25TH KENTUCKY ALFALFA CONFERENCE PROCEEDINGS

Volume 25, Number 1

Garry Lacefield & Christi Forsythe, Editors

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Cave City Convention Center

Sponsored by
University of Kentucky●College of Agriculture●Cooperative Extension Service
Kentucky Forage and Grassland Council

Schedule for the Day

8:00	Registration, Visit Exhibits, Silent Auction
8:40	Welcome
8:50	Kentucky Alfalfa Conference: 25th Anniversary – Dr. Garry Lacefield
9:00	Teaching Stand Management Using Virtual Alfalfa Plants – Dr. Ray Smith
9:10	Impact of Alfalfa in Lincoln County – Mr. Dan Grigson
9:30	Advances in Alfalfa Seed Coating – Mr. Bill Talley
9:50	Alfalfa Hay for Horses – Dr. Laurie Lawrence
10:10	Break, Visit Exhibits, Silent Auction
10:40	Progress Toward Sclerotinia-Resistant Varieties – Dr. Paul Vincelli
11:00	Growing Alfalfa for Wildlife – Dr. Don Ball
11:30	Alfalfa in our Dairy Operation – Mr. Lee Robey
12:00	Lunch, Visit Exhibits, Silent Auction, Awards
1:00	Roundup Ready Alfalfa: From Pipe Dream to Reality – Dr. Mark McCaslin
1:30	Alfalfa: Crop for the Future – Dr. Neal Martin
2:00	Alfalfa – Queen of the Forage Crops: It Don't Get Any Better – Mr. Warren Thompson
2:30	Discussion and Adjourn

F O R E W O R D

This conference marks the twenty-fifth consecutive year we have come together to address problems and potentials of alfalfa. We are certainly encouraged with the interest in and opportunities for alfalfa in Kentucky. We are optimistic that we will observe expansion in acres, yield, and markets. It is our hope that the information presented herein and the discussions of the day will be of value to each of you in your alfalfa program.

On behalf of the Program Committee, I would like to express our thanks to each of you for your faithful participation over the past twenty-five years. I also want to thank all speakers, moderators, committee members, and workers for their many contributions.

My personal thanks to the Program Committee, the Kentucky Forage and Grassland Council, and the Kentucky Department for Agriculture for their encouragement and assistance. I also want to thank all the exhibitors for their important contributions and financial support. We would also like to acknowledge the Barnhart Fund for Excellence for their financial support. A special thanks is extended to Mrs. Christi Forsythe for her assistance in preparing and editing the program and proceedings.

Garry Lacefield
Program Chairman
XXV Annual Kentucky Alfalfa Conference

Don't forget to visit our Extension Forage Website

http://www.uky.edu/Ag/Forage

KENTUCKY ALFALFA AWARDS

The Kentucky Alfalfa Awards Program was initiated in 2000 at the 20th Anniversary of the Kentucky Alfalfa Conference. The Awards Program is funded annually from revenues generated each year for the Silent Auction during the Annual Conference.

Year	Warren Thompson Industry Award	Charlie Schnitzler Producer Award	Garry D. Lacefield Public Service Award
2005	Barney Booher	Roy Reichenbach	Ken Johnson
2004	Gary Coughlin	Minos Cox	Mike Collins
2003	Phil Howell	Lee Robey	Monroe Rasnake Jimmy Henning
2002	Tom Keene	John Nowak	Billy Ray Smith
2001	Bill Talley	Larry Jeffries	Timothy H. Taylor W. C. Templeton, Jr.
2000	Warren Thompson	Sue Schnitzler*	Garry Lacefield

*Accepted on behalf of her father who was tragically killed in a farming accident on March 11, 1991.

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KENTUCKY ALFALFA CONFERENCE
25TH ANNIVERSARY

Garry D. Lacefield
Extension Forage Specialist
University of Kentucky

Today marks the 25th consecutive year we have come together for a full day's conference featuring "Alfalfa - Queen of the Forages" as the theme and focal point. Only one other state in the U.S. has such an annual event.

The Beginning - I have always had respect for alfalfa and even selected alfalfa as the crop that I did my Ph.D. work on at the University of Missouri. Warren Thompson had a very active and effective extension program in alfalfa throughout his career. Ken Evans and I had an active extension program on alfalfa during the seventies. Two key events during 1980 resulted in a renewed emphasis on alfalfa in Kentucky and the beginning of the Alfalfa Conference.

In the summer of 1980, I was invited by the Certified Alfalfa Seed Council on a study tour of the alfalfa seed producing area in five western states. During that tour, I met, got to know and visited with some of the leading alfalfa "experts" in the U.S. Their experience and enthusiasm and the opportunities offered me during that tour resulted in me returning to Kentucky with a renewed enthusiasm for alfalfa and its role in Kentucky. At that time, Kentucky had approximately 150,000 acres of alfalfa. A University of Kentucky study conducted earlier indicated a million acre potential.

In the fall of 1980, and shortly after my trip out west, we scheduled a KFGC Board meeting in Louisville. I had made arrangements for some farm visits in Shelby County on the afternoon before the board meeting. Dr. Monroe Rasnake traveled with me from Princeton to Louisville. During check-in at the hotel, Charlie Schnitzler and Wallace Campbell came in the lobby after driving in from Lincoln County. I invited Charlie and Wallace to accompany us on the farm visits. They agreed and we were off to Shelby County on a beautiful fall day to visit alfalfa fields. Roy Catlett had several visits lined-up. I remember visiting several fields with Jack and Frederica Clore. We also visited other alfalfa fields on several farms in the county. It was a most enjoyable afternoon and I learned a lot from Charlie and Wallace as we traveled. During these visits, Roy and I discussed the possibility of having a winter meeting just on alfalfa since there was so much interest in the County. Charlie Schnitzler told me during our travels that he felt the opportunities for alfalfa in Kentucky were great and encouraged me to place greater emphasis on this high yielding, high-quality crop. As always, Charlie volunteered to help in any way.

Over the next few weeks I developed some plans for a statewide meeting and discussed these plans with Ken Evans, Warren Thompson, Monroe Rasnake, Charlie Schnitzler and several county agents. Each of these people were most supportive and encouraged me to move ahead.

In January of 1981, we had our first Kentucky Alfalfa Conference in Shelbyville and repeated it in Princeton. The attendance, participation and feedback was excellent. In 1982, the 2nd Annual Kentucky Alfalfa Conference was held in Lexington and Princeton in conjunction with the National Alfalfa Symposium. In 1984, we met in Princeton and with standing room only realized we had out grown that facility. We continued to meet each year (Table 1) with attendance of 200 to over 400.

Table 1. Alfalfa Conference Dates and Locations

1981	Shelbyville/Princeton
1982	Lexington*/Princeton
1983	Cave City
1984	Princeton
1985	Elizabethtown
1986 & 1987	Cave City
1988	Mt. Sterling
1989 through 1997	Cave City
1998	Bowling Green*
1999 through 2005	Cave City

*Held in conjunction with National Alfalfa Symposium

Program Content - A review of the programs over the past twenty-four years indicates we have spent a lot of time on the basics. Soils, fertility, weed control, insect and disease control, establishment, varieties, harvesting, handling, storing, grazing, quality, marketing, economics, and alfalfa in livestock feeding programs have been frequent topics on past programs. Producers have been featured on many of the programs over the year and it was a producer, Mr. Charlie Schnitzler that served as our keynote speaker on our first conference program. In addition to the basics, we have complemented the program with timely, cutting-edge issues dealing with advances in seed coating, variety development, hybrid alfalfa, grazing tolerance, Roundup Ready, balage, pest management, etc.

Hay Show - In 1989, we began the Hay Show in cooperation with the Kentucky Department of Agriculture and later joined by the Kentucky Pride Hay Growers Association. The contest was sponsored by Garst Seed Company. Approximately $3,000 in prizes and trophies were awarded. The program has changed over the past decade. At present, in cooperation with the Kentucky Forage and Grassland Council, University of Kentucky and Kentucky Department of Agriculture, we present awards for the “monthly” highest quality alfalfa and alfalfa-grass hay tested through the Department of Agriculture.

Industry - A Valuable Assist - With only two exceptions, we have had exhibits at each conference. We value the support and contributions of all our exhibitors. Several exhibitors here today have been present at every conference. I have never asked one of the exhibitors for anything that they didn't readily agree. Their financial contributions have helped us keep all our bills paid. Our surveys indicate that participants enjoy getting to visit with all the exhibitors and that exhibitors enjoy having the opportunity to meet and visit with Kentucky's leaders in alfalfa production, research and education.

