for both systems; protein concentration of dual-purpose wheat was about 9% less than grain-only wheat (Table 1).

Several quality traits determined by the USDA-ARS Hard Red Winter Wheat Quality Laboratory in Manhattan, KS were also measured. Wheat harvested from graze-plus-grain and grain-only productions systems had different dough processing and bread making properties corresponding to lower grain protein level of the dual-purpose wheat (Table 2).

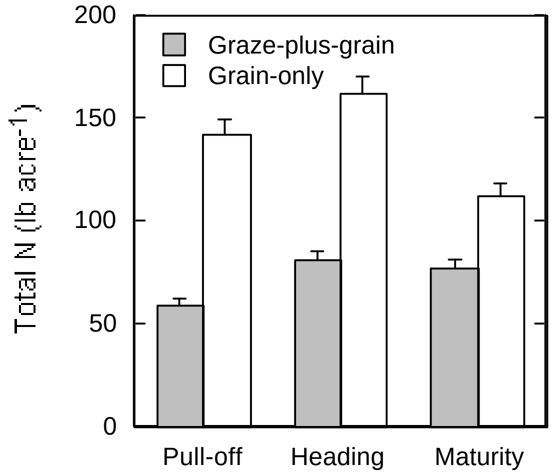

Fig. 2. Aboveground N content of genotype 2163 wheat managed as a graze-plus-grain or grain only crop. Dates were: pull-off 10 Mar 1997; heading 30 Apr 1997; harvest 6 June 1997. Small vertical bars represent 1 SE.

Table 1. Effects of grazing genotype 2163 wheat from 6 Oct 1996 until 10 Mar 1997 on yield, harvest index, kernel dry weight, and grain protein (14% moisture basis).

Trait	Graze plus grain	Grain only	*P* > |t|
Yield (bu/ acre)	36	44	0.08
Harvest index	0.44	0.29	0.01
Kernel wt. (oz/1000)	0.78	0.78	0.63
Protein (%)	11.6	12.7	0.03

Several quality traits determined by the USDA-ARS Hard Red Winter Wheat Quality Laboratory in Manhattan, KS were measured. Wheat harvested from graze-plus-grain and grain-only productions systems had different dough processing and bread making properties corresponding to lower grain protein level of the dual-purpose wheat (Table 2).

This experiment was followed by a more in depth study in 1998 and 1999 at Marshall, OK. Twelve wheat varieties that varied in yield potential and harvest index were evaluated (Table 3). All plots were preplant fertilized to provide 190 lb N/acre (fertilizer + residual soil nitrate-N).

Table 2. Selected grain physical and flour mixograph and bread making (0.22 lb flour) traits of genotype 2163 wheat from graze-plus-grain and grain only plots.

Trait	Graze plus grain	Grain only	*P* > |t|
Ash, %	0.185	0.192	0.23
Flour yield (%)	61.6	61.3	0.57
Milling score	73.1	74.7	0.12
Absorption (%)	61.5	63.0	<0.01
Mix time (min)	3.75	3.22	0.06
Tolerance score	4	4	1.00
Bake mix time (min)	6.06	4.82	<0.01
Proof height (in)	2.87	2.95	0.07
Loaf wt. (lb)	0.34	0.34	0.25
Crumb score	3.70	4.38	0.13
Loaf vol (ft^3)	0.028	0.031	<0.01
Specific vol. (ft^3/lb)	0.082	0.091	<0.01

Table 3. Year of release and agronomic traits of the twelve HRWW cultivars evaluated.

Cultivar	Year of release	Plant height	Harvest maturity
Turkey	1919	Tall	Late
Triumph 64	1964	Tall	Medium
Scout 66	1966	Tall	Late
TAM 101	1971	Short	Med/Late
Vona	1976	Med	Early
TAM 105	1979	Short	Med/Late
Chisholm	1983	Med	Early
2157	1987	Med	Medium
2163	1989	Med	Medium
Karl 92	1992	Med	Early
Custer	1994	Med	Early
2174	1997	Med	Medium

At heading and harvest, plants were collected from a 1 m (3.3 feet) length of row in replicated plots of each cultivar located in fields where wheat was grazed (1.5 acre per 500 1b steer) from early November until jointing (onset of first hollow-stem of the earliest maturing cultivar). Plant and grain responses to the two production systems were not consistent each year. However, averaged across years and cultivars the weight of the flag leaf of dual-purpose grown wheat at heading was 25% less than that for the grain-only system with a N concentration up to 14% less (Table 4). Shoot dry weight and N content at heading of grain-only wheat was greater than dual-purpose wheat in 1998 but not 1999. At harvest, averaged across cultivars, the number of spikes, shoot dry weight, grain dry weight and grain N of dual-purpose grown wheat were all less than that of wheat grown with the grain-only system in 1998 but not 1999 (Table 4).

These results demonstrate that shoot and grain traits of wheat grown as a dual-purpose crop of forage and grain can differ from that of wheat grown for grain-only. However, for a set of cultivars that have a wide range in plant height, harvest index, and yield potential, the magnitudes of these differences due to management system were not the same each year. An interaction between management system and environmental conditions appears to play an important role in plant responses to dual-purpose production and can lead to decreased yield and grain protein, when shoot dry weight and N accumulated at heading are decreased. These decreases, however, are not always dependent on the harvest index. Additional research is required to confirm these findings and develop practices that could be used to minimize the potential for lower yields and grain protein of wheat grown in a dual-purpose production system.

Table 4. Selected traits of dual-purpose and grain-only wheat shoots at heading and harvest. Values are overall averages of the 12 cultivars evaluated.

	1998			1999		
Trait	Graze + grain	Grain only	*P* > |t|	Graze + grain	Grain only	*P* > |t|
			Heading			
Tillers (#/ft row)	55	63	0.016	60	48	< 0.001
Flag leaf dry wt (lb/1000)	0.174	0.229	0.001	0.185	0.247	< 0.001
Flag leaf N (%)	4.05	4.19	0.005	3.01	3.52	< 0.001
Shoot dry wt (lb/acre)	7,530	9,940	< 0.001	8,580	8,150	NS
Shoot N (lb/acre)	121	168	< 0.001	132	134	NS
			Harvest			
Spikes (#/ft row)	46	56	0.003	51	45	NS
Shoot dry wt (lb/acre)	15,500	20,800	0.001	14,300	15,000	NS
Grain dry wt (lb acre)	3,530	4,740	0.006	2,600	2,720	NS
Harvest index	0.23	0.23	NS	0.18	0.18	NS
Grain N (%)	2.54	2.69	0.014	2.45	2.45	NS

IMPACT OF SEASON AND SOIL MOISTURE ON FORAGE PRODUCTION BY SOUTHERN TALLGRASS PRAIRIE, OKLAHOMA

Brian K. Northup

RATIONALE

Tallgrass prairie can play an important role in livestock production systems of southern and central Oklahoma. It represents a low-input source of forage from May through October, though quality can be variable. The timing and level of production during the growing season depends on a combination of soil moisture availability, timing of rains during the year, and growth and maturity of plants. The effects of season and plant (tiller) maturity affects on productivity and forage quality must be understood to ensure proper management.

OBJECTIVE

The objective of this study was to examine the effect of time of growing season, soil moisture, and maturation of grass tillers on the productivity of a native southern tallgrass prairie site.

METHODS

Experimental plots were established in February 1999 on two slope positions (ridge and bottom of slope) of a Norge silt loam soil. Each plot was divided into a series of sub-plots, and data were collected from sets of these sub-plots at 14-day intervals from March 24 (12 days after a prescribed burn) through October 1. Aboveground standing crop was collected from 5.4 ft^2 areas of the sub-plots. Productivity and maturity of tillers of two dominant grasses (big bluestem and little bluestem) were described by collecting 75 plants of each species from the remainder of the sub-plots, growth staging the plants and weighing the materials. Soil moisture was measured at the same times the plant community was sampled, by collecting samples from three depths of the profile (0-4, 4-10, and 10-20 in).

RESULTS

The majority of the 1999 standing crop (Fig. 1a) was produced early in the growing season (May-June), with the principal reason being the increase in weight and maturity of tillers of the dominant grasses (Fig. 1b). The biggest increases in standing crop occurred when plants were in the vegetative (leafy) and elongating (stem) stages of maturity. Thereafter, production slowed as plants entered the flowering stages, while levels of dead materials (leaves and other parts shed by plants) increased. Crude protein in tallgrass hay declines with advance of growing season and generally falls below the level required to support cattle growth by mid-growing season (Fig. 1c). Soil moisture was above the level required to support plant growth until August (Fig. 1d), which helped the plant community (and individual plants) reach a high level of production. These results help describe the capacity of native tallgrass prairie to produce forage and the trade-offs that exist between quantity and quality. The best time to hay or graze to gain the optimum combination of amount and quality of forage appears to be during June. Additional data will be collected through October 2000, and 2001, to help describe effects of different growing seasons.

