IMPACT OF MICROBIAL INOCULANTS ON THE QUALITY AND FERMENTATION STABILITY OF ALFALFA ROUND-BALE BALEAGE

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Non Technical Summary
The importance of alfalfa as a high protein and highly digestible forage has become increasingly apparent to innovative beef cattle producers and small and medium-sized dairies in the eastern U.S. Baled silage has become a transformational technology, which makes the use of alfalfa less risky and more rewarding to these producers. Interest in alfalfa and interseeding alfalfa into grass hayfields has created demand for a greater extension education effort to train producers how to utilize alfalfa, as well as using baleage technology to appropriately harvest and store the hay. Major questions remain about the need for and efficacy of alfalfa-specific inoculants to ensure adequate fermentation and/or baleage stability. This work proposes to raise the profile of alfalfa in two ways. First, we seek to build up on our recent successes in promoting alfalfa’s utility for these farms. Secondly, we seek to evaluate microbial inoculant technologies that may improve the fermentation profile of alfalfa and alfalfa-grass baleage. In this proposal, we will show how these two aspects of raising the profile of alfalfa are connected. We propose work that will integrate extension and applied research. In the extension component, we will promote the use of alfalfa and alfalfa-grass mixtures to beef cattle producers and small and medium-sized dairies by providing the linkages with the transformational technology of baleage. In the research component, we will buttress the baled silage system by assessing the need for and efficacy of microbial inoculants for improving the fermentation and aerobic stability of alfalfa/grass baleage.

Animal Health Component 60%

Research Effort Categories
Basic 40%
Applied 60%
Developmental 0%
**Classification**
Knowledge Area
205 - Plant Management Systems;

Subject Of Investigation
1699 - Pasture and forage crops, general/other;

Field Of Science
1060 - Biology (whole systems);

**Keywords**
baleage
alfalfa
fermentation
microbial inoculants
post-harvest

**Goals / Objectives**
Goals: Increase the knowledge and understanding of growing alfalfa and/or interseeding alfalfa into grass (cool season perennial and warm season perennial) hayfields. Increase producers’ skill in producing high quality alfalfa or alfalfa-mixed baleage. Investigate the efficacy of homofermentative and/or heterfermentative inoculants on the fermentation profile and silage stability of alfalfa-grass baleage.