Awards – During the 20th Kentucky Alfalfa Conference and in cooperation with the Kentucky Forage & Grassland Council, the Alfalfa Awards Program was initiated. Since 2000, we have recognized outstanding achievement in the Producer, Public and Industry segments (Table 2).

Table 2. Kentucky Alfalfa Awards Recipients

Year	Warren Thompson Industry Award	Charlie Schnitzler Producer Award	Garry D. Lacefield Public Service Award
2005			
2004	Gary Coughlin	Minos Cox	Mike Collins
2003	Phil Howell	Lee Robey	Monroe Rasnake Jimmy Henning
2002	Tom Keene	John Nowak	Billy Ray Smith
2001	Bill Talley	Larry Jeffries	Timothy H. Taylor W. C. Templeton, Jr.
2000	Warren Thompson	Sue Schnitzler*	Garry Lacefield

*Accepted on behalf of her father who was tragically killed in a farming accident on March 11, 1991.

Summary – It’s hard to believe when this Conference started, my oldest son was four years old. At the 24th Kentucky Alfalfa Conference he was a speaker. Now, he is a new father and I am a new Papa. Time indeed has passed fast. I have been involved in many different conferences, symposia, and meetings over the years, but this Conference has been special. It is special for two important reasons: 1) the plant – Alfalfa—Queen of the Forage Crops – has been a tried and true performer. It has proven it’s abilities to produce high yields and high quality and be a moneymaker, 2) people – I have never come to this Conference without thinking of all the people that work so hard to make it happen. From my inspiration initially (Charlie Schnitzler) to this group of special friends that I have invited to speak here today and all those in-between I say THANK YOU. I am also appreciative of the exhibitors who have been so supportive, to all the County Agents who give unselfishly to insure the Conference runs smooth. I am thankful to all who have attended over the past 25 years from throughout Kentucky along with 32 other states and nine countries. I also want to thank the Kentucky Forage & Grassland Council, Department of Agriculture, and the U.K. Agronomy Department for their many contributions.

Special THANK YOU to our core committee who have worked closely with me including: Dr. Monroe Rasnake, Mr. Bill Talley, Mr. Tom Keene, Mr. Ken Johnson, Mr. Phil Howell, Dr. Jimmy Henning and the Mammoth Cave Extension Agents for Agriculture & Natural Resources.

I close with a very special THANK YOU to Christi Forsythe, who has done the most to make this Conference such a success. Her attention to details in preparing programs, coordinating exhibits, editing proceedings, and keeping the records is much appreciated.

TEACHING STAND MANAGEMENT USING VIRTUAL ALFALFA PLANTS

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INTRODUCTION

A 'virtual' alfalfa plant model was developed at the University of Manitoba in Canada as part of a comprehensive grazing research project. This model shows an alfalfa plant 'growing' on a computer screen and the plant's response to grazing (similar to time-lapse photography). The original model was designed and constructed by Av Singh to show the research potential of visually modeling alfalfa plant growth. The ability to visually 'grow' a plant on a computer screen also provides an excellent teaching and extension tool.

MATERIALS AND METHODS

Detailed plant measurements were used in the construction of Singh's model, based on single plants subjected to the following management conditions: 1) No grazing; 2) Rotational grazing; and 3) Continuous grazing. Singh's model can be downloaded as a video clip at http://www.cpsc.ucalgary.ca/~lars/models/. The current model shows our progress to date in modifying the existing single plant 'virtual' alfalfa model from a research model into a user-friendly teaching and extension model. Software development and programming changes include the following: 1) easier modification of individual alfalfa plants and alfalfa swards in response to different management scenarios, and 2) simpler format for data entry and manipulation. The morphogenetic rules describing alfalfa development were written using the plant modeling language of L-systems and were interpreted by the program *cpfg* (continuous plant and fractal generator). L-studio™ (University of Calgary, Calgary, Alberta, Canada) is a software package that creates a user-interface between L-system based modeling and the simulation program, *cpfg* under Windows (Microsoft Corporation, Redmond, WA).

OBJECTIVE

The objective of this project is to develop a virtual alfalfa model that will simulate the response of an alfalfa sward to various grazing intensities and other management conditions.

RESULTS

The current version of the virtual model incorporates 20 alfalfa plants growing in a simulated alfalfa sward. One option of this model shows stand persistence over time between grazing tolerant and intolerant varieties. Another option shows stand persistence of 'Florida 77' from the seedling stage (Fig. 1), after two years of continuous grazing (Fig. 2), and after two years of rotational grazing (Fig. 3) using data from research conducted at the Univ. of Georgia (Bouton and Gates, 2003). The visual quality of these figures is poor since they where taken from video clips in a PowerPoint presentation, but quality is crisp in the original working model or with large file size video clips. When the model is running on a computer plant growth and stand loss are shown as they occur on a daily basis over a two-year stand life. The virtual model is not limited to these scenarios. Simple modifications in plant growth parameters allow the simulation of numerous grazing or clipping scenarios. We are currently developing a version of the virtual model to simulate the effect of potato leafhopper infestation on stand vigor and yield.

Figure 1 - Simulated alfalfa sward at the seedling stage.

Figure 2 - Florida 77 following two years continuous grazing.

Figure 3 - Florida 77 following two years rotational grazing.

SUMMARY AND CONCLUSIONS

These results show the value of virtual modeling as a research tool, but the greatest value of this model will be in showing livestock producers the effect of mismanagement and/or poor cultivar choice. A visual model allows producers to observe the implications of their management choices without having to wait for several years and suffer economic losses due to poor decisions.

REFERENCES

Bouton, J.H. and R.N. Gates. 2003. Agron. J. 95:1491-1494.

Singh, A. PhD Dissertation. Univ. of Manitoba, Winnipeg, MB, Canada

IMPACT OF ALFALFA IN LINCOLN COUNTY

Dan Grigson
Lincoln County Extension Agent for Agriculture & Natural Resources

Lincoln County is located 45 miles south of Lexington, Kentucky. It is part of 3 geographical regions of the state-the outer Bluegrass, the Knobs, and the Eastern Pennyroyal area. Thus the land ranges from moderate sloping fields that can be row cropped to fields that are nearly too steep to mow. The majority of the land is best suited for hay and pasture production. The soil fertility is moderately high with limestone, sandstone, shale and siltstone parent material. The land is very well suited to growing very productive forage crops.

Lincoln County farmers have utilized the resources of the land very well and developed quality livestock and forage systems. These farmers realize that good forage leads to better livestock profits. Lincoln County has a strong livestock industry that generates over $23 million annually. The good forage produced is the backbone of that strong livestock industry. Lincoln County is the 6th largest cattle and calves production county in the state, the 8th largest beef cow county, the 5th largest dairy county and has a sizeable goat and pleasure horse enterprise. It takes a lot of feed for this livestock industry. We annually produce 9,000 acres of alfalfa, 32,000 acres of grass and grass legume hay, 7,000 acres of corn silage, 2,500 acres of small grain mostly for silage, hay, and pasture and 30,000+ acres of pasture.

Lincoln County farmers have a reputation for being good forage producers. Over the years they have produced good yields and good quality. Much of this is a result of their willingness to learn how to improve their forage production. I must thank the Lincoln County forage pioneers who blazed the way to better forage production. They've made my job easy because the producers were already doing a good job and had the desire to learn more about improving pasture, silage, and hay crops. I have to thank Kelsey Driskill, Russell Cornelius, Charlie Schnitzler, Wallace Campbell, J.B. Holtzclaw, Ken Evans and others who led the way to better forages. And I must continue thanking Warren Thompson for being the Alfalfa Ambassador to Lincoln County, spending many days there helping agents, farmers and industry produce and market great crops of alfalfa. Thanks to them, 65-70% of the pasture is improved with legumes and fertility management, renovation is a standard practice, no-till is the popular renovation method, and alfalfa grazing is a regular practice. These guys left me big shoes to fill!

Thanks to the help of these pioneers and the support of Dr. Lacefield and Dr. Henning, I've tried to continue to have extensive educational programs on forage production and livestock's utilization of the forage. I have had 24 years of all types of forage demonstrations. I believe these demonstrations have really complimented our educational efforts for all forages.