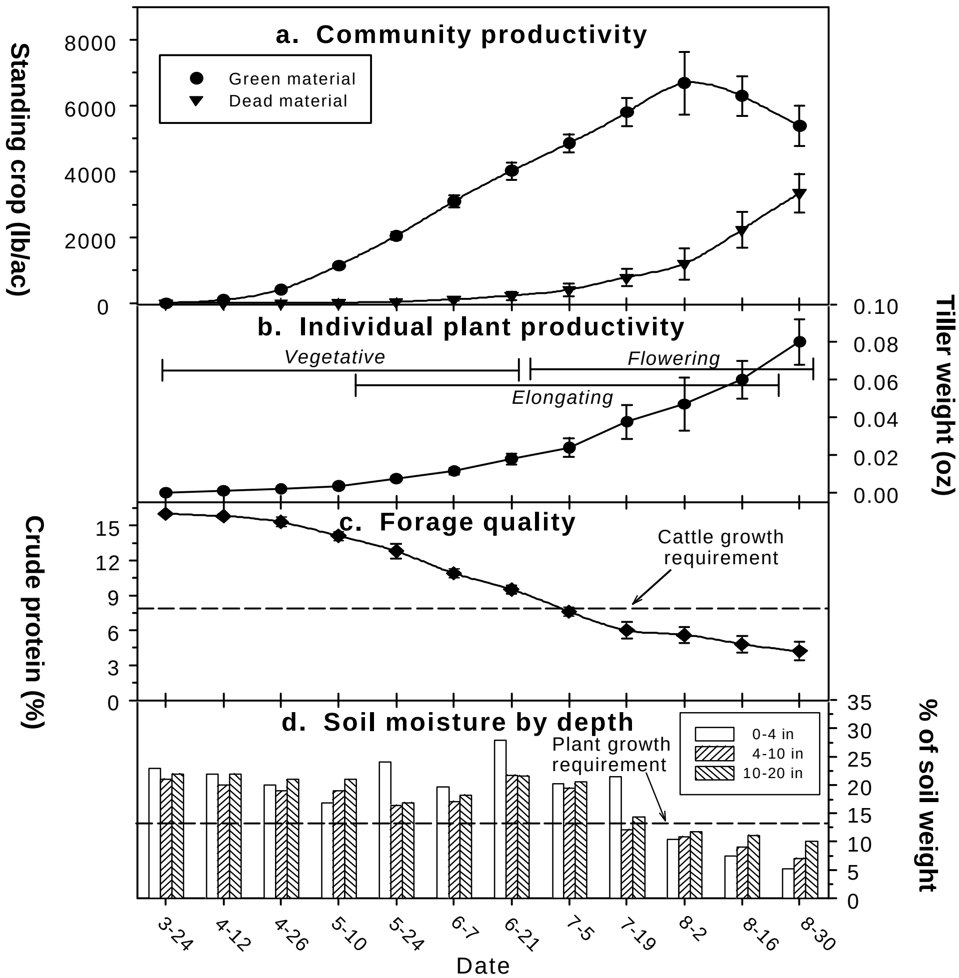

Fig. 1. Changes in community and plant (including key growth stages at different times) productivity, forage quality and soil moisture during the 2000 growing season on a tallgrass prairie site in the Southern Great Plains. Forage quality represents averages calculated from a series of studies conducted on different tallgrass prairie sites.

CLIMATE AND MANAGEMENT IMPACTS ON SPECIES COMPOSITION OF A SOUTHERN TALLGRASS PRAIRIE, OKLAHOMA

Brian K. Northup and J. Daniel

RATIONALE

Native tallgrass prairie is an important resource for livestock producers in the Southern Great Plains of Oklahoma. It requires few inputs and can produce large amounts of forage if properly managed. The species composition of these plant communities is important to their productivity, since key species like big bluestem, Indian grass, switchgrass and little bluestem can produce from 50 to 80% of any given year's standing crop. The amount and timing of rains can also affect production. Dry (or wet) periods at specific times of the year can cause shifts in composition and amounts of produced forage. Understanding how pasture management and climate can affect species composition and productivity is important to sustainable use of tallgrass prairie in Oklahoma.

OBJECTIVE

The objective of this study was to describe how different forms of pasture management and climate affect the composition of annual production in a set of experimental pastures.

METHODS

Plant community responses of four-acre experimental pastures managed in different ways were recorded during 1985 through 1995, and rainfall received was measured with a set of rain gauges. Management regimes applied to pastures were: heavily grazed by stocker cattle (82 animal unit days [AUD] grazing per year, where AUD represents the amount of forage required to support a 1000 lb cow plus 300 lb calf, or the equivalent amount of other grazing animals); lightly grazed by stocker cattle (46 AUD grazing per year); and lightly grazed with regular applications of broadleaf herbicide (1 qt/ac Grazon T+P every 2 years) and fertilizer (102 lb/ac 46-0-0 and 95 lb/ac 18-46-0). Within each pasture, an ungrazed plot was fenced in as a comparison for describing grazing effects. Each year, the contribution of forage species (by percent of standing crop) to annual production of the pastures were described by estimation techniques, and divided into different classes. Included were the four key warm-season grasses (big bluestem, little bluestem, Indian grass and switchgrass) and 5 classes (shortgrasses [grama grasses]; annual bromes [cheatgrass and Japanese brome]; perennial cool-season grasses [5 species]; other warm-season grasses [13 species]; and broad-leaved forbs [19 species]) based on growth habits and season of production. Specialized analysis techniques were applied to determine which of these forages acted as functional groups in response to grazing and pasture management, during the study.

RESULTS

The analysis techniques used divided the four key grasses and five classes into three functional groups that described responses of available forages to management and rainfall. Group “A” was composed of the four key grasses and forbs, group “B” the classes warm-season grasses and annual bromes, and group “C” the shortgrasses and cool-season grasses. Contributions of group “A” forages declined, and group “B” forages generally increased during the study under all management combinations, though responses varied with rainfall (Fig. 1). Contribution of group “C” forages remained relatively constant, and contributed only small amounts of material to standing crop, except in 1990-1991 when their productivity more than doubled. Group “C” forages also remained high on heavily grazed pastures after 1991. All three management systems caused shifts (compared to ungrazed plots) in the composition of available forage, as defined by functional groups, beginning in 1990-91 (Fig. 1). This shift was due to the combination of dry conditions (Table 1) at key times for recharge of soil moisture (November-February) and early plant growth (March-June) during 1988-89, and applied grazing pressures; the effects on the plant communities lagged rainfall by one year. The composition of standing crop in all pastures had not returned to 1985 levels by 1995. Heavy grazing and application of fertilizers and herbicide appeared to favor the less-common warm-season grasses (including annual foxtails, crabgrass, dropseeds and three-awns) over the four dominant species.

Results indicate that even conservative grazing can have a negative effect on the composition of grazed plant communities, particularly if drought occurs at key times of the year. Also, large-scale application of fertilizers and herbicides had little value in increasing production by the dominant grasses on native prairie; herbicides also cause the loss of production by forbs (2-10% of total). The underlying theme from the results of this study is that management systems (including grazing) applied to tallgrass prairie of the Southern Great Plains must remain flexible and be balanced against rainfall in order to be sustainable and of value to producers.

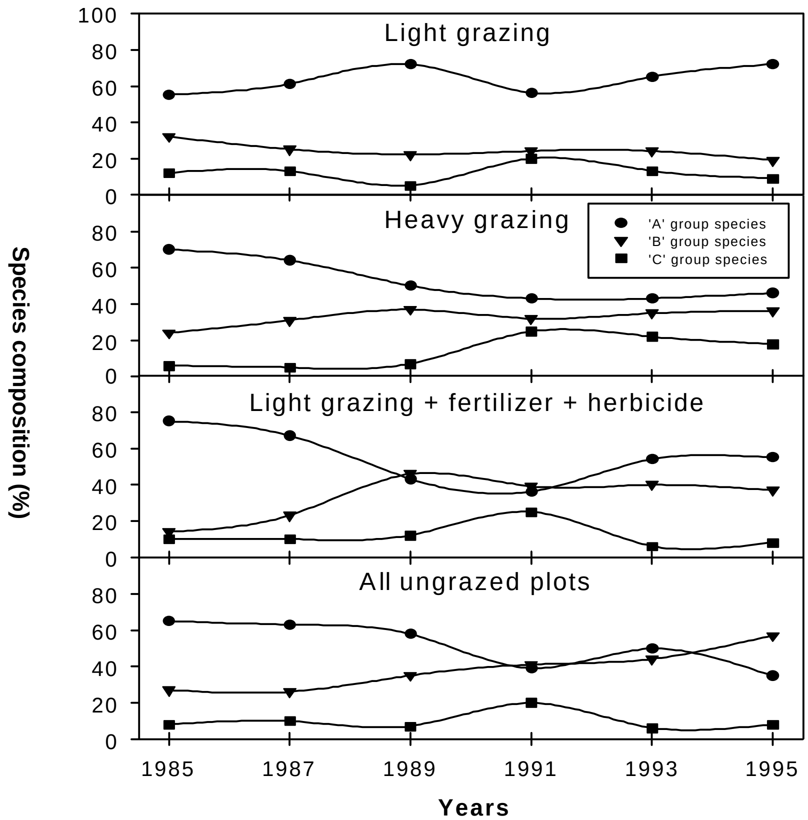

Fig. 1. Changes in species composition of production by a Southern tallgrass prairie site during 1985-1995, in response to pasture management. 'A' group plants included the four dominant warm-season grasses and forbs. 'B' group plants the other warm-season grasses and annual bromes. 'C' group plants the short grasses and cool-season grasses.

Table 1. Precipitation record for watershed pastures of the Grazinglands Research Laboratory during 1985 through 1995.

Year	Jan.-Feb.	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Total
	----- inches -----						
1985	4.4	10.8	6.7	3.4	9.1	1.9	36.3
1986	0.3	3.3	14.0	6.6	17.1	3.8	45.1
1987	4.9	2.1	15.5	7.5	5.7	5.9	41.7
1988	1.5	10.0	4.2	1.7	9.2	1.8	28.4
1989	3.0	3.5	17.9	6.6	8.1	0.1	39.2
1990	6.2	11.1	7.8	4.3	6.5	2.4	38.2
1991	0.7	4.6	9.4	6.6	6.9	6.5	34.7
1992	1.0	3.7	9.7	8.8	2.7	9.6	35.5
1993	4.5	6.0	16.2	3.9	6.2	3.2	40.0
1994	1.4	12.7	5.6	3.5	3.6	6.6	33.4
1995	1.0	6.9	16.6	7.2	6.4	1.9	39.9
Avg (85-95)	2.6	6.8	11.2	5.5	7.4	3.9	37.4
Avg (77-99)	2.2	5.0	10.9	5.1	6.1	3.6	32.9

PIGEONPEA: NEW SOURCE OF FORAGE FOR THE SOUTHERN GREAT PLAINS

Srinivas C. Rao and S. W. Coleman

RATIONALE

A universal goal of stocker programs is to graze high quality pastures year-round to reduce the cost of using harvested or purchased feed. The primary forage resource for livestock in the Southern Great Plains is winter wheat from late fall through March or May, followed by warm-season perennial grasses. This grazing system leaves a void in available forage from late August until November, raising the need to evaluate alternative forages. Pigeonpea is one of the major summer grain legumes of the tropics and subtropics. Because it has the potential to produce large quantities of high quality biomass, pigeonpea survivability and production in the Southern Great Plains region must be determined.

OBJECTIVE

The objective of this study was to investigate the seasonal forage production patterns and nutritive value of pigeonpea from July through October in the Southern Great Plains region.

RESULTS

Three pigeonpea cultivars, [ICP 8151(long duration), ICPX 910007 (medium duration), and PBNA (dwarf height, long duration)], were obtained from ICRISAT, India, for this study. Plots were disked twice soon after wheat harvest and 60 lbs of phosphorus was broadcast applied before second disking. No nitrogen was applied. Pigeopeas were planted early June at the rate of 30 lbs seed per acre in rows spaced 24 inches apart. Crop was grown under rainfed conditions. Whole-plant dry matter yield increased linearly across sampling dates (Table 1). At final harvest in October, the accumulated dry matter yield was lowest for PBNA and highest for ICPX 910007.

Protein content and dry matter digestibility of whole plants averaged over growing season was highest for PBNA as compared to the other cultivars (Table 2).

Leaf to stem ratio was highest for PBNA (Table 3). While leaf protein content was similar for all cultivars tested, stem protein content was highest for PBNA. Leaf and stem digestibilities were similar.

This research demonstrates that pigeonpeas provide abundant forage of high quality from August until October when deficits often occur with other pasture systems. The forage quality of pigeonpeas approaches that of alfalfa and soybean and could be used to reduce or eliminate supplemental feed costs. Future research will focus on determining stocker acceptability, feeding value, and incorporation of pigeonpeas into grazing systems of the Southern Great Plains.

Table 1. Mean dry matter accumulation of three pigeonpea cultivars over sampling dates.

Cultivars	July 7	Aug 8	Aug 26	Sep 11	Oct 3	Cultivar means
	----------	----------	lb acre^{-1}	----------	----------	lb acre^{-1}
ICP8151	1290 A†	2820 A	5260 A	6860 A	12530 A	5750 B
ICPX910007	1140 A	2960 A	5840 A	7880 A	15800 A	6720 A
PBNA	930 A	2520 A	3560 B	6690 A	9470 B	4630 C
Sampling day means	1120 e‡	2770 d	4890 c	7140 b	12600 a	

†In a column, means followed by same upper case letter are not significantly different at $P \leq 0.05$.
‡In a row, means followed by same lower case letter are not significantly different at $P \leq 0.05$.

Table 2. Average protein and dry matter digestibility (DMD) of three pigeonpea cultivars over growing period.

Cultivar	Protein	DMD
	---------------- % ----------------	
ICP8151	14.5 B†	57.6 B
ICPX910007	14.3 B	57.2 B
PBNA	17.8 A	61.4 A

†In a column, means followed by same upper case letter are not significantly different at *P* ≤ 0.05.

Table 3. Yields, protein content, and dry matter digestibility (DMD) for the leaf and stem of three pigeonpea cultivars.

	Dry wt.		Protein		DMD	
Cultiva	Leaf	Stem	Leaf	Stem	Leaf	Stem
	-------- lb acre^{-1} --------		------------ % ------------		------------ % ------------	
ICP8151	2360 A†	3340 B	24 A	5.0 B	74.0 A	43.5 A
ICPX910007	2770 A	3990 A	24 A	5.0 B	73.5 A	43.6 A
PBNA	2600 A	2030 C	24 A	7.5 A	72.2 B	44.3 A

†In a column, means followed by same upper case letter are not significantly different at *P* ≤ 0.05.

SEASONAL CLIMATE FORECASTS: AN OPPORTUNITY FOR AGRICULTURE

J. M. Schneider and J. D. Garbrecht

RATIONALE

Agriculture in Oklahoma, and in the Great Plains in general, relies mainly on dry land farming. This has been a risky enterprise since plow first turned sod. The single largest risk factor is the huge variation in weather and climate, particularly seasonal rainfall, from year to year, and decade to decade. Scientists currently studying Great Plains climate tend to describe it as "droughts punctuated by floods". Agricultural research over the last century has produced an impressive array of tools, options and management strategies that maximize productivity in this harsh environment. But fiscal success or failure is still mostly determined by whether precipitation and temperature over a season or year were "average" or not. Skillful predictions of climate for the coming year would represent a significant opportunity to fine tune agricultural management for maximum productivity. In bad years, adverse conditions could be mitigated through early preparations and adaptive management strategies. In good years, favorable climate conditions could be exploited. Since the definition of "bad" or "good" climate variations depends on the particular agricultural application, some interpretation of a forecast climate's impact is necessary. In this article we will highlight some experimental seasonal climate forecasts produced by the National Oceanic and Atmospheric Administration (NOAA), as an introduction to associated research by the USDA-ARS to interpret, extend and apply these forecasts to meet agricultural needs.

DESCRIPTION OF CLIMATE FORECASTS

Experimental, successful, fallible, and free are words that describe the seasonal climate forecasts provided monthly by NOAA's Climate Prediction Center (CPC). The suite of forecast products can be viewed on this federal agency's World Wide Web site (http://www.cpc.ncep.noaa.gov), along with a wealth of other climate information. Monthly and seasonal climate forecasts show expected departures from average conditions for air temperature and total precipitation for the coming month, and for three-month periods out to a year ahead of time. Note that these are not *weather* forecasts – they do not predict weather on individual days for a particular small area. Instead, they predict the sum of the weather (climate) for 90-day periods over a large region. The size of the forecast region can cover several crop reporting districts. In central Oklahoma, the forecast region is roughly 40,000 square miles, or about half the size of Oklahoma. There are two different, but complimentary, seasonal climate forecasts offered by NOAA/CPC. The appearance of the climate forecasts is very different from everyday weather maps, so some introduction is in order.