**Project Methods**
Methods and Procedures Objective 1: Use of microbial inoculants to improve the fermentation, nutritive value, dry matter digestibility, and aerobic stability of alfalfa/grass baleage. To accomplish these research objective and test our hypothesis, we propose to compare an untreated water control and five inoculant treatments applied in a manner consistent with the manufacturer recommendations. The five inoculants will include (1) Pioneer 11H50 inoculant (DuPont Pioneer Johnston, IA), applied at 11.0 mg/kg to supply 1.25 x 1011 cfu/g of Lactobacillus plantarum; (2) Pioneer 1174 inoculant (DuPont Pioneer Johnston, IA), applied at 11.0 mg/kg to supply 1.25 x 1011 cfu/g of L. plantarum and Enterococcus faecium; (3) Pioneer 11AFT (DuPont Pioneer Johnston, IA), applied at 11.0 mg/kg to supply 1.0 x 1011 cfu/g of L. plantarum and L. buchneri; (4) SiloKing inoculant (AgriKing Inc.), applied at 7.9 mg/kg of fresh forage to supply 1.0 x 105 cfu/g of a mixture of L. plantarum, E. faecium, and Pediococcus pentosaceus, [the SiloKing inoculant was chosen based on work by Arriola et al. (2015) where the fermentation profile indicated significantly less secondary fermentation, kept clostridia counts low, exhibited lower non-protein N concentrations, and resulted in superior IVDMD] and (5) Silo Solve MC (CHR Hansen, Horsholm, Denmark), applied at 1.1 mg/kg to supply 1.5 x 104 cfu/g of L. plantarum, E. faecium and L. lactis. Each inoculant contains homofermentative species that will enhance overall fermentation, while 11AFT contains homo- and heterofermentative species. Locations and Forage Management: The study will be conducted at three locations across the eastern U.S. region (Athens, GA; River Falls, WI; Starkville, MS). An existing or newly-established stand of Bulldog 505 (GA and MS) and Magnum 7 (WI) alfalfa will be used for the study. Alfalfa will be interseeded into different grass systems: (1) bermudagrass in GA, (2) bahiagrass in MS, and (3)
orchardgrass in WI. Lime, phosphorous, and potassium along with the necessary micronutrients will be applied to each stand based on soil test recommendations. Alfalfa will be harvested at a 3-inch stubble height when it reaches 10% bloom with a disk mower fitted with a conditioner. Ten representative samples for chemical analysis will be taken from the windrowed forage after mowing and immediately prior to baling. Alfalfa will be wilted until it reaches 50-65% moisture and baling will start immediately after the forage reaches this moisture range. A round baler will be used and type and model will vary by location. Inoculants will be mixed with approximately 3.2 gallons (~12 L) of deionized water or other suitable water source for use in inoculation (i.e., non-chlorinated water) and sprayed onto the forage using a tractor mounted, tank and continuous-flow sprayer with a 3-nozzle boom affixed to the pickup of the round baler (Krueger et al., 2008). The nozzles will be oriented to uniformly apply inoculant to the windrow as the baler is picking it up and just before the forage enters the baler chamber. The sprayer will be switched off and two bales of untreated forage will be run through the baler after each treatment to clean out the baler and minimize cross contamination. The field will be divided into 6 blocks and each treatment will be applied to windrows in each block to ensure that each treatment will be applied to comparable forage. Thirty-six round bales (6 per treatment; 12-1500 lbs, 4 ft x 4 ft diameter) will be made at the second or third harvest in year 1 and 2 of the study. Each bale will be individually wrapped with 8 layers of white silage wrap plastic at the storage site. Eighteen bales (3 per treatment) will be randomly assigned and kept intact for 112-d and then opened for sampling. These bales will be weighed just before wrapping on 0-d and just after opening at 112-d. Bale weights and dry matter concentrations will be used to calculate dry matter losses. Other bales (3 per treatment) will be stored for 21-d and sampled by coring after storage periods of 7, 14 and 21-d. Each sample will be placed in individually labeled plastic sample bags and kept on ice in a cooler before being frozen until subjected to chemical analysis. Temperature sensors will be placed in two of the bales in each treatment and set to record readings every 30 minutes for 21-d.

Chemical Analysis Baleage samples will first be analyzed to determine pH by mixing approximately 50 g of forage with 500 mL of distilled water and blended for one minute and pH measured using an electrode. Dry matter concentrations will be measured by drying forage samples in a forced-draft oven at 60°C for 48-h. Half of the remaining material in each of the samples will be sent to a commercial laboratory for analysis of pH, total lactic acid bacteria, yeasts, clostridia, molds, nutritive value, soluble protein, and volatile fatty acids (VFAs). In-vitro 48-h DM digestibility will be conducted for each sampling period. The other half will be retained as a precaution or for reanalysis, if required, until publication of the data. Statistical Analysis: The experiment will be a completely randomized design and data will be analyzed with the mixed models of SAS (v. 9.4, SAS Institute Inc., Cary, NC). In the analysis, treatments will be considered the fixed effect and bales will be considered a random effect. Means will be separated by Fishers F-protected least significant difference (LSD) where significance will be declared at P ≤ 0.05 and tendencies at 0.05 < P < 0.10.

Objective 2: Extension and Outreach Component: We plan a comprehensive extension program that FOCUSES on training producers and Extension personnel on the opportunities for producing alfalfa and utilizing baled silage systems for conserving high quality alfalfa and alfalfa-grass baleage. The extension effort will include hands-on workshops and field days wherein the principles of alfalfa production and management will be presented to a target audience of beef cattle producers and small and medium-sized dairies. We plan on continuing existing on-farm demonstrations and field days using current funding mechanisms. However, this proposed work will greatly expand the intensity of our extension efforts and expand it across the eastern U.S., as well as to other areas
of the U.S. via extension.org. Additionally, the extension activities will highlight the research component of our work. These activities will include on-farm demonstrations to educate producers on inoculation benefits, best management practices, and appropriate harvesting and post-harvest handling of alfalfa.

**Progress** 09/01/15 to 08/31/16

**Outputs**
Target Audience: Our target audience included beef cattle producers, small and medium-sized dairymen, Extension Agents, NRCS Conservationists and technical service providers, and agribusinessmen/suppliers, and undergraduate students in the Forage Crops courses offered in Fall and Spring (UWRF). Changes/Problems: Georgia: Our biggest challenge has been severe drought. Once we assembled all of our materials for the inoculant study in early June, we have had very little rainfall. We are hopeful for rain to stimulate growth in late August/early September, but we have not had enough rainfall (65% below normal for June, July, and August to date) to provide enough bales for the study. The other major change/problem is that we could not locate a satisfactory M.S. student for this project. So, we have assigned a new PhD student to this project half time with the other half coming from a project funded by the Georgia Beef Commission which examines the forage quality and agronomic benefits of interseeding alfalfa into bermudagrass in South Georgia (an allied topic but distinctly different from the scope of this project). Mississippi: Our biggest challenge has been too much rain at the time of harvest making it difficult to bring the moisture content desirable level for baleage production. Bahiagrass field was sprayed with paraquat at 2 pt/ac on October 19, 2016. Alfalfa was established at a rate of 20 lbs/ac with a no-till drill on November 11, 2015. Fifty tons of lime (2 tons/acre) and 2 tons of potash (90 lb K/ac) were applied on October 19, 2015 based on soil test recommendations. One ton of potash applied on May 17, 2016 after the first cut (50 lb K/ac). In February 25, 2016, Pursuit (imazethapyr) was applied at 4 ounces per acre with 0.25% v/v of nonionic surfactant in 20 gallons of water. In March 4, 2016, Poast (sethoxydin) was applied at 2 pints per acre 20 gallons of water plus 1 pint of crop oil per acre. One challenge has been scouting and controlling armyworms. Mustang Max was applied at a rate of 2.8 oz per acre when alfalfa was 4-6 inches. Application was done on May 23, 2016. First cut occurred on May 12, 2016. A total of 70, 4x5 round bales were produced with average weight of 1676 lbs. Research data collection will start during the second harvest on June 27, 2016. A second run of data collection is expected in second week of August if the weather allows it. Wisconsin: Our biggest challenge has been the establishment of orchardgrass in existing alfalfa stands. In the first run, the harvest maturity is past 10% bloom. The other major change/problem, because of the summer break, has been the availability of student workers. However, a leading farmer is collaborating with the field activities. What opportunities for training and professional development has the project provided? Through the three field days, we trained both county agents and NRCS personnel in better assist producers in planting alfalfa. From obtaining the right variety for the area to developing a nutrient management plan. Also to identify nutrient deficiencies in alfalfa and how to correct them. We conducted 9 workshops and field days in the spring and summer of 2016 and 4 guest lectures on "Forage Crop Silage Production and Conservation" (Fall 2015 and Spring 2016). How have the results been disseminated to communities of interest? Field day presentations have been made available to the attendees and also posted in university website for access. Continue data collection and working with extension on developing and expanding the alfalfa community of practice. Information will also presented through newsletters, extension publication, fact sheets and presenting the data at national and regional meetings. What do you plan to do during the next reporting period to accomplish the goals? We plan to continue conducting workshops and programs, as well as making and
evaluating the efficacy of inoculants on alfalfa-grass baleage. We plan to continue conducting training sessions as part of the Forage Course, specifically stressing the importance of inoculants in alfalfa production and conservation. We also plan on replanting orchardgrass, and evaluating the efficacy of inoculants on alfalfa-grass baleage as soon as we have orchardgrass growth. We also plan to develop short video clips of management practices and webinars that can be uploaded to website and extension COP.

Impacts
What was accomplished under these goals? In Georgia, we have demonstrably increased the knowledge and understanding of growing alfalfa and/or interseeding alfalfa into warm-season perennial grass hayfields; increased producers skill in producing high quality alfalfa or alfalfa-mixed baleage as evidenced by individual producers reporting increased forage quality; and assembled the materials to investigate the efficacy of homofermentative and/or heterfermentative inoculants on the fermentation profile and silage stability of alfalfa-grass baleage as soon as we receive enough rainfall to allow regrowth of the alfalfa to occur in August/early September in Mississippi, we increased knowledge of alfalfa production in MS and well as producers interesting on establishing small acreage of alfalfa for baleage and hay production. We have also trained county agents to provide more accurate information about alfalfa production in the south and making producers aware of the management practices that have be in place to be successful and maintain the persistence of the stand. In Wisconsin, we overseeded 9 acres of alfalfa with late maturing orchardgrass. We will bale the mix on August 14th 2016.