Project Title: Nitrogen fertilization strategies for annual ryegrass pasture

Investigators: Robert L. Kallenbach and Richard J. Crawford, Jr.

Objectives and relevance of project: Livestock operations as far north as southern Iowa are planting annual ryegrass pastures as an alternative to feeding hay in winter. Easy establishment, rapid autumn growth, and high forage quality are making annual ryegrass popular with dairy and beef farmers alike. In fact, seed sales of cold-tolerant cultivars of annual ryegrass in Missouri have quadrupled over the past four years. However, despite the growing acceptance of annual ryegrass for winter grazing, there is little information about how to properly fertilize it.

The overall objective is to determine the optimum rate and timing of N fertilizer for annual ryegrass in Missouri. Specific objectives are:

Objective 1: Determine the optimum N rate at planting to maximize fall growth of annual ryegrass for winter grazing.

Objective 2: Determine if N applications in late-winter (1 March) are economical.

Procedures:

Treatments: This experiment has 16 treatments; four N rates at planting (0, 50, 100, and 150 lb./acre of N) followed by the either 0, 50, 100, or 150 lb./acre of N in late winter. The table below describes the rate and date of N applications for treatments.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N at planting</th>
<th>N in Late winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>150</td>
</tr>
<tr>
<td>5</td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>7</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>8</td>
<td>50</td>
<td>150</td>
</tr>
<tr>
<td>9</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>11</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>12</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>13</td>
<td>150</td>
<td>0</td>
</tr>
<tr>
<td>14</td>
<td>150</td>
<td>50</td>
</tr>
<tr>
<td>15</td>
<td>150</td>
<td>100</td>
</tr>
<tr>
<td>16</td>
<td>150</td>
<td>150</td>
</tr>
</tbody>
</table>

Cultural practices: We will conduct this study at the Southwest Missouri Research and Education Center near Mt. Vernon, MO. The soil type at Mt Vernon is from the Hoberg-Keno-Creldon association. Thirty lb./acre of ‘Marshall’ annual ryegrass will be drilled into a prepared seedbed on 1 September, each year. Soil P and K will be maintained at the levels recommended by the University of Missouri Soil Testing Laboratory for cool-season grasses. A Gandy drop spreader will be used to apply N treatments. A new plot area will be used each year.
Design: Each of the sixteen treatments will be replicated four times in a randomized complete block design {64 total plots (4 reps x 16 treatments)}. Individual plots will be 25 ft. x 35 ft.

Measurements:
Forage yield will be measured when the average height in an individual treatment reaches 10 to 12 inches. This is the recommended height to begin grazing annual ryegrass. Weekly measurements of canopy height will be recorded to guide harvests. Once a treatment reaches 10 to 12 inches in height, forage yield will be determined by clipping a 3 ft. x 30 ft. strip in each plot to a 4-inch stubble height.

Forage quality (crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF) and ergovaline) will be measured at the same time as forage yield. Samples will be dried at 125°F for 72 hours in a forced-air oven, before being ground to pass a 1-mm screen. Crude protein, ADF and NDF will be measured using NIRS with appropriate wet chemistry calibrations.

Tiller density will be determined in October and April each year. We will measure tiller density by counting the tillers on plants taken from five, 3-inch diameter cores from each plot.

Total soil nitrogen to a depth of 40 in. will be determined prior to application of N and in May (after the growing season for annual ryegrass), each year. Samples will be split into three sections: 0-10 in, 10-20 in., and 20-40 in.

Current Status/importance of research area: Annual ryegrass (Lolium multiflorum Lam.) has become a popular forage crop for winter grazing in southern Missouri. Although annual ryegrass has been popular for many years in the southern USA, acreage in Missouri has more than quadrupled over the past three years. New, cold-tolerant cultivars have extended the growing region of annual ryegrass to the north.

Annual ryegrass has several features that make it popular with livestock producers. When planted in late-summer, annual ryegrass can produce 2 to 3 tons of high-quality feed per acre before December and an additional 3 to 4 tons in the spring (Bishop-Hurley et al., 2001). Few other forage crops can produce this much forage for winter grazing. Annual ryegrass is able to achieve these yields in autumn because it continues to grow even after the first killing frost. Cold-tolerant cultivars can grow when average daily temperatures are below 4°C. In addition, the lack of true dormancy in annual ryegrass allows it to grow during warm spells in winter and to resume growth earlier in spring than many perennial cool-season grasses.

In addition to its rapid fall growth, the forage quality of annual ryegrass is outstanding. During vegetative growth, annual ryegrass has crude protein levels that exceed 20% and dry matter digestibility that approaches 75% (Dunavin, 1990). Because of its high quality, producers can successfully use annual ryegrass to feed both stocker cattle and lactating dairy cows. For example, stocker calf gains of 1.0 to 2.7 lb./day are common in the southern USA (Evers, 1995). In addition, milk yields of 85 lb./day have been reported for dairy cows grazing annual ryegrass pastures (Thom and Bryant, 1996).

However, we still have a lot to learn about the management of annual ryegrass for winter pasture in Missouri. There is little research about how to fertilize annual ryegrass that is grown outside the southern USA. Research from other regions suggests that annual ryegrass responds tremendously to N fertilizer, but proper fertilization rates and strategies for states outside the southern USA are lacking.
**Timetable for proposed research:** This study will begin in August 2002 and end in October 2005 (three years of study). The table below gives a brief summary of the project's activities. (* indicates a task to be done on an annual basis throughout the three-year study)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepare seedbed for annual ryegrass planting</td>
<td>8/20/02*</td>
</tr>
<tr>
<td>Take soil core samples to a 40-inch depth for initial soil nitrogen</td>
<td>8/31/02*</td>
</tr>
<tr>
<td>determinations</td>
<td></td>
</tr>
<tr>
<td>Plant annual ryegrass at 30 lb./acre</td>
<td>9/1/02*</td>
</tr>
<tr>
<td>Apply N fertilizer at rates of 0, 50, 100, or 150 lb./acre to appropriate plots</td>
<td>9/1/02*</td>
</tr>
<tr>
<td>Take five, 3 inch diameter cores from each plot &amp; count the number of tillers</td>
<td>10/10/02</td>
</tr>
<tr>
<td>Analyze latest results &amp; report findings to Fertilizer/Ag Lime Advisory Council</td>
<td>12/15/02*</td>
</tr>
<tr>
<td>Harvest appropriate plots for forage yield and retain subsamples for forage quality analysis</td>
<td>Ongoing as forage growth dictates. Anticipate 5 to 7 harvests per year.</td>
</tr>
<tr>
<td>Apply N to plots receiving late winter fertilizer</td>
<td>3/1/03</td>
</tr>
<tr>
<td>Take five, 3 inch diameter cores from each plot &amp; count the number of tillers</td>
<td>4/15/03*</td>
</tr>
<tr>
<td>Take soil cores from each plot to determine residual soil N</td>
<td>6/1/03*</td>
</tr>
<tr>
<td>Analyze samples taken to date for forage quality</td>
<td>7/31/03*</td>
</tr>
<tr>
<td>Incorporate latest findings into soil testing reports, grazing school curriculum and winter-pasture workshops. Work with popular press on articles</td>
<td>8/2005</td>
</tr>
<tr>
<td>Prepare updated MU guide on fertilization of annual ryegrass for winter grazing</td>
<td>9/2005</td>
</tr>
<tr>
<td>Prepare and submit an article on this research to a peer-reviewed journal</td>
<td>10/2005</td>
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</table>

**Application/transfer of knowledge:** We will transfer our results in four ways. First, we will incorporate the results and recommendations from this study into the curriculum of the Missouri Grazing Schools and the annual Winter Grazing Workshops at Mt. Vernon. Second, we will work with the Soil Fertility Working Group and the University of Missouri Soil Testing Laboratory to refine the recommendations printed on soil testing results. Third, we will publish a new guidesheet on the use of annual ryegrass in Missouri that incorporates the latest findings from this research. Finally, we will prepare articles to be published in statewide and national magazines such as Missouri Ruralist, Graze, Stockman Grass Farmer and scientific (peer-reviewed) journals.

**References:**


Budget:

Year 1

**Salary and Benefits**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount ($)</th>
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<tr>
<td>Research Specialist (25% of $30,000)</td>
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<tr>
<td>Benefits for Research Specialist</td>
<td>1,875</td>
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<td><strong>Total Salary and Benefits</strong></td>
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**Operating Expenses**

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<th>Description</th>
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<tr>
<td>Seed, fertilizer, bags, repair parts for harvester and other field supplies</td>
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<tr>
<td>NIR charges for forage quality analysis (approx. 300 samples @ $1 each)</td>
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<tr>
<td>Forage quality wet chemistry for NIR calibration (90 samples @ $10.50 each)</td>
<td>945</td>
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<tr>
<td>Soil N analysis (66 samples @ $8 each)</td>
<td>528</td>
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<tr>
<td>Travel to SWC (mileage, lodging, and meals for six trips per year)</td>
<td>1,464</td>
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<tr>
<td><strong>Total Operating Expenses</strong></td>
<td>4,987</td>
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**Equipment**

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<th>Description</th>
<th>Amount ($)</th>
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</thead>
<tbody>
<tr>
<td>None requested</td>
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<td><strong>Total Equipment</strong></td>
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**Total Proposal Request for Year #1** $14,362

Year 2

**Salary and Benefits**

<table>
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<th>Description</th>
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<tbody>
<tr>
<td>Research Specialist (25% of $31,500)</td>
<td>7,875</td>
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<tr>
<td>Benefits for Research Specialist</td>
<td>1,969</td>
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<td><strong>Total Salary and Benefits</strong></td>
<td>9,844</td>
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**Operating Expenses**

<table>
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<tr>
<td>Seed, fertilizer, bags, repair parts for harvester and other field supplies</td>
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<tr>
<td>NIR charges for forage quality analysis (approx. 300 samples @ $1 each)</td>
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<tr>
<td>Forage quality wet chemistry for NIR calibration (60 samples @ $11 each)</td>
<td>666</td>
</tr>
<tr>
<td>Soil N analysis (66 samples @ $8 each)</td>
<td>528</td>
</tr>
<tr>
<td>Travel to SWC (mileage, lodging, and meals for six trips per year)</td>
<td>1,464</td>
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<tr>
<td><strong>Total Operating Expenses</strong></td>
<td>4,808</td>
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**Equipment**

<table>
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<tr>
<th>Description</th>
<th>Amount ($)</th>
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<tr>
<td>None requested</td>
<td>0</td>
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<tr>
<td><strong>Total Equipment</strong></td>
<td>0</td>
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**Total Proposal Request for Year #2** $14,652
Year 3

**Salary and Benefits**
Research Specialist (25% of $33,075) $ 8,269
Benefits for Research Specialist $ 2,067
Total Salary and Benefits $10,336

**Operating Expenses**
Seed, fertilizer, bags, repair parts for harvester and other field supplies $ 1,850
NIR charges for forage quality analysis (approx. 300 samples @ $1 each) $ 300
Forage quality wet chemistry for NIR calibration (60 samples @ $11 each) $ 666
Soil N analysis (66 samples @ $8 each) $ 528
Travel to SWC (mileage, lodging, and meals for six trips per year) $ 1,464
Total Operating Expenses $ 4,808

**Equipment**
None requested $ 0
Total Equipment $ 0

*Total Proposal Request for Year #3* $15,144

*Grand Total for three years* $44,158
Resume for
Robert L. Kallenbach

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Columbia, MO 65203
Phone (573) 446-6834

EDUCATION:
Ph.D., Agronomy, with an emphasis in statistics. 1994. Texas Tech University, Lubbock TX.
B.S., Agronomy. 1989. Southwest Missouri State University, Springfield, MO.

PROFESSIONAL EMPLOYMENT AND RESEARCH EXPERIENCE:
Jan. 1998 to present. Assistant Professor/State Extension Specialist – Forage Crops. University of Missouri – Columbia. (70% Extension – 30% Research)
Responsibilities: Project leader for research and extension education projects on forage crops for Missouri. Current research focuses on developing improved winter-feeding systems for beef and dairy cattle. Specific projects include winter-annual forage evaluations, improving winter grazing of tall fescue, adaptation of rhizomatous birdsfoot trefoil for winter grazing, alfalfa management strategies to lower hay production costs, and preventing grass tetany in grazing livestock. Coordinate extension education programs on “pasture-based dairy production” and “winter-feeding systems for beef cattle”. Train and advise graduate students. Obtain outside funding for agricultural research and extension education projects. Manage university grant accounts. Provide educational support to hay, livestock, and forage producers statewide.

Responsibilities: Principal investigator and project leader for agricultural research and extension projects for the Palo Verde and Imperial valleys of California. Research and educational projects included irrigation management for alfalfa, cutting strategies to control weed invasions in alfalfa, alfalfa variety evaluations, and efficient nitrogen management for sudangrass hay.

PROFESSIONAL HONORS AND AWARDS:
2001: Provost's Award for Creative Extension Programming by New Faculty
1997: Certificate of Meritorious Service to the University of California and Riverside County
1994: Texas Tech University nominee for the Gerald O. Mott Meritorious Graduate Student Award in Crop Science
Selected Outstanding Ph.D. Student by Gamma Sigma Delta Agricultural Honor Society
1993: Selected Graduate Student Representative to the College of Agricultural Sciences and Natural Resources Deans' Advisory Committee
1991: Selected as DeKalb Outstanding Student in Agronomy
1989: Elected to Delta Tau Alpha National Honor Society
MEMBERSHIP IN PROFESSIONAL SOCIETIES:
Missouri Forage and Grassland Council
American Forage and Grassland Council
American Society of Agronomy
Crop Science Society of America
Gamma Sigma Delta Honor Society of Agriculture

SELECTED PUBLICATIONS:

Refereed Journal Articles:


Technical Reports:


Official Extension Publications:


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(417) 466-2148

EDUCATION


CAREER RELATED and WORK EXPERIENCE

Superintendent, University of Missouri (1993-present). Administrative head of Southwest Research Center, a 900 acre agricultural research facility located 200 miles from the MU campus.

Research Associate/Research Assistant Professor, University of Missouri (1983-present). Supervise and assist with the design, conduct and analysis of grazing and forage quality trials at the Southwest Research Center in Mt. Vernon, MO. Present scientific results and various topics at local, regional and national meetings and conferences.


Research Technologist II, Graduate Research Assistant and Doctoral Candidate, West Virginia University (1979-1983). Supervise research laboratory with 2-3 full-time and 5 part-time employees. Assist in the design, data collection and analysis of in vivo and in vitro nutrition studies. Perform laboratory analyses on feed and digesta samples; statistical analysis using computer programs. Prepare and review manuscripts for publication in scientific journals. Major areas of research included protein degradation and bypass and buffer requirements for ruminants.

Research and Teaching Assistant, University of Maine (1976-1979). Nutritional studies included in situ protein degradation, protein solubility and manipulation of rumen fermentation. Taught two semester laboratory in "Anatomy and Physiology" and "Laboratory Animal Care" for students in veterinary technology program. Assisted in surgical fitting of cattle, sheep and deer with ruminal and abomasal cannulae.
ACTIVITIES AND HONORS

Missouri Forage and Grassland Council - Member (since 1986)
Missouri Dairy Association - Associate Member (since 1987)
Missouri Cattlemen's Association - Associate Member (since 1987)
St. Susanne's Church - Knights of Columbus; Parish Council; RCIA; CCD; Youth Minister
Boy Scouts of America - Unit Commissioner; Tiger Cub Co-ordinator; Treasurer; Cubmaster; Scoutmaster; Recipient of St. George Award (1993), Golden Sun Award (1994), Silver Beaver Award (1999)
Mt. Vernon Chamber of Commerce “Citizen of the Year” (1999)
Missouri FFA Association - Recipient of Honorary State FFA Degree (1995)
Missouri FFA Association - Honorary Area FFA Degree (1999)

PUBLICATIONS