The first forecast is the "Current Monthly/Seasonal Forecast", which is issued for both average temperature and total precipitation for 90-day periods. Forecasts can be viewed at the CPC web site listed above by clicking on "Outlooks (Forecasts)", then "Seasonal", and then choosing one of the "Color Maps" near the bottom of the page. An example is shown in Fig. 1. Note that this forecast doesn't tell you how *much* wetter or dryer, warmer or cooler, just how *likely* it is to be different from normal. This forecast predicts whether the climate will be "Above", "Near Normal", or "Below", relative to average conditions from 1961 through 1990. The forecast is presented as a map of the U.S. with different colors for the different conditions. The more intense colors indicate higher odds that the climate will be "Above" or "Below" normal.

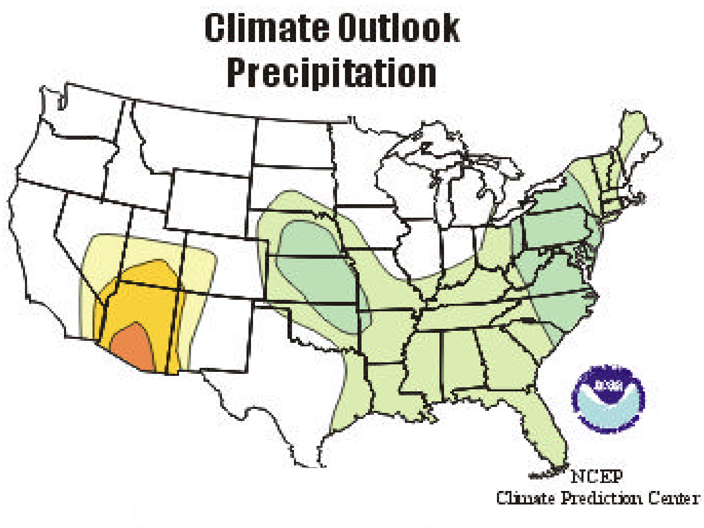

Fig. 1. Monthly/seasonal forecast of climate anomaly for August-September-October 1999.

The second seasonal climate forecast is called the "Probability of Exceedance Forecast". This forecast predicts the *size* of the change in average temperature, total precipitation, and degree (heating or cooling) days over 90-day periods. They are available at the site listed above, on the same page as the other forecasts; click on "Prob of Exceed" for the lead time desired. The easiest presentation to read is a map of the U.S., similar to the "Current Monthly/Seasonal Forecast". An example is shown in Fig. 2. The map shows contours of the "normal" conditions in black lines on the map, and the forecast "exceedance" (amount above or below normal) as colored areas. This map makes it easy to recognize both the average conditions and the forecast changes.

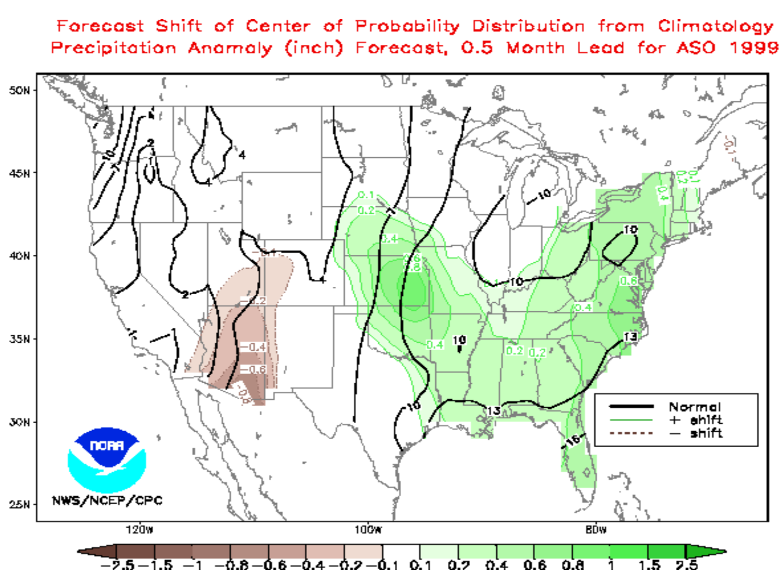

Fig. 2. Probability of exceedance forecast for August-September-October 1999.

The NOAA climate forecasts are experimental because they are relatively new, and because they are being continuously improved with new research results. They represent the best current scientific knowledge of predictable aspects of the climate, but that knowledge is limited and imperfect. The situation is similar to looking out over moderately foggy terrain – nearby objects are easy to see, but further objects tend to be obscured. Similarly, this season's forecast is more certain than next season's forecast. As a result, the forecast for any 90-day period tends to change as you get closer to it in time, usually becoming more specific and more accurate. NOAA has issued climate forecasts since 1995, and has experienced both fantastic success and failure, occasionally at the same time for different regions. Overall, the forecast success rate is better than random chance could produce, and is expected to improve as new research findings are incorporated.

ASSESSING, ADAPTING, AND APPLYING CLIMATE FORECASTS FOR AGRICULTURE AND NATURAL RESOURCE MANAGEMENT

J. M. Schneider and J. D. Garbrecht

RATIONALE

If you've seen some of the climate forecasts available these days, you may be asking yourself some very reasonable questions, like "What do these climate forecasts really mean for my operation?", "How accurate are they?", and "Can I trust them?". A variety of climate forecasts are available from private, state, and federal agencies, all a bit different, all pretty new. The seasonal climate forecasts produced by NOAA's Climate Prediction Center deserve particular attention for two reasons: 1) they incorporate the best current scientific understanding; and 2) they are free and available to anyone with World Wide Web access (See "Seasonal Climate Forecasts: An Opportunity for Agriculture" for the address). As one might expect, NOAA's climate forecasts are intended for a general audience, so there are a number of challenges facing any agricultural user who wants to apply them. That's where our research effort kicks in. Here at the Agricultural Research Service (ARS) Grazinglands Research Laboratory (GRL) in El Reno, we are conducting research on the issues related to applying climate forecasts in agribusiness. These issues include:

1. The large size of the region covered by the forecast (about half the size of Oklahoma); most users need forecasts for areas the size of ranches and farms.
2. The long period (90 days) for which the forecast is issued; agribusiness needs forecasts for weeks and days, as well as over seasons.
3. The local uncertainty associated with a regional forecast; in other words, does the forecast skill change if the forecast is applied to a smaller area?
4. The impact forecasted climate conditions will have on soil water, surface water runoff, and forage and grain production.

The rest of this article will touch on each of these issues briefly. All of the research discussed below will initially be developed and tested for the Great Plains.

METHODS

First, the climate forecasts predict an average air temperature and average total precipitation for a region that usually covers several crop reporting districts. Such averaged values may not be of much use to an individual operator. For example, within such a large region, we know that precipitation will actually have a wide range of variation, location to location, that is not indicated in the regional forecast.

Some of this variation is random, but some of it is systematic, the natural result of seasonal storm tracks. When applying the climate forecast at the farm and ranch level, this range of variation must be accounted for properly. The ARS-GRL conducts research to develop methods to estimate the range of variability of air temperature and precipitation within a region, and to provide procedures for the local interpretation of the regional climate forecast.

Second, the climate forecasts are issued for the next month, and for three-month periods thereafter. Average air temperature and total precipitation over one and three-month periods can be used for general planning and management. However, the agricultural user often needs more detailed information, such as the expected variation in air temperature during the period, the expected number of rainy days, the expected number of consecutive days without rain, or the expected intensity of rainfall events. The ARS-GRL conducts research to develop methods to estimate the likely distribution of critical events (storms, droughts, frosts, etc.) during the three-month forecast period.

Third, the amount of uncertainty associated with the climate forecast applies to the large region. Use of the forecasts at the farm or ranch level implies an additional local uncertainty that reflects the variability of air temperature and precipitation across the larger region. In other words, the local climate forecasts may be less certain, and possibly less skillful. For proper assessment of the risk-benefit of using a regional forecast at the local level, the local forecast skill must be determined. The ARS - GRL conducts research to establish the skill of a local climate forecast, given NOAA's regional climate forecast.

Fourth, a climate forecast is only truly useful for agribusiness if it can be used to make planning or management decisions. To this end ARS - GRL conducts research to establish the impact of the forecasted climate on surface water runoff, soil water storage, and forage or grain production potential. Such specific information can be used to determine the number of livestock that a farm operation can support during the upcoming season; the need for outside forage supply; decisions on winter wheat grazing or grain production options; fertilizer needs; erosion protection; and other cost-benefit issues.

EXPECTED BENEFITS

The research at the ARS-GRL outlined above will produce several tangible outcomes with direct benefit to the agricultural community. First, we will provide recommendations to NOAA that may lead to the development of more agriculture-specific climate forecasts. Second, we will provide information on expected changes in the soil water and crop productivity as a result of forecasted climate conditions suitable for use while making agribusiness decisions. Third, we will provide alternative agronomic practices that can be used to mitigate adverse and exploit favorable climate conditions during the upcoming growing season. And fourth, we will organize the forecast, risk, and impact information into a decision support system that can be accessed by the farmer or rancher. In short, give us a couple of years, and we'll tell you what the NOAA climate forecasts mean to you.

SIRE BREED EVALUATION IN STOCKER CATTLE FROM BRANGUS COWS

M.A. Brown, L.A. Richards, W.A. Phillips

RATIONALE

The stocker industry in the Southern Great Plains primarily depends on cattle from outside the region. Many stocker calves managed on wheat pasture originate from the Southeast, where much of the cow herd is influenced by Brahman breeding. This influence results from the need to use cows adjusted to the hot, humid production environment of the southeast U.S. There are concerns, however, that percentage Brahman calves are more susceptible to cold stress as stockers and feeders, that they do not gain as well under feedlot conditions, and that their carcasses are less tender compared to calves that are not percentage Brahman. Data from the Grazinglands Research Laboratory indicated that Hereford x Brahman stockers (50% Brahman) were superior to Hereford x Angus stockers in stocker gains in the winter and spring, but not in feedlot gains in the fall. Research at other institutions has indicated a negative relationship of meat tenderness to percentage Brahman. However, the influence of other breeds in combination with Brahman-influenced cattle on stocker and feedlot gains and carcass quality has not been well defined. There is a need to evaluate postweaning performance of calves sired by Continental, British, and tropically-adapted sires from Brahman-influenced cows.

OBJECTIVE

The objective of this research is to evaluate stocker, feedlot, and carcass traits of calves from Charolais, Gelbvieh, Hereford, Bonsmara, Romosinuano and Brangus sires bred to Brangus cows.

METHODS

In a project with the International Brangus Breeders Association, 200 Brangus females were acquired to evaluate postweaning performance of calves from Charolais, Gelbvieh, Hereford, Bonsmara, Romosinuano, and Brangus sires. These represent Continental, British, and tropically-adapted sire breeds. The Bonsmara is a South African breed that is a composite of native Africander and British breeds. The Romosinuano is a South American breed and is considered a Criollo type. Approximately equal numbers of cows and heifers will be bred to each sire breed. Calves will be spring born, weaned in the fall and grazed on wheat pasture through March of the subsequent year. After wheat pasture, steer calves will be placed in feedlot, finished to 10 mm backfat, and evaluated for carcass quality. Heifers will be placed on warm-season grass to evaluate yearling gains and reproductive traits. Phase II of this research will involve evaluation of productivity of calves generated from these heifers bred to terminal cross sires. Stocker, feedlot, and carcass performance will be evaluated as described in the first phase. Breeding for Phase I was initiated spring of 2000 and phase I of the project will terminate spring of 2005. Phase II will begin in 2002 and continue through 2007 with calves evaluated similar to those in Phase I.

EXPECTED BENEFITS

Results from this research will allow comparison of the specific combining ability of different sire breeds with Brangus cows, i.e., it will provide information on which sire breeds work best with Brangus cows for stocker and feedlot performance as well as carcass merit. Research will also provide information to stocker operators on expected performance of new tropically-adapted breeds to aid in decision-making on stocker calf purchases.

PREWEANING PERFORMANCE OF CALVES FROM CONTINENTAL, BRITISH, AND TROPICALLY-ADAPTED SIRES

M.A. Brown, W.A. Phillips, L.A. Richards

RATIONALE

Brangus cattle are exceptionally well-adapted to the production environment of the Southern Great Plains. Their heat-tolerance allows them to be productive in the hot and dry summers, but they are also able to thrive in the moderate winters. Brangus cows have good maternal ability and a low incidence of calving difficulty. When they are bred to a sire breed other than Brangus, Brahman, or Angus, approximately 87.5% of maximum hybrid vigor is possible in their calves. Consequently, they have good potential as a commercial cow for calf production. However, there is little information regarding use of Brangus cows in crossbreeding systems in the production environment of the Southern Great Plains. There is evidence that the maternal preweaning environment can influence postweaning performance and there is a need to evaluate the relationships of preweaning production environment with postweaning performance of stocker calves.

OBJECTIVE

The objective of this research is to evaluate preweaning performance of calves from Charolais, Gelbvieh, Hereford, Bonsmara, Romosinuano and Brangus sires bred to Brangus cows and to estimate interactions of maternal preweaning environment with postweaning stocker performance among the different breed groups.

METHODS

In an agreement with the International Brangus Breeders Association, 200 Brangus females were acquired to evaluate performance of calves from Charolais, Gelbvieh, Hereford, Bonsmara, Romosinuano, and Brangus sires. These represent Continental, British, and tropically-adapted sire breeds. The Bonsmara is a South African breed that is a composite of native Africander and British breeds. The Romosinuano is a South American breed and is considered a Criollo type. In the first phase of this long-term experiment, approximately equal numbers of cows and heifers will be bred to each sire breed. Calves will be spring-born on wheat pasture, managed on warm-season grasses during the summer, and weaned in the fall. Milk production and quality will be measured in a subsample of cows to estimate the maternal component of the preweaning environment. Calves will be placed on wheat pasture or cool-season grasses for stocker evaluation and steer calves will be evaluated for feedlot performance and carcass merit. The second phase of this research will involve evaluation of the relation of preweaning environment to stocker performance in calves produced from heifers retained from Phase 1 and bred to terminal cross sires. Breeding for Phase I was initiated spring of 2000 and phase I of the project will terminate spring of 2005. Phase II will begin in 2002 and continue through 2007 with calves evaluated similar to those in Phase I.

EXPECTED BENEFITS

Results from this research will allow comparison of the specific combining ability of different sire breeds with Brangus cows, i.e., it will provide information on which sire breeds work best with Brangus cows for calf production. Information gathered will also help to determine impacts of preweaning environment on levels of postweaning performance and carcass merit.

IMPROVING STOCKER PERFORMANCE DURING THE FIRST 28 DAYS OF THE GRAZING SEASON

W.A. Phillips, M.A. Brown, and L.A. Richards

RATIONALE

In the fall, millions of calves are transported to the southern Great Plains to graze winter wheat pasture before entering the feedlot for finishing. For the majority of these stocker calves, this is the first time they have been exposed to winter wheat pasture as a feed source. Although winter wheat pasture contains high concentrations of digestible protein and energy, stocker productivity is very low for the first 21 to 28 days of grazing. To increase winter wheat pasture stocker productivity the adaptation period must be shortened.

METHODS

Stocker cattle of different genetic makeup and that have never grazed cool-season grasses will be divided into two groups. One group will graze winter pasture, while the other group remains in dry lot on a diet of mixed feed and hay. Body weights will be taken at 2-day intervals for the first 28 days of the grazing season to determine how long it takes stocker cattle to adjust to the new diet of winter wheat forage and begin to gain weight at the same rate as the stockers in dry lot that did not have to adjust to a new diet. Forage intake, grazing behavior and the interactions of diet on the length of the adaptation period will be determined.

EXPECTED BENEFITS

By decreasing the adaptation period, stockers can begin to gain weight sooner and increase the amount of weight gained over the entire grazing season.

NUTRITIONAL ALTERNATIVES FOR STOCKER GENERATION ON THE SOUTHERN GREAT PLAINS

Lisa A. Richards, M. A. Brown, W. A. Phillips

RATIONALE

Adaptation of stockers to wheat pasture and overall gains may be influenced by preweaning grazing experience. This can impact rumen function and familiarity of stockers with wheat forage. While traditional cow-calf production on the Southern Great Plains utilizes native prairie, early calf exposure to spring wheat pasture may create a learned or physiological “memory” and allow quicker adaptation to wheat after weaning in the fall. These home-grown calves could transfer grazing knowledge to naïve stockers from other regions. Alternatively, a stocker may better adapt by consuming a wheat product just prior to placing on wheat pasture. Due to the potential of Oklahoma forages to support both stockers and cow herds that generate stockers, there is the need to determine the impacts of calf experience on subsequent stocker performance and heifer development.

OBJECTIVE

The objective of this research is to investigate the effects of early calf experience with wheat pasture and weaning diets containing wheat products on stocker adaptation to wheat pasture. Additionally, the interaction of these treatments with feeding an ionophore to promote stocker growth and the fertility of heifers will be tested. This research will be done in conjunction with developing a herd to meet the research goals of “Preweaning Performance of Calves from Continental, British, and Tropically-adapted Sires.”

METHODS

Brangus calves born in spring 2000 at the Grazinglands Research Center were exposed to wheat during their first 1 to 5 months of life by nursing cows grazing wheat pasture. In June 2000, cows and calves were placed on native range. At weaning in October 2000, ninety heifers and steers will be separated into two groups and offered either a diet based on wheat hay or bermuda grass hay. Calves then will be grazed on dormant warm season pasture with free access to wheat or bermuda grass hays until wheat pasture is available for grazing. Initial and weekly weights will be taken for the first 40 days on wheat pasture. Steers from each weaning group will be bolused with a slow-release alkane marker to determine changes in digestibility and intake during the adaptation period. Stockers will be weighed monthly until removed from wheat in March (steers) or May (heifers) to investigate carry-over effects of weaning diets.

At weaning, heifers will be further allotted to two supplemental treatments. Stocker heifers will be offered a low protein supplement formulated to provide either 0 or 200 mg of monensin per day. Heifers will be group-fed supplements through the start of the breeding season in May. Differences in forage intake, digestibility, and supplement intake will be determined by using nutritional markers. Onset of estrus will be determined by monitoring for increased serum progesterone levels prior to synchronization for artificial insemination. Age of and time to breeding will be determined.

EXPECTED BENEFITS

Future research will focus on the timing and duration of feeding wheat products and cool-season grasses pre-weaning, post-weaning, and in receiving diets to improve the adaptation and overall performance of stockers grazing wheat pasture. Other management schemes and supplemental ingredients for developing heifers on wheat will be investigated. Developing alternatives to utilize available resources provide stocker operators the means to optimize production on the Southern Great Plains.

STOCKER PRODUCTION ON COOL-SEASON FORAGE SYSTEMS

Lisa A. Richards, B.K. Northup, C.T. MacKown, and H.S. Mayeux

RATIONALE

There is great potential for perennial cool-season grasses and legumes to enhance stocker production in the Southern Great Plains. Cool-season perennial pastures could be used when small grains or warm season forages are less available, rotationally grazed with these forages, extend existing feed resources, or even replace annual pastures. However, the ability of cool-season perennial pastures to carry stockers and to persist have been inconsistent in Oklahoma. Questions remain on the impacts of grazing pressure, weather variability, and management inputs on perennials as needed to optimize stocker gains in comparison to wheat. Implementing a broad-based research program investigating both animal and plant responses will provide the knowledge needed to successfully integrate cool-season perennial grasses and legumes into grazing systems of the Southern Great Plains.

OBJECTIVE

Two experiments will be conducted to identify sustainable management practices that optimize stocker production on cool-season perennial forages. The objectives are to determine: (1) stocker gain, stocking rate, and duration of the grazing season when pastures are fertilized at increasing nitrogen rates as compared to wheat; and (2) diet selection and digestibility by stocker cattle grazing mixed grass-legume plots.

METHODS

In one experiment, thirty-six, five-acre pastures will be established to evaluate four forage types and three nitrogen (N) fertilization levels on stocker production over 5 years. Pastures of wheat, 'Jose' tall wheatgrass, 'Manska' intermediate wheatgrass, and 'Lincoln' smooth brome will be fertilized with 30, 90, or 150 lb N/acre/year. Four stockers will initially graze pastures in the spring (February through May), and extra steers will be added to maintain a grazing pressure of 65% utilization of available forage. Pasture carrying capacity, stocker gain, and actual length and times of the year for grazing will be determined. Measures of forage intake, preference, digestibility, nitrogen components, and nutrient composition will be related to stocker nutrient utilization and performance.

In the second experiment, two sets of plots will be established with 8 pure stands and 18 combinations (50:50) of grasses and legumes for small-scale grazing studies. Grasses will include 'Lincoln' smooth brome, 'Jose' tall wheatgrass, and 'Manska' intermediate wheatgrass. Legumes will include cicer milkvetch, birdsfoot trefoil, 'Haygrazer' alfalfa, arrowleaf clover, and rose clover. The selection of cool-season grasses and legumes within mixed plots by cattle will be determined using cannulated stockers adjusted to individual feedings of single species. Plant and nutrient composition of the selected diet will be determined to evaluate grazing pressure, bloat potential, and nutrient value when stockers are allowed access to legume and grass mixes.

EXPECTED BENEFITS

Stocker response will be related to plant measures, as described in "Management Impacts on Persistence of Introduced Grasses and Legumes in the Southern Great Plains," to integrate findings and formulate producer recommendations. Results should reveal inputs needed to optimize stocker performance on cool-season perennial grasses when used as an alternative or compliment to wheat pasture. Steer selection within mixed grass-legume plots will reveal the grazing pressure, nutrient intakes, and planting proportions of grasses and legumes needed to successfully support stocker grazing and growth. Future research will promote the efficiency and consistency of stocker production on introduced forages or those developed at the Grazinglands Research Laboratory when incorporated into grazing systems of the Southern Great Plains.

INTAKE AND DIGESTIBILITY MARKERS FOR STOCKER CATTLE AND LAMBS

Lisa A. Richards, W.A. Phillips, and M.A. Brown

RATIONALE

Stocker performance is influenced by forage intake and nutrient utilization. Intake can be measured by feeding known amounts of freshly-cut or preserved forage to penned animals. Digestibility is directly calculated by nutrients consumed minus those excreted. However, these methods do not consider the impact of grazing behavior on performance. A more realistic picture of forage intake and digestibility in the field may be acquired by using indirect measures, such as nutritional "markers." Markers are unique chemical or physical components either found within plants (internal markers) or not naturally found in high concentrations under pasture settings (external markers). However, little is known about the application of markers to young, growing stockers grazing high quality, cool-season forages. The development of more reliable field measures will allow scientists to better address intake and nutritional challenges of forage-based diets in the Southern Great Plains.

OBJECTIVE

This research will evaluate the use of nutritional markers when feeding wheat and cool-season perennial grasses to stockers to enable the determination of intake and nutrient utilization under grazing conditions.

METHODS

A trial was conducted in summer 2000 to evaluate the effects of cool-season hay type and morning or afternoon harvest time on lamb intake (see “Lamb Preference of Cool-season Hays Harvested in the Morning or Afternoon”). Hay fiber stained with chromic oxide was fed in one meal with experimental diets of wheat, ‘Paiute’ orchardgrass, ‘Triumph’ fescue, ‘Luna’ pubescent wheatgrass, or ‘Jose’ wheatgrass. Total fecal collections were made to test the use of pulsed chromic oxide in estimating fecal output for the back-calculation of intake.

Ten steers will be individually fed wheat silage to simulate wheat pasture. Steers will receive slow-release boluses delivering two different external markers, chromic oxide and wax-like alkanes (Captec Ltd., Auckland, New Zealand). Wheat silage will naturally provide internal markers, including indigestible fiber, plant waxes, and plant pigments. By knowing forage intake and total fecal output, marker percentages and recoveries will be evaluated. Reliable combinations of internal and external markers to calculate digestibility and fecal output, respectively, will be determined. Estimated intake will be calculated by dividing fecal output by percent indigestibility and compared to actual measures.

EXPECTED BENEFITS

A protocol for testing nutritional markers in the field will be developed. Future research will incorporate the use of remote sensing devices (i.e., GPS collars) with markers. These methods ultimately will be applied in grazing studies and under production settings to further explain and enhance stocker intake and grazing behavior in the Southern Great Plains.

PASTURE AND SOIL DYNAMICS TO ACHIEVE SUSTAINABLE GRAZING ON MARGINAL FARMS

Paul W. Bartholomew and Robert D. Williams

RATIONALE

Low output and high production costs mean that small resource-poor farmers in central and eastern Oklahoma are able to generate only limited farm incomes from their ruminant livestock enterprises. Seasonal and total shortfall in forage production is a primary contributor to this problem through a direct effect on livestock performance and through increase in production costs because of the need for expenditure on off-farm supplies of supplementary feed, which may be used for as much as five months out of the year. Efforts to increase home-produced forage will contribute to a reduction in production costs and therefore to increase in net farm income and welfare of target farmers.

OBJECTIVE

The objective of this new program, implemented in collaboration with the Grasslands Center of Excellence of Langston University, is to develop forage production technologies appropriate for the small resource-poor farmer, in order to improve pasture production systems on small farms, with resulting enhancement of small farm profitability and sustainability.

PROPOSED RESEARCH

The research undertaken will address forage production problems in the context of the particular constraints experienced by the small resource-poor farmer. Under small farm conditions, labor and equipment availability are likely to limit the possibilities for relay cropping or frequent re-establishment of pastures, and economic constraints may limit the use of purchased inputs such as fertilizer or plant protection products. Increase in forage production for small farmers will therefore focus on the use of perennial or self-seeding annual forages and on identification of compatible mixtures of warm and cool-season species which will allow extended or year-round forage production through serial growth of mixture components. Introduction of persistent legume species into pasture mixtures will reduce the need for purchased nitrogen fertilizer and increase sustainability of the pasture system. In an initial phase the following work is planned:

- Assess the compatibility and productivity in mixtures of a range of warm and cool-season forage species which have already been grown successfully as monocrops in Oklahoma,
- Evaluate short-term indicators of persistence for a range of forage species,
- Measure variation in low-temperature dry matter accumulation of forage species,
- Assess relative growth, competitive ability and resource use of forage crops grown in pasture mixtures,
- Investigate the capacity of grass and legume forage species for perennation through self-seeding and establishment of soil seed banks,
- Evaluate methods of non-destructive measurement of forage biomass and botanical composition,
- Assess the effectiveness of establishment, persistence and productivity of a range of non-

traditional forage crops,

- Evaluate the influence on forage production of inter-annual and inter-site variability in climatic potential across the targeted 18 counties of east-central Oklahoma.

SPATIAL AND TEMPORAL VARIABILITY IN THE NITROGEN COMPOSITION OF WINTER WHEAT PASTURE

Charles T. MacKown and B.K Northup

RATIONALE

Winter wheat pasture is used extensively throughout the Southern Great Plains to support the stocker industry. Producers often seek to provide an early and abundant supply of wheat to support the grazing needs of animals from late fall into early spring. Most producers apply the entire nitrogen (N) needs for wheat prior to or at planting time, unless the soils have a high leaching potential, where N should be applied as needed. To offset fertilizer N requirements, preplant soil tests for available N are sometimes used along with targeted yield goals (forage: 30 lb N per 1000 lb; grain: 100 lb N per 50 bu) to determine the amount of N fertilizer to apply. With preplant applications, the amount of N available is likely beyond the needs of wheat pasture used for late fall grazing. Preliminary investigations at the Grazingland Research Laboratory on the role of grazed wheat plants in the initial low weight gains of stockers adapting to wheat revealed substantially less variability in concentrations of total N than nitrate among plant samples randomly collected from a pasture. This variability did not appear to be linked to amount of forage produced at locations sampled. Although the nitrate levels observed would not normally be toxic (less than 1000 ppm nitrate-N), they could give rise to chronic illness in young ruminant livestock. Non-stressed plants accumulate nitrate when uptake exceeds their ability to convert the absorbed nitrate into N compounds supporting plant growth. For wheat pastures, this can occur during late fall when available N is abundant. Determining how variation in the N composition of wheat pastures occurs will help in developing strategies that insure the nutritional uniformity of wheat pastures and decrease the potential accumulation of nitrate in wheat forage.

OBJECTIVES

Variations in plant dry matter, available soil N, and plant concentrations of total N and nitrate in time and space will be analyzed to assess differences and develop links among traits.

METHODS

Wheat will be grown using management practices appropriate for a dual-purpose crop of forage plus grain. Sample locations will be mapped along transects across wheat pastures so the locations can be resampled at different times. Sampling will begin after wheat produces enough forage to support a stocking rate no greater than 2 acres per animal. Samples will be collected at different times over a 28-day period. At each sample location, a soil core to a depth of 12 inches will be collected and aboveground plant tissue separated into components normally grazed and ungrazed. Soil and plant samples will be analyzed for N using standard laboratory procedures. Numerical analysis of the data will be used to determine spatial and temporal relationships among the traits measured.

EXPECTED BENEFITS

Information generated from this research will allow us to determine the underlying causes for variation in the N composition of wheat pastures and identify plant and soil factors associated with variable nitrate concentration in grazed wheat. This knowledge could lead to alternative management approaches that lessen potentially undesirable accumulation of nitrate while maintaining the nutritional benefits of wheat forage. Additionally, this research should provide further insights into the chemical composition traits of wheat that impact stocker adaptation to wheat pastures.

COOL-SEASON GRASS ESTABLISHMENT: N UPTAKE AND GROWTH TRAITS OF DESIRABLE PERENNIALS VS WEEDY ANNUALS

Charles T. MacKown, Douglas A. Johnson, Thomas A. Jones, and Margaret G. Redinbaugh

RATIONALE

Annual weed infestation is often a problem during establishment of cool-season perennial grasses on grazinglands and particularly on disturbed rangeland. Two invasive annual cool-season grasses, cheatgrass (*Bromus tectorum* L.) and medusahead (*Taeniatherum caput-medusae* (L.) Nevski) have decreased the productivity of millions of acres of livestock and wildlife grazinglands, decreased the biological diversity of grazinglands, and increased the incidence and severity of wildfires. Recent evidence reveals that on disturbed rangeland, increased nitrogen (N) availability favors establishment of the annual invasive cool-season grasses more than desirable perennial cool-season grasses. Decreasing the availability of N on disturbed sites as well as decreasing the biological conversion of released ammonium to nitrate N (both plant available forms) enhances establishment of perennial grasses. To account for the these observations and to develop management strategies appropriate to enhance the establishment of desirable perennial cool-season grasses in the presence of invasive annual grasses, fundamental knowledge of the mechanisms underlying N uptake and metabolism of the ammonium and nitrate forms of N is required.

OBJECTIVES

The objectives of this research are to determine plant growth response and N uptake, assimilation, and distribution when provided either as ammonium, nitrate, or an equal mixture for seedlings of desirable perennial and weedy annual cool-season grasses.

METHODS

Two annual cool-season grasses, cheatgrass and medusahead, and five perennial cool-season grasses will be studied. The perennials possess beneficial traits that make them desirable for disturbed rangeland and include four accessions of the short-lived native, squirreltail (*Elymus elymoides* (Raf.) Swezey = *Sitanion hystrix*. (Nutt.) J.G. Smith), and one accession of bluebunch wheatgrass (*Pseudoroegneria spicata* (Pursh) A. Löve = *Agropyron spicatum* Pursh). To precisely control the availability and form of N, a hydroponic (soilless) culture system will be used along with stable isotope forms of the N sources to measure steady-state uptake, assimilation, and distribution of N. In addition, use of the hydroponic culture system makes it possible to accurately determine the effects of N source on dry-matter accumulation and partitioning between roots and shoots, factors that can affect competition for resources (light, water, nutrients) and establishment.

EXPECTED BENEFITS

Knowledge developed from this research will identify fundamental N-use traits of cool-season perennial and invasive annual grasses. This knowledge would form the foundation for development of management strategies to alter the availability, source of plant N, and N-metabolism selection criteria for successful establishment of perennial material in the presence of weedy annual grasses.

PRELIMINARY RESULTS

Some of the responses of the grasses to N in the form of nitrate have been determined. Additional experiments with ammonium and equal amounts of ammonium plus nitrate are in progress. With nitrate, the annual grasses had greater growth than the perennials and the shoot-to-root ratio of the annual weed cheatgrass (5.41) was 34 to 103% greater than all the other grasses, including medusahead, the other annual weed. The steady-state nitrate uptake activity of cheatgrass roots (8.70 mmol g^{-1} root dry wt. h^{-1}) was 46 to 119% greater than the other grasses. The nitrate uptake of the other annual weed, medusahead, was 55% less than cheatgrass and not significantly different from three of the five perennial grasses. Cheatgrass, but not medusahead, had greater nitrate uptake activity than the perennial grasses, a response consistent with the hypothesis of a competitive advantage of the annual over perennials when nitrate is the predominate N-form. The additional experiments should allow us to determine if the superior seedling growth of the annual grasses may be more important for competition for resources (nitrogen, water, light, and other nutrients) than differences in N use.

MANAGEMENT IMPACTS ON PERSISTENCE OF INTRODUCED GRASSES AND LEGUMES IN THE SOUTHERN GREAT PLAINS, OKLAHOMA

Brian K. Northup, C.T. MacKown, L.A. Richards, and H.S. Mayeux

RATIONALE

The traditional agricultural base of the Southern Great Plains (SGP) is winter wheat and stocker cattle production systems. The primary forage resource within this area is wheat pasture in the winter and spring (often used as a dual-purpose forage and grain crop), and both native and introduced warm-season perennial grasses in summer. However, forage production shortfalls exist in September through December and early spring, when wheat pasture is less productive or grazing ceases if a seed crop is desired. Warm-season forages are not a viable alternative at these times, due to low forage quality (September-December) or lack of growth (March - May).

Plants in the SGP are often stressed by drought and extreme fluctuations in temperature. The potential for severe wind and water erosion can also be high. Conversion of wheat pasture to perennial species (especially grasses) would provide more dependable cover and eliminate the need for regular tillage. Furthermore, increasing fertilizer costs and potential water pollution problems support the use of introduced legumes in grazing systems. Including introduced legumes in a mix of perennial forages offers producers (1) a potential ‘growing’ protein supplement to improve gains by stocker cattle, and (2) a biological source of nitrogen (N) to offset annual fertilizer requirements of grasses. The potential to replace annual wheat with pasture systems based on perennial grasses, with legumes incorporated to supply N, may be an attractive alternative for producers in the SGP. Usefulness of legumes in plantings of cool-season grasses has not been fully investigated in the SGP region. Such plantings should have lower maintenance costs and be more environmentally friendly. Establishment and maintenance of introduced cool-season forages is a challenge in the SGP. In some cases, grazing pressure could have a negative impact on species that tolerate the climate of the SGP. Cool-season perennials tolerant of management and environmental stresses must be identified or developed.

OBJECTIVES

The project will measure plant and animal responses to management practices applied to cool-season perennial pastures. Plant response objectives include; (1) determine optimum N inputs to ensure persistence of perennial introduced cool-season grasses; (2) define grazing strategies that allow plantings of perennial cool-season grasses to persist; (3) describe benefits of forage quality and available N derived from introduced legumes. Animal response procedures are described in “Stocker Production on Cool-Season Forage Systems” of this publication.

METHODS

A series of experiments will be conducted over the next 5 years to determine sustainable choices for perennial forages and management strategies to overcome potential environmental and management constraints of the SGP.

Three, 60-acre blocks of pastures, each containing different cool-season grasses will be established. Within each block there will be three, 5-acre pastures each of winter wheat (as a control), ‘Lincoln’ smooth brome, ‘Jose’ tall wheatgrass, and ‘Manska’ intermediate wheatgrass. These perennial grasses have been used extensively in cool-season plantings throughout the Great Plains, and appear to differ in persistence and palatability to grazing cattle. Plantings of each species will receive one of three levels of N fertilization in addition to a fall application of 40 lb/acre: unfertilized to serve as a baseline, 50 lb/acre, and 110 lb/acre. All pastures will receive the same level of grazing each year, about 65% use of current year’s herbage, which should be a significant stressor, and allow the identification of persistent species. Fenced enclosures (about 0.2 acres) will be established within each pasture to serve as controls to compare the responses of grazed and ungrazed plants.

Small plot plantings (8’ x 25’) of single-species and grass-legume combinations will also be established, and clipping treatments will be applied to mimic moderate and intense grazing pressure. Grass species will include ‘Lincoln’ smooth brome, ‘Jose’ tall wheatgrass, and ‘Manska’ intermediate wheatgrass. Perennial legumes include two rhizomatous species - cicer milkvetch and birdsfoot trefoil (ARS-2620) - and ‘Haygrazer’ alfalfa. Annual legumes will include ‘arrowleaf’ clover and ‘rose’ clover (Overton R-18). All of these legumes are adapted to lower rainfall environments (22-30 inches) and will re-seed if properly managed.

EXPECTED BENEFITS

Information from these experiments will be used to test how different grass and grass-legume stands are affected by management systems and high levels of grazing pressure. The experiments will ultimately help describe the value of these introduced forages to producers of the Southern Great Plains. Plant-based measurements will include: changes in densities (number per unit area) of grasses and legumes; productivity of grasses and legumes in response to defoliation; quality of produced forages; N mobilization and economy of plants under different defoliation treatments; and soil moisture dynamics under key grass-legume combinations. Information produced by the small plot study will be used to design a future study that tests the value of the more persistent combinations of cool-season grasses and legumes in grazing systems used in the SGP.

IDENTIFICATION AND EVALUATION OF PIGEONPEA GERMPLASM TO OVERCOME WEED PROBLEM

Srinivas C. Rao

RATIONALE

Studies conducted at the Grazinglands Research Laboratory for the past five years demonstrated that pigeonpea has the potential to produce an abundant high quality annual crop in the Southern Great Plains. Current pigeonpea cultivars suffer from slow emergence and early growth due to below optimum temperatures at spring planting. Consequently, pigeonpeas are vulnerable to competition from early germinating and rapidly growing weeds, such as pigweed and johnsongrass. No herbicide is labeled for use on pigeonpea. Identification of pigeonpea germplasm that germinates well at low soil temperature and emerges and grows rapidly would be an alternative to use of herbicides to overcome this weed problem.

OBJECTIVE

The objective is to evaluate and identify pigeonpea germplasm that germinates quickly and has rapid early growth at temperatures similar to those encountered in the spring in the Southern Great Plains.

METHODS

Pigeonpea is a major crop at the International Crop Research Institute for Semi-Arid and Tropics (ICRISAT) in India. At present ICRISAT maintains 12,393 germplasm accessions of pigeonpea. A systematic evaluation of the germplasm originating from high elevations and high latitude location is likely to provide genetic materials having potential for adaptation to the Southern Great Plains.

A set of 115 accessions of pigeonpea and its wild relatives, originating from Australia, Fiji, India, Kenya, Sikkim, South Africa and Tanzania, were selected for this study. The selections were made on the basis of elevation (1600 to 6600 ft) and flowering date (130 to 160 days after seeding). Seeds will be germinated in incubators with temperatures of 7, 10, 12.5 and 15°C. Based on results from the germination test, seed of favorable accessions will be planted in pots and grown in environmental chambers to determine the early growth rate.

EXPECTED BENEFITS

The identification of pigeonpeas with rapid germination and initial fast growth will allow producers to lessen or even eliminate herbicide control of weeds when this annual legume is grown in the Southern Great Plains.

REMOTE SENSING OF FORAGE QUALITY AND QUANTITY

Patrick J. Starks

RATIONALE

In previous research conducted at the Grazinglands Research Laboratory, technology was developed that allowed determination of forage quality by analyzing forage samples using bench-top near-infrared spectrophotometers (a type of remote sensing device). In this approach, certain wavelengths of reflected light from the forage sample are associated with and correlated to various nutrient parameters such as percent crude protein, acid detergent fiber, neural detergent fiber, and in vitro dry matter disappearance. This technology can provide accurate determinations of forage quality and has been adopted by forage testing labs and research labs in many parts of the U.S. However, it can take weeks to provide the information back to the agricultural producer, because of delays with sample handling, laboratory processing, and results reporting. Furthermore, the forage samples gathered may poorly represent a pasture or specific site within a pasture. Remotely sensed data (e.g., from satellites or aircraft) can be tied to specific field locations, thereby giving a true view of actual field conditions. Remote sensing approaches have been developed to produce estimates of standing “biomass”. These estimates are often expressed as an index value that needs to be related to actual biomass through some other mechanism such as a crop model or through ground verification. Timely delivery of site-specific information concerning the amount and quality of forages would allow rapid adjustments to be made to grazing/feeding management plans, thereby increasing forage utilization and reducing unnecessary agricultural production costs.

OBJECTIVE

The objective of this research is to produce remote sensing based technologies that would allow near real time, accurate, site-specific assessments of forage quality and quantity.

METHODS

Beginning in the summer of 1999, remotely sensed data (using hand-held systems) were collected over several plots of warm season species of grass and legumes located at the Grazinglands Research Laboratory. These grasses and legumes included several varieties of bermudagrass, old world bluestem, crabgrass and alfalfa. During the summer of 2000, remotely sensed data were collected over these same species as well as several warm season species located in Florida (Bahia, perennial peanut, elephant grass, limpograss, bermudagrass, and pangola grass). The diversity of grasses and legumes were selected in order to provide a wide variation in nutrient value, digestibility, and biomass. Nutrient values of the grasses and legumes collected in 1999 have been determined in the laboratory and have shown to be well correlated with remotely sensed data obtained from the bench top system. The year 2000 forage samples have been collected and will be processed later this year. Data from the field remote sensing devices will be analyzed in much the same fashion as that from the bench top system.

EXPECTED BENEFITS

If successful, determination of forage quality and quantity from field remote sensing systems can be combined with geo-positioning technology to allow precision management of grazing lands, thereby reducing input costs and improving profitability.

LIST OF CONTRIBUTORS AND ACKNOWLEDGEMENT

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The authors wish to express their appreciation to the Technical and Administrative support staff of the Grazinglands Research Laboratory for their assistance in conducting the research described in this publication. Their contribution and support is essential for the success of the research program.