I have no doubt though that our alfalfa projects have had the greatest impact on our county's agricultural economy. We have compared hay varieties, looked at weed control, hay marketing, no-till seeding, chemical preservatives, baleage, fertility management and etc. Our educational efforts have helped our producers achieve those 7 ton yields, produce clean hay, and preserve quality hay and silage. We've helped 12-15 producers develop cash alfalfa hay as a major enterprise marketing that hay in the area and across the south. Alfalfa has made good money for our livestock producers and cash hay sellers.

But, our greatest effort that has the potential to really impact our state's and region's livestock industry is our work with alfalfa grazing. In the fall of 1989, Warren Thompson told me about what I believe is "Grazings-Greatest Find". The first true grazing alfalfa-Alfagraze bred by Dr. Joe Bouton at the University of Georgia. Thanks to Warren Thompson and America's Alfalfa, the first on farm test of Alfagraze was seeded in the spring of 1990 on the John Elliott Farm. We compared Apollo to Alfagraze under stocker and beef cow grazing pressure. We quickly saw that the Alfagraze could take the abuse and keep on producing. We found it to be good for hay fields as well as grazing. The Alfagraze lasted 7 years which was twice the length of the Apollo. We shared our findings through field days, tours and media methods. Each year we added more Alfagraze demos around the county and these farmers also had great success. Our farmers quickly began to seed Alfagraze for grazing and hay for beef stockers, beef cows, and dairy cattle.

As you know this led to a flurry of activity to develop the next generation of alfalfa grazing varieties. We find Alfagraze to still be great but we see grazing varieties. Now with better disease resistance, quicker re-growth, and higher yields. Most all of our good seed companies have quality grazing alfalfas now.

I want to share some of our producers success with alfalfa grazing programs. John Elliott has gone from the first 5 acre test plot to over 150 acres of alfalfa for grazing. He has doubled his pasture yields, increased calf gains by .5-.7 lbs. per day, enjoyed a 95% conception rate on a 60 day breeding program, increased his cow herd by 60%, backgrounds his calves and makes a lot of good round bale alfalfa haylage to feed his livestock. Elliott and I agree that grazing alfalfa has made a tremendous impact on his farming profits.

Holtzclaw Farms have great success with alfalfa grazing. They utilize their hills planting no-till corn. Then they graze the corn November-January. They then freeze seed grazing alfalfas, clovers, and orchardgrass on these hills. They were doing great with clover, but thanks to the grazing alfalfas, they have increased their stocker steer numbers by 15%. They have enjoyed 2.5 lbs. per day gains on alfalfa grass. They buy calves at 400 pounds and put them on the alfalfa-grass fields. In November, they get access to the corn, alfalfa fields and alfalfa-grass round bale silage. They sold their calves January 9 weighing 950 pounds at $1.02 per pound. Bill Holtzclaw says, "alfalfa makes the cream for me."

Lincoln County's "Mr. Alfalfa" is Roy Reichenbach. He has sold a lot of tons of quality alfalfa hay to satisfied dairy and horse customers for thirty years. He has been a pioneer for no-till alfalfa seeding. He has helped us do a lot of alfalfa demonstrations and hosted numerous tours of his farm. He had always had some success grazing alfalfa in dry years and in November. So when Alfagraze came along he jumped on it really quick and now he sow's grazing alfalfa in all of his pastures and about 90% of his hay fields. He has seeded alfalfa on hills that most folks won't ride a tractor on thus greatly enhancing that land's grazing potential. Reichenbach has been able to increase his stocker numbers by 30%, enjoy better daily gains, produce gain cheaper on cattle than when on silage, and produce quality alfalfa-grass that is great for his feeding and cash hay enterprises.

Our dairy farmers have had great success with alfalfa grazing also. Bo Gander saw a 13 lb. increase in milk production in 2 years of grazing. He added 15 more cows to the herd without additional acreage. He enjoyed cheaper feed cost and better production. Eddie Simpson saw 12 lb. per cow increase in milk production thanks to alfalfa grazing. He no longer had the summer slump and as Eddie says, "It's so easy to do."

There are many more success stories for our beef and dairy producers who are grazing. Alfalfa grazing has helped us increase livestock productivity while reducing feed costs thus making bigger profits for our farmers. We have just scratched the surface in regard to the potential for more alfalfa grazing in Lincoln County. We now know that those fescue and sagegrass hills all over Kentucky and the region can be converted into productive alfalfa-grass pastures. That can mean more cattle, more milk, more goats, more hay and more profits for our farmers. The potential is tremendous.

Alfalfa acreage is growing in the county. We have moved up to be the 4th largest alfalfa producing county in the state. The Phase I cost share dollars helped us increase our acreage nearly 2000 acres in the past three years to where we now have 9000 acres. I get questions all the time from farmers who want to add alfalfa acreage. Our beef cow producers have realized that feeding alfalfa grass hay to their cows generally eliminates the need to feed grain and or protein tubs. They realize they can produce a pound of gain cheaper. I expect a good growth in acreage of alfalfa for beef cows as our herds are growing to offset lost tobacco income.

As we consider the more opportunities available using alfalfa, there is the chance for more beef profits. Producers can run more cattle per acre, have better calving rates, more average daily calf gains, all which add up to better profits. Dairy farmers also have the chance to use alfalfa to make more dairy profits as they will be able to run more cows and heifers per acre, have better quality feed, thus increasing daily milk production while actually decreasing feed costs. Producers with other livestock species can also enjoy better profits thanks to alfalfa production.

Alfalfa has had a huge impact on Lincoln County, but we’re not where I want our farmers to be yet. Thus, I challenge myself to do more educational programs. I see the need for more demonstrations, more field days, meetings, cost share programs and other methods to show farmers. The benefits of producing and utilizing alfalfa on their farms.

To Kentucky farmers, I challenge you to take advantage of the benefits of alfalfa for hay and grazing. Alfalfa is Queen of the Forage Crops. It is our best forage. That should be important to farmers who want to make money because “Better Forage Equals Better Profits”.

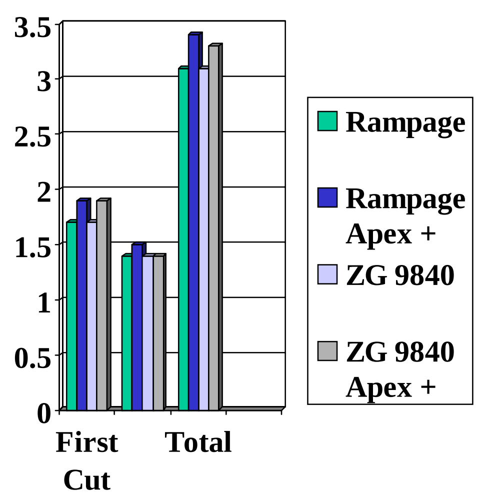
ADVANCES IN ALFALFA SEED COATING

Bill Talley
President
Summit Seeds, Inc.

Seed coating for alfalfa has been available since the mid to late 70's. Over the last 30 years, advances in the industry have made it the choice of many producers. The purpose of the coatings at that time was mainly to add weight to increase the ballistic properties and to be a carrier for the rhizobia. Through research and new technology, coatings have evolved and shown great agronomic benefits. Seed coating can provide an opportunity to supply effective quantities of needed materials to each seed, which can influence both the physical property, and the microenvironment of the seed. Coatings can protect the rhizobia and provide a microenvironment for quick nodulation, insuring good seed-soil contact. This improves the movement of water to the seed, and increases the seed weight and size, which improves seed plantability. Treating the seed with a precise loading of pesticides and /or fungicides, supplying of growth regulators, incorporating hydrophilic and/or hydrophobic materials in the coating regulates water imbibition and germination, and adds beneficial elements and micronutrients to the seed. Indeed the future of seed coating may develop into a prescription approach – coating the seeds with the necessary elements to fit the needs of the field and the crop for optimum growth.

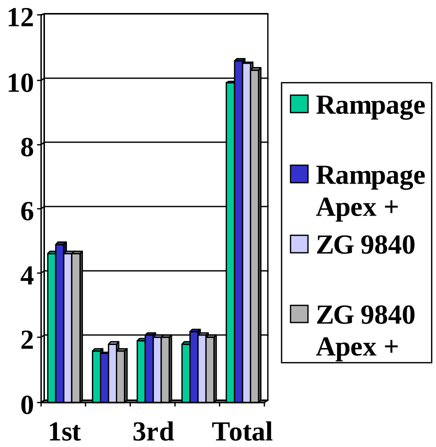
Currently Summit Seed coatings has a patent for a specialized coating for use in high ph soils. This has been a joint effort between Summit Seed Coatings and a seed company located in Idaho. The results have shown a significant improvement in university research trials and have been especially beneficial in farm trials. This product is marketed under the Apex Plus Coating name and

Table 1. University of Idaho Seed Coating Study



- Seeding Rate 16 # per Acre Pound for Pound
- Raw Preinoculated
- Apex Plus
- Two Varieties
- Apex Plus Significantly Higher at .05
- Spring Seeding

Table 2. University of Idaho Seed Coating Study

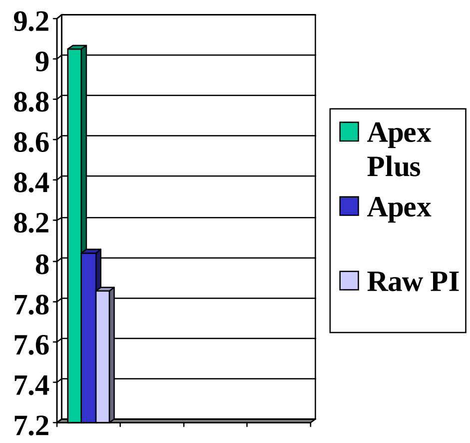


- Seeding Rate 16 # per Acre Pound for Pound
- Raw Preinoculated
- Apex Plus
- Two Varieties
- Fall Seeding

Mico Rhizo brand name (Tables 1-3).

High ph soils are not a problem for Kentucky farmers, who generally have more problems with low ph soils. This is probably the number one problem seen when looking at a stand problem or establishment problem. It is extremely important to get the pH of the soil between six and seven before planting. Summit Seed Coatings has started research with a southern university this past fall, to do an initial screening of different products that can be added to the seed coating aiding in establishment and nodulation in low ph soils. This is being done in lab tests at this time and will move out to field trials if any products look promising. We are planning to have a product commercially available in two years, if the research goes favorably.

Table 3. Utah State University Seed Coating Study



- Seeding Rate 16 # per Acre Pound for Pound
- Raw Preinoculated
- Apex
- Apex Plus
- Yield per acre

Another area that I feel will benefit Kentucky alfalfa growers will be the addition of Micronutrients and plant growth regulators to the alfalfa seed coating. W-L Research and Caudill Seed are applying 3-D growth supplement to their alfalfa seed at this time. This was started spring of 2004 and had favorable field results and testimonies. We look for this to expand and we look for more micronutrients to be used. We also see the potential for the super absorbent starches and polymers to be added to the coating.

These starches and polymers can greatly increase the water holding capacity of the seed and the germination zone to increase germination and seedling survival.

The future holds many new possibilities for alfalfa seed coatings. The coating of the future may be a prescription coating based on your farm, its soil condition, and the weather and climate conditions at the time of planting. Summit works with several Alfalfa seed companies and farmers that want prescription seed coatings for their farms at this time. I foresee more of this in the future, but to make this work it takes lead-time of three–six months to bring all the logistics together. By working on this on a small scale we should be able to reduce lead times considerably and make prescription seed coatings a reality.

ALFALFA HAY FOR HORSES (AND HORSE OWNERS!)

Laurie Lawrence and Bryan Cassill
Department of Animal Sciences
University of Kentucky

Alfalfa is one of the most common hays fed to horses in Kentucky. Other hays that are often used include timothy and orchardgrass. As a legume, alfalfa has many nutritional advantages over timothy or orchardgrass. Alfalfa hay contains more protein and calcium than grass hays and thus is an excellent source of these nutrients for broodmares and growing horses. Another legume that may be useful as a hay for horses is red clover. Nutritionally, red clover has many of the same advantages as alfalfa. However, red clover has some non-nutritional characteristics which have traditionally limited its popularity with horse owners. Red clover will occasionally cause horses to slobber excessively. “Clover slobbers” is not usually harmful to horses, but it is not a pleasing sight for horse owners. Even when red clover hay does not cause slobbering, some horse owners avoid it. Red clover hay may not have a nice green color preferred by horse owners, and it may also be somewhat dusty.

Recent research at the University of Kentucky has evaluated the preferences of horses for alfalfa and red clover hays. In addition, we have studied some of the sensory characteristics of hay (smell, texture, color). One of our questions was “Do any of criteria applied by humans to hay selection relate to whether a hay is preferred by horses?”

Two studies were conducted. In the first study, horses and humans evaluated two varieties of first cutting red clover and one variety of first cutting alfalfa. In the second study, a second cutting of each hay was compared. For both experiments, the red clover and alfalfa crops were raised at UK, so harvesting, baling and storage conditions were similar. The studies were conducted approximately 6-8 months after the hay had been baled. Each variety of hay was sampled for nutrient composition (Table 1).

Table 1. Composition of the Red Clover (RC1 and RC2) and Alfalfa (Alf) Hays*.						
	First Cutting			Second Cutting		
	RC1	RC2	Alf	RC1	RC2	Alf
Dry Matter (%)	91.3	91.5	92.1	92.1	91.5	92.9
Crude Protein (%)	15.5	14.5	18.1	17.3	17.5	17.6
ADF (%)	25.6	28.0	29.2	25.6	28.6	26.5
NDF(%)	35.4	38.5	38.7	39.2	40.3	37.0
NFC (%)	31.6	29.8	27.7	27.8	26.2	30.0
Ca (%)	1.9	1.16	1.39	1.54	1.55	1.22
P (%)	0.26	0.24	0.31	0.27	0.25	0.31

* Varieties were Kenland (RC1), Freedom (RC2) and Rushmore (Alfalfa)

SENSORY CHARACTERISTICS OF THE HAY

The sensory characteristics scored by humans included color, texture, dustiness, mold and smell. At least five people scored several bales of each hay. Each evaluator worked independently and scores were averaged after all evaluations were complete. Prior to scoring the test hays, evaluators practiced with the scoring system using approximately 20 hay samples. For each characteristic, a ten point scale was used where 1 was the best score and 10 was the worst score. A complete description of the scoring system is attached at the end of this paper, but briefly:

Dustiness:
- 1 = no dust
- 5= moderate dust in 30-60% of the bale
- 10= very heavy dust throughout the bale.

Mold:
- 1= no visible mold
- 5= visible mold on 50% of flakes
- 10= heavy mold throughout the bale

Color:
- 1=very bright green throughout bale
- 5= light brown with green mixed in
- 10= very dark brown to black

Smell:
- 1= freshly mown hay aroma, no other odors
- 5= a definite musty odor and may contain a slight putrefied or fermented odor
- 10=a strong fermented odor or a foreign odor from a contaminant

Texture:
- 1= very soft and leafy
- 5= medium texture with 40-60% stems or coarse material
- 10= very rough texture, high level of weeds and coarse material

The results of the sensory scoring are shown in Table 2. For the first cutting hays, the evaluators rated the red clover hays as having more mold and a less desirable odor than the alfalfa hay. In addition the first cutting clover hays were rated as having a mostly brown color, compared to the alfalfa which was rated as mostly green with some brown.

For the second cutting hays, differences between the alfalfa hay and the red clover hays were more obvious. The alfalfa hay had less mold and dust than the clover hay. In addition, the second cutting alfalfa hay had a greener color and better smell than the second cutting clover. However, the clover hays had a better texture score than the alfalfa. The second cutting clover hays were described as “medium texture with 40-60% stems”, whereas the alfalfa hay was described as “rough texture of mostly stems”.

Table 2. Sensory Ratings for the Red Clover and Alfalfa Hays.

	Dust	Mold	Color	Smell	Texture
First Cutting					
Red Clover 1	3.4	3.1	5.9	4.5	6.6
Red Clover 2	3.6	4.0	6.7	5.3	6.5
Alfalfa	2.8	1.6*	4.4*	3.4*	4.8*
Second Cutting					
Red Clover 1	4.9	4.5	6.3	4.6	3.9
Red Clover 2	4.9	5.8	7.2	5.3	4.1
Alfalfa	1.6*	1.2*	4.4*	3.5*	5.9*

*The alfalfa score was significantly different ($P<0.05$) from the red clover scores.
Several bales of hay were scored for each variety by at least 5 evaluators. Each value in Table 2 represents at least 20 scores.

HORSE PREFERENCES

After the hays were scored for sensory characteristics they were fed to six mature horses. First, the horses were adapted to a diet of timothy hay and a small amount of grain. Preference testing was conducted three mornings a week, before the horses received their normal morning feeding. Two-choice preference tests were used. Each horse was given 1 hour to select from two hay nets containing different hays. Hay nets were filled with 11 lb of the test hays and hung in the horses’ stalls. The horses were given 1 hour to consume as much of each hay as they wanted. At the end of the hour, the hay nets were removed and the amount of hay remaining in each net was weighed. Each horse was test twice for each combination.

Preference was determined by comparing the amount of each hay consumed by each horse. The comparisons that were made were:

First cutting alfalfa versus First cutting red clover 1
First cutting alfalfa versus First cutting red clover 2

First cutting red clover 1 versus First cutting red clover 2
Second cutting alfalfa versus second cutting red clover 1
Second cutting alfalfa versus second cutting red clover 2
Second cutting red clover 1 versus Second cutting red clover 2

Table 3. Amount of hay consumed when horses were given a choice between alfalfa and red clover hays for 1 hour.

		First Cutting	Second Cutting
Comparison: RC1 vs. Alf			
	RC1	2.2 +/- 2.2 lb	2.6 +/- 2.0 lb
	Alf	2.6 +/- 1.3 lb	2.2 +/- 1.5 lb
Comparison: RC2 vs Alf			
	RC2	2.2 +/- 1.3 lb	2.9 +/- 1.1 lb
	Alf	2.6 +/- 1.0 lb	1.5 +/- 0.6 lb
Comparison: RC1 vs RC2			
	RC1	1.8 +/- 1.1 lb	2.0 +/- 1.1 lb
	RC2	2.9 +/- 1.3 lb	2.9 +/- 0.7 lb

Table 3 illustrates that horses did not exhibit a strong preference for any of the three hays. When they were offered a choice between red clover and alfalfa, they consumed similar amounts of each one. For the second cutting hays, the horses did not appear to show a preference when offered the RC1 and alfalfa, but there was a trend for horses to prefer the second cutting RC2 over the second cutting alfalfa. There was also a trend for horses to prefer the RC2 hay over the RC1, for both cuttings.

HORSES VERSUS HUMANS

One of our goals was to determine whether the sensory scores made by human evaluators would relate to choices made by the horse evaluators. The answer to this question appears to be "no". In the first cutting hay, the sensory scores were consistently better for the alfalfa hay than for the red clover hay, except in the dust category, which were not different. When offered the first cutting hays, the horses did not exhibit a clear preference. For the second cutting hay, the sensory scores for dust, mold, smell and color were much better for the alfalfa than for the clover hays. However, horses clearly did not prefer the alfalfa. In fact, there was a trend for horses to prefer RC2 over the alfalfa hay! Although most of the sensory scores were in favor of the alfalfa hay for the second cutting, the texture score actually favored the red clover hay. Further research needs to be performed but it is possible that texture is a relatively important sensory characteristic for horses.

LEGUME OR GRASS HAYS

This study had two additional components. When it became clear that these horses did not prefer alfalfa to red clover hay, we conducted a preference test where horses could choose between the second cutting alfalfa hay and timothy hay. The study was conducted as above, where horses were given access to one hay net containing alfalfa and one hay net containing timothy and allowed 1 hour to consume the hays. The results are shown below (Table 4). It is clear that horses much preferred the alfalfa over the timothy. The result of the preference testing between timothy and alfalfa is consistent with many other studies that have shown that horses will consume alfalfa more readily than many grass hays.

Table 4. Amount of timothy or alfalfa hay consumed by horses in 1 hour.

Horse	Timothy (lb)	Alfalfa (lb)
D	1.0	3.7
Y	0.0	5.3
J	0.0	5.3
M	0.0	4.4
E	0.0	2.9
S	0.0	2.6
Mean	0.17 lb	4.0 lb (P<0.05)

Finally, we were interested in whether the legume hay consumed by the horses on test days would affect the amount of timothy they consumed on those days. As described above, the horses were used for preference tests three days a week. Preference tests were conducted before the horses were given their regular morning feed. For one week during the study, the amount of timothy consumed by the horses was measured on both preference testing days and non-test days. We hypothesized that on the days that the horses were given a preference test they would consume less timothy hay, because the legume they consumed in the preference test would replace an equal amount of timothy in their diet. We found that on the days that horses were not given a preference test, they consumed about 17 pounds of timothy hay. On the days that they were given a preference test, they consumed about 17 pounds of timothy and 5 pounds of the legume hays. Clearly, the access to the legume hays did not affect the amount of timothy the horses consumed, so there was no replacement effect. A replacement effect could occur if horses were given the opportunity to consume greater amounts of legume hay; however, additional research is needed to examine this possibility.

SUMMARY

The use of preference tests indicated that horses do not discriminate against red clover, in comparison to alfalfa, even though humans do. Sensory characteristics of the hay that were assessed by humans such as mold, dust, odor and color favored alfalfa hay over red clover hay. However, for the comparison of the second cutting red clover to the second cutting alfalfa, the red clover had a more desirable texture score. Even though horses did not appear to have a preference for alfalfa over red clover, they showed a clear preference for alfalfa over timothy hay.

Appendix 1: Visual Hay Evaluation System

In this system, the dust score is distinguished from the mold score by color. If a whitish color is seen on the cut edge of the bale then a mold score will be obtained.

	Dust Score
1	No dust
2	Very slight dust in 10 to 20% of the bale- cut side only
3	Slight dust in 20 to 50% of the bale
4	Moderate dust in 10 to 30% of bale
5	Moderate dust in 30 to 60% of the bale
6	Moderate dust in greater than 50% of the bale or heavy dust in 10%
7	Heavy dust in 10 to 40% of the bale
8	Heavy dust in 40 to 60% of the bale
9	Heavy dust throughout the bale
10	Very heavy dust throughout the bale

	Mold Score
1	No visible mold
2	Visible mold in only one location in the entire bale
3	Visible mold at low level in 2 to 3 locations
4	Some visible mold in 25% of the flakes
5	Visible mold on the outside of half of the flakes
6	Visible mold inside 10 to 20% of the flakes
7	Visible mold in 20 to 40% of the bale
8	Visible mold in 40 to 60 % of the bale
9	Visible mold in greater than 80% of the bale
10	Heavy mold throughout the bale

	Color Score
1	Very bright green- excellent color throughout the bale
2	Very good color with some slight bleaching
3	Green color with some slight brown spots
4	Olive green to brown mixed with green
5	Light brown with green mixed
6	Mostly light brown
7	Medium brown color in most flakes
8	Dark brown in some locations or flakes
9	Dark brown in 50% of the bale
10	Very dark brown to black

Texture Score

1 Very soft- mostly leafy material throughout the bale
2 Soft- with very few stems and weeds
3 Still soft but with 30 to 40% stems or coarse material (including weeds)
4 Medium texture with 40 to 60% stems or coarse material (including weeds)
5 Medium texture with 60 to 80% stems and coarse material (including weeds)
6 Rough texture of mostly stems.
7 Rough texture with very little leaf content and the bale is made up of mostly stems and weeds
8 Rough texture with no leaf content and 50 to 60% weeds and small stems
9 Rough texture with no leaf content and 60 to 80% weeds and small stems
10 Very rough texture with 80 to 100% weed content and lacks the evidence to distinguish what the type of hay is within the bale

Odor Score

1 Freshly mown hay aroma, no other odor can be detected
2 Freshly mown hay aroma, but a slight mustiness can be detected
3 Greater degree of mustiness, freshly mown hay aroma is difficult to detect
4 Hay has only a musty odor, completely lacking any sense of being freshly mown, may also be combined with a foreign odor such as animal urine or other non-toxic substances
5 The hay contains a musty odor and has slight putrefied/ fermented odor
6 The hay is becoming more putrefied/fermented, with a slight hint of mustiness
7 Only a fermented/putrefied odor remains
8 Strong odor that is becoming more apparent then the putrefied odor
9 Very strong fermented odor with no other odors detectable
10 The hay smells “hot” and has a repulsive degree of a sour and fermented odor, may also be combined with a foreign substance such as gasoline, oil, pesticide, etc.

PROGRESS TOWARDS SCLEROTINIA-RESISTANT VARIETIES

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Sclerotinia crown and stem rot (SCSR), caused by the fungus *Sclerotinia trifoliorum*, is one of the most important factors limiting the success of late-summer alfalfa seedings in the region. Infections of *S. trifoliorum* that progress into the crown of a fall-sown alfalfa plant can kill it during winter or spring green up. Stand losses by the following spring may be insignificant (1-3%) or nearly total, with 95-99% of the stand being dead (and often even rotted away and gone by spring green-up).

Several factors account for the substantial risk from this disease in late-summer seedings of alfalfa on Kentucky farms:

(1) The fungus is commonly found in fields and pastures with a history of forage legumes: alfalfa, red clover, white clover, and others (Vincelli & Nesmith, *unpublished data*).

(2) The infectious, airborne spores of *S. trifoliorum* are produced from late October through around Christmas (ref. 14).

(3) Alfalfa plants are most susceptible during the first 8-10 weeks of good growing conditions (ref. 1, 9).

(4) The vast majority of alfalfa varieties on the market are susceptible to SCSR.

The bad news about SCSR is that few control options are available. In a “nutshell”, our research to develop reliable cultural controls has been unsuccessful (ref 12; P. Vincelli, *unpubl. data*). Likewise, experimental fungicides can successfully control the disease (ref. 6-9, 11-14) but are neither economical nor legal.

The good news is that alfalfa can be bred for increased resistance to SCSR (ref. 2-5). Unfortunately, to date there is no alfalfa variety with a high degree of resistance to SCSR. Furthermore, UK work conducted a decade ago showed that varieties that exhibited partial resistance to SCSR elsewhere in the U.S. sometimes performed very poorly in Kentucky (12-13), because of the very high disease pressure experienced here (10). After consultations with certain commercial alfalfa breeders, it became clear that selections for increased resistance to SCSR needed to be conducted under Kentucky conditions if adequate levels of resistance were to be achieved.

THE UK SCLEROTINIA DISEASE NURSERY

The University of Kentucky Departments of Plant Pathology and Agronomy initiated a cooperative project at UK's Spindletop Farm to facilitate breeding progress in alfalfa against SCSR. This program has had two objectives:

1. to provide an opportunity for commercial breeders to select surviving plants from their elite lines following natural epidemics of SCSR;

2. to evaluate the performance of in currently available alfalfa varieties reported to have partial resistance to SCSR.

In order to achieve these objectives, we created a "disease nursery" at the UK Spindletop Research Farm where the following rotation has been practiced:

1. Red clover is drilled into prepared ground in February-March of year 1. Grain infested with *S. trifoliorum* is applied to 6-ft wide strips in October of the same year. The disease is allowed to run its course, though sprinkler irrigation may be provided if conditions are unusually dry.

2. Strips (6-ft wide) of red clover that were not inoculated are rototilled and sown in mid-September of year 2 to alfalfa entries provided by commercial breeders; controls are also sown. The inoculated strips of red clover straddling each strip of alfalfa plots are left undisturbed, to serve as a source of natural ascospore inoculum of *S. trifoliorum*. Each entry is represented by eight plots; four are treated several times with an experimental fungicide (serving as controls), and four are untreated plots. The disease is allowed to run its course.

3. Data on stand survival are collected in May-June of year 3, usually about 14 days after taking the first cutting. Commercial breeders are then invited to select surviving plants from their entries.

There are two aspects of this approach which are important. First, it assures moderate to high disease pressure, minimizing "escapes" (susceptible plants that were not exposed to inoculum), so that breeders have the best chance possible to select plants with genes for resistance. Second, this method allows for plant inoculation in a way that mimics natural field conditions. This increases the likelihood that plants with resistance to ascospore infection will survive and be selected.

SOME RESULTS FROM THE UK DISEASE NURSERY

We have consistently achieved high disease pressure in these experiments, as evidenced by severe stand loss in the susceptible checks (Tables 1-4). It is important to note that this level of disease pressure has been observed repeatedly on commercial farms in Kentucky (Table 5, for example), so this is not an unrealistic level of disease pressure for an alfalfa seeding to encounter.

In our earliest experiments, we were disappointed to see very poor performance of entries that had been selected to have some partial resistance to SCSR, such as 93-116 and A9109 (Table 1) as well as Interceptor and A9714 (Table 2). While these were disappointing results, these early experiments showed just how far breeders needed to go in order to develop adequate levels of resistance for Kentucky conditions.

Table 1. Stand density following an outbreak of SCSR at Spindletop Farm (sown 1 Sep 1995)*.

	Percent stand on 3 May 1996**	
Entry	Nontreated plots	Plots treated w/ fungicide
MSR ………………………………..	21 a	87 a
93-116 ……………………………..	8 ab	86 a
A9109 ……………………………...	7 ab	81 a
92-31 ………………………………	5 ab	84 a
WL-323 ……………………………	3 ab	89 a
C228 ………………………………	2 b	92 a
Armor (susceptible check)…………	2 b	94 a

*Establishment method differed slightly in this trial: alfalfa entries were sown directly into untilled red clover residue killed by SCSR followed by Roundup application.
**Means presented are arithmetic means; statistical groupings are based on arcsine-transformed data. Means for a given date followed by the same letter are not significantly different, Waller–Duncan K-ratio *t*-test (k=100, p=0.05).

Table 2. Stand density following an outbreak of SCSR at Spindletop Farm (sown 25 Sep 1998).				
	Percent row fill on 8 Jun 1999*		Percent row fill on 19 Jul 1999*	
Entry	Nontreated Plots	Plots treated w/fungicide	Nontreated plots	Plots treated w/fungicide
Pioneer 5454 (susceptible check)..	2 c	67 ab	3 f	78 bc
6030 ……………………………..	4 c	58 b	7 def	72 c
A9714 …………………………	5 c	78 a	17 de	85 ab
C416 ……………………………	6 c	79 a	16 d	89 a
DK141 …………………………..	3 c	73 a	5 ef	85 ab
Interceptor ………………………	3 c	60 b	6 ef	78 bc
ZH97 ……………………………	5 c	68 ab	12 de	79 bc

*Means presented are arithmetic means; statistical groupings are based on arcsine-transformed data. Means for a given date followed by the same letter are not significantly different, Waller–Duncan K-ratio *t*-test (*k*=100, *p*=0.05).

As this work has progressed, results have become more encouraging. In recent tests, we have found **all** entries selected for resistance to SCSR provided better stands than the susceptible check, even under high disease pressure (Tables 3 & 4). Furthermore, while Cimarron SR has consistently been shown to have a degree of partial resistance to SCSR under Kentucky conditions, it has been exciting to see that at least one entry in each test had even higher levels of survival than Cimarron SR (Tables 3 & 4).

Table 3. Stand density following an outbreak of SCSR at Spindletop Farm (sown 18 Sep 2001).

	Percent row fill on 24 May 2002*	
Alfalfa entry	Nontreated plots	Plots treated with Fungicide
40t174…………………………………	64 cd	99 ab
50t176 ………………………………	79 c	98 ab
SR1 …………………………………	45 ef	98 ab
SR2 …………………………………	46 ef	99 ab
SR3 …………………………………	56 de	100 a
SR4 …………………………………	40 f	99 ab
WL338 SR ..………………………..	66 cd	100 a
Cimarron SR ..………………………	51 def	99 ab
MSR2 ………………………………	45 ef	96 b
Pioneer 5454 (susceptible check)...	13 g	98 ab

*Means presented are arithmetic means; statistical groupings are based on arcsine-transformed data. Means for a given date followed by the same letter are not significantly different, Waller–Duncan K-ratio *t*-test (*k*=100, *p*=0.05).

Table 4. Stand density following an outbreak of SCSR at Spindletop Farm (sown

17 Sep 2002).

Alfalfa entry	Percent row fill on 15 May 2003* Untreated plots	Plots treated with Fungicide
41S145 ……………………………..	62.5 c	98.8 ab
50T176 ...…………………………..	61.3 c	99.3 ab
51S147 ……………………………..	38.8 d	96.3 ab
ZG0147a …………………………..	28.8 de	93.5 b
ZG0150a …...………………………	23.0 ef	96.8 ab
ZG0152a …………………………..	31.3 de	96.5 ab
V102SR ……………………………	26.3 de	94.8 b
WL338SR ………………………….	38.3 d	99.8 a
WPAR02SR ……………………….	26.3 de	94.8 b
Cimarron SR ………………………	41.3 d	97.8 ab
Pioneer 54V54 (susceptible check)	10.5 f	96.5 ab

*Means presented are arithmetic means; statistical groupings are based on arcsine-transformed data. Means in either row followed by the same letter are not significantly different, Waller–Duncan K-ratio *t*-test (k=100, p=0.05).

SIGNIFICANCE TO PRODUCERS

Producers will be interested to know that in every test where Cimarron VR or Cimarron SR have been evaluated under high pressure from SCSR, we have seen some degree of stand improvement as compared to a susceptible check. Unfortunately, Cimarron VR and Cimarron SR have not provided complete protection against the disease under high—but realistic—disease pressure. In fact, in a test on a commercial farm, stand survival in Cimarron VR in the spring following sowing was no better than that of the susceptible check, although the stand of Cimarron VR was significantly higher than the susceptible check later in the life of the stand (Table 5). Thus, producers should not expect Cimarron SR or any of the current variety to provide complete control of SCSR. Nevertheless, our results show clear evidence of progress in breeding for partial resistance to SCSR at Great Plains Research, which in fairness was achieved before we started our SCSR disease nurseries and plant digs at UK. If Cimarron VR and Cimarron SR show significant stand improvement under high disease pressure, as they have done in our tests, then I would expect them to perform better--and probably adequately--under lower disease pressure, as some farms experience.

Table 5. Stand density following an outbreak of SCSR on a commercial farm in Adair County (sown 23 Sep 1996).

Cultivar	% ground cover 6 May 1997[1]	% ground cover 12 Apr 2000	% ground cover 28 Apr 2000
Cimarron VR …………………………….	22	63 a[2]	79 a
WL 322 SR ……………………………….	13	46 b	68 b
Fortress (susceptible check) …………..	7	41 b	62 b

[1]ANOVA effect for cultivar is insignificant *(P.0.2)*
[2]Means followed by the same letter are not significantly different, Waller-Duncan k-ratio t-test, k=100, P=0.05

We have also observed significant stand improvement against SCSR with WL 338 SR in two tests. Most encouragingly, FFR Cooperative has a line (50T176, selected through the UK-SCSR nursery) which has performed significantly better than Cimarron SR, with stands of over 60% under high disease pressure in. This is a very encouraging sign. Based on their selections conducted at UK and elsewhere, I expect that in the future, this company will have commercial alfalfa cultivars with moderately high levels of resistance to SCSR.

Sowing alfalfa in late summer poses a risk from SCSR, and variety selection won't completely negate that risk. However, over the past decade we have seen that certain varieties can provide a degree of protection from stand loss, should SCSR be active on your farm. The currently available varieties with partial resistance will not provide complete protection against high pressure from SCSR. However, if planning to seed in late-summer or early autumn, it seems sensible to me to consider sowing those varieties that have been proven to provide some protection against SCSR under the high disease pressure possible in Kentucky.

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GROWING ALFALFA FOR WILDLIFE

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Alfalfa has long been recognized as a superb forage crop, which is why it is widely grown for dairy cattle, horses, sheep, and many other types of domesticated forage-consuming animals. Reasons for its popularity include wide adaptation, excellent nutritive value, good yield potential, perennial growth habit, a long growing season, and the fact that (in association with *Rhizobium* bacteria) it is a nitrogen-fixing legume that does not require periodic applications of nitrogen fertilizer.

Although alfalfa is widely grown for livestock, most people do not think of it as a wildlife-enhancing crop, and especially not as a crop to be planted specifically for wildlife. This is despite the fact that many of the same attributes that make it popular as a crop grown for domestic animals are also valuable in wildlife settings. However, there are reasons to believe that attitudes regarding alfalfa's potential as a wildlife crop are changing at present.

WILDLIFE ENHANCEMENT AS A FRINGE BENEFIT

Evidence of alfalfa's potential for wildlife purposes is that wild animals have always recognized it as a great crop; they feel free to visit alfalfa fields, consume alfalfa forage, or otherwise use it anytime it is planted within the geographical area in which they live. In fact, some animals even alter their range in order to access it more easily or more frequently! There is hardly any alfalfa producer who has not had the experience of seeing deer, birds, or other wild animals in their alfalfa field(s).

Yet, the extent to which alfalfa is used by wildlife is almost certainly underestimated by most producers. After all, wild animals are shy and secretive and generally prefer to avoid being in close proximity to humans. Many are primarily or exclusively nocturnal, and thus are active only at times when humans are not generally present. In addition, there may be a considerable amount of unobserved underground biological activity in an alfalfa field including by mice, voles, ground squirrels, and other rodents.

In the Sacramento Valley in California, wildlife biologists did extensive studies of alfalfa fields to determine the extent of wildlife activity. They found that of 643 resident and migratory amphibians, birds, mammals, and reptiles known to occur in that area, 162 species (about 25%) were regularly using alfalfa fields to some extent, and about 10% percent were using alfalfa fields extensively.

In recent years agriculture has been criticized by some environmentalists who believe that virtually everything associated with food production has negative environmental consequences. In reality that is not the case. In many settings, especially in areas in which cities are encroaching on agricultural land, alfalfa makes an important contribution to wildlife and to the environment.

The point is that an alfalfa field is much more biologically diverse than it may appear, and actually offers a great deal to many wildlife species, including to game animals and game birds. Thus, anyone who grows alfalfa is, to some extent at least, enhancing wildlife, and thus might consider this to be a fringe benefit of growing the crop.

Growing Alfalfa Primarily For Wildlife

There are several reasons why alfalfa is not commonly considered a wildlife crop. First, although many farmers are wildlife enthusiasts, the majority of wildlife enthusiasts are not farmers. Thus, they often have limited experience with forage crops, and many don't fully understand the benefits the crop offers (unfortunately, some farmers don't fully understand them either). In addition, some may be a bit intimidated by the relatively precise planting requirements and management concerns associated with alfalfa, or may simply be unwilling to learn about and exercise such management.

Wildlife management has evolved greatly in recent years. Twenty or twenty-five years ago it was not particularly common practice to make plantings of any type strictly for wildlife. When such plantings were made, in most cases they mostly consisted of cool season annuals (often small grain or, in many areas, small grain and annual ryegrass) that, once established, required little management. In many cases the main, and often the only, objective for making such plantings was to attract game animals during hunting season in order to increase the likelihood of hunting success.

Things have changed. These days many wildlife managers are quite sophisticated in their management approaches. An increasing number are thinking about the long-term implications of management practices, including the importance of striving to provide optimum nutrition throughout the year. There is more awareness that nutrition can improve the health of wild animals, increase their size and weight, as well as increase wildlife populations by enhancing reproductive rates. Furthermore, while most plantings for wildlife are still made by hunters (or by people who are hired by hunters to do this work), there is also increasing interest in non-game wildlife by non-hunters as well as by hunters.

There have also been developments within the alfalfa industry that have facilitated the use of alfalfa in wildlife management. For example, advances in disease resistance, seed coating technology, and weed control have value in plantings of alfalfa made for wildlife enhancement just as they do in fields planted to produce forage for livestock. In particular, the introduction of grazing-tolerant varieties has greatly increased the feasibility of planting alfalfa in areas in which wildlife populations (mainly deer or other large mammals) are so high that excessive defoliation is a threat to long-term stand persistence.

WHY CONSIDER PLANTING ALFALFA FOR WILDLIFE?

The answer to this question was touched upon in the introductory paragraphs of this paper, but a more detailed explanation should be helpful. There are numerous wildlife species, of course, and alfalfa offers different benefits to different wild animals. Because alfalfa as a wildlife crop is planted mainly by hunting enthusiasts, the emphasis in this discussion will be on benefits to game animals or to hunting enthusiasts. As viewed from the perspective of a wildlife manager, the benefits alfalfa offers can be put into a few main categories.

*Perenniation- As is the case with most farmers, wildlife enthusiasts like to use perennials whenever possible. The expense, the establishment risk, and especially the time and effort, involved in regularly planting annuals is something they would like to avoid.

*Nitrogen Fixation- Wildlife managers also like the fact that legumes such as alfalfa can symbiotically fix nitrogen when in association with *Rhizobium* bacteria. However, in the case of wildlife enthusiasts, appreciation of this unique trait of legumes is not so much due to avoidance of the expense of applying nitrogen, which is often an important incentive for of many livestock or hay producers. Rather, wildlife managers are especially likely to appreciate the fact that use of legumes means that application of nitrogen is one less management practice to be remembered and accomplished.

*Forage Quality- The nutritional benefits alfalfa provides to livestock are likewise of benefit to wild animals that consume the forage. In the case of deer, which is the wildlife species for which alfalfa is most commonly planted in the eastern United States, the nutritional attributes of alfalfa are of special interest. Not only is alfalfa forage highly digestible with a high protein content, it also contains high levels of calcium and phosphorus, which are important in antler development (this is a major selling point to deer hunters). In addition, having alfalfa available during summer helps ensure adequate milk production by does, increases the likelihood of rebreeding, and helps increase deer weights prior to the onset of winter.

*Insect Attractant- Alfalfa is an excellent insectory. In a study done near Ithaca, New York, entomologists identified 591 insect species in a single field. For many species of birds, including game birds such as quail and wild turkey, availability of a good supply of insects is quite important, especially when the birds are young. Alfalfa provides birds with high quality green leaf material as well as insects.

*Long Period Of Forage Availability – Bridging nutritional gaps is of critical importance in wildlife management, and it is difficult to find a crop that rivals alfalfa with regard to the ability to provide high quality forage over a long period of time. For example, in the Upper South alfalfa can provide forage for wildlife for 6 or 7 months in most years, and in the Deep South, alfalfa varieties that are in fall dormancy categories 7 or higher come close to being a year-around source of forage. In view of the fact that most wildlife species prefer a varied diet, having alfalfa available for wildlife over a long period of time is a major advantage. It is also important that alfalfa is a source of high quality forage during drought periods when other forage crops are unproductive.

*Potential To Attract Or Hold Wildlife- Some species of animals range over large areas. Because of its attractiveness to wildlife, alfalfa can be used as a tool to help keep wild animals in an area where they are desired. To a degree, it can even be used as a tool to encourage them to stay away from areas where they are **not** wanted. For example, a planting of alfalfa on a side of a large farm or ranch that is a long way from a paved road can decrease the likelihood of collisions with motor vehicles.

*Cover- Although many other plants provide cover for wildlife as well or better than alfalfa, this is another benefit to wildlife that can be mentioned. Alfalfa can be especially attractive to small animals such as rabbits, and for young game birds including quail or wild turkeys that simultaneously need cover as well as a high level of nutrition.

UNIQUE ASPECTS OF GROWING ALFALFA FOR WILDLIFE

Site selection is always important in alfalfa production, but location of a suitable site for a wildlife planting deserves special mention. Plantings made specifically for wildlife are often located in remote areas, so ease of access with planting and fertilizer application equipment is a consideration. Though locating plantings close to trees or other heavy cover may provide advantages to wildlife, alfalfa will not be productive in shady areas or in close proximity to tree roots.

Also, wildlife plantings are often made in areas that have not been in regular agricultural production, and thus may need more attention than is the case with most sites where alfalfa is planted on farms. Thus, the desirability of planning ahead and starting early to get a field in proper condition (taking soil tests, applying lime, eliminating roots or undesirable species, etc.) is especially important.

Most of the agronomic considerations associated with establishing alfalfa for wildlife are the same as for growing the crop for livestock. For example, it must be planted on a suitable soil type and a well-drained site. In addition, lime will usually need to be applied several months before planting to raise the soil pH to a suitable level, any needed fertilizer nutrients should be applied in accordance with a soil test, the seed should be planted with precision, etc.

Although a wildlife enthusiast generally will be pleased with a beautiful, thick stand, alfalfa stand density is actually not as important in wildlife plantings (especially in older stands) as is the case when plantings are made for livestock or for hay production. Although mowing to reduce shading or making a herbicide application may sometimes be desirable, as long as grasses or volunteer forbs are not offering excessive competition, in many cases it is not particularly harmful to have some volunteer plants growing along with alfalfa in a wildlife situation.

Assuming that alfalfa has been planted on a suitable site, a good stand obtained, and that pH and nutrient needs of the crop are met, the life of a stand planted for wildlife can be as long, and may actually exceed, that of a planting made for livestock. In many wildlife plantings there is less defoliation stress than occurs when alfalfa is used for hay or pasture. Also, with a planting made for wildlife there is usually less need to immediately replant another forage when alfalfa stands thin. A low percentage of alfalfa in a mixture with volunteer species may make a perfectly acceptable wildlife food plot.

FINAL THOUGHTS

While alfalfa clearly has many attributes as a wildlife plant, it is not right for every wildlife situation, just as it is not right for every livestock farm. Many soils and sites are not suitable for growing alfalfa, and various people have different goals, attitudes, and resources. Alfalfa should be viewed as a tool that is available to a wildlife manager that can be used when an appropriate situation arises. Furthermore, most wildlife species prefer a diversity of foods in their diet. Thus, even in situations in which it is clear that alfalfa can be used to advantage for wildlife purposes, it usually should be only one of a number of species planted for wild animals on a given piece of property.

However, interest in alfalfa as a wildlife crop has increased greatly in recent years. Foremost among the reasons why this has happened are: (1) greater interest among wildlife managers in providing year-around nutrition for wild animals; and (2) and the availability of grazing tolerant varieties. Many wildlife managers have already proven that alfalfa can play an important role in wildlife enhancement, and it appears likely that the trend toward greater use of alfalfa for wildlife purposes will continue for the foreseeable future.

ALFALFA IN OUR DAIRY OPERATION

Lee Robey
Robey Farms
Logan County, KY

Welcome to Robey Farms. Our farm has been in our family for six generations. The farm was founded by my great grandfather, Herbert Robey, in 1899. Four generations live and are actively involved in the farm operation today. My mom and dad, Jane and D.L., my wife Denise and I, our oldest son Chris and his wife Jessica and three grandchildren, Jessalyn, Ethan, and Whitley, our middle son Adam and his wife Amanda, our youngest son Eli, who is a Sophomore at U.K. majoring in Ag. Economics, and my older brother Carr.

Our farm consists of 7500 acres. Approximately one half of that is owned and one half is leased. Our main enterprises are dairy, grain, and tobacco. The dairy consists of 960 mature cows with 1200 more of young stock. Our cropping for 2005 will consist of approximately 4000 acres of corn, 500-600 acres of that being chopped for corn silage. 2600 acres of wheat and barley that will be double-cropped in soybeans, 450 acres of alfalfa, 500 acres of pasture and hay, approximately 150-175 acres of tobacco.

Our alfalfa program is very important to our farm and especially important to our dairy herd. We try to plan ahead at least 2 years in advance to establish a new stand. We prefer fall seeding and usually seed between August 10 and September 10. Our preferred seeding method is to harvest wheat in late June. Then we like to lime with 2½ - 3 tons and till the soil. In some years we will harvest corn silage in late July and lime and prepare the seedbed. We till the ground with John Deere disk rippers that do a good job of breaking up any compaction that could be in the soil. Then we like to use a field cultivator because it does such an excellent job of leveling the ground. After one pass with the field cultivator, we will use disc and roller to make a firm seed bed that will retain moisture. We are always watching new alfalfa varieties and considering new varieties that will work in our program for yield and quality. Currently, we are using 403T and FK421.

Our farm supplier dealer will blend our alfalfa seed with fertilizer and spread it on our fields with an air truck. Our seeding and fertilizer are 25 pounds of coated seed, 200 pounds of 11-52-0, 300 lbs. 0-0-60, 2 lbs. Boron, 5 lbs. of Sulfur, 40 lbs. of a complete micronutrient mix. Then we roll that seed in with Brillion rollers and also a John Deere roller harrow. It is very important not to get the seed too deep, ¼ to ½ inch. For us, that usually requires about 3 passes with the rollers. This gives us excellent seed to soil contact and leaves a very firm seed bed. That conserves moisture and prevents erosion. It is very important that the blenders, tinder trucks, and the air trucks that are handling the seed and fertilizer mix aren't contaminated with any other seed or chemicals.

Hopefully, before we seed, we would have good moisture and then again enough rainfall for the seed to germinate. If necessary, we will irrigate to get our seeds well germinated. We have a hard hose irrigation machine that applies approximately ¾ of an inch per acre per hour. Hopefully, approximately in 14 days, we will have good emergence and at that time we will apply an insecticide to keep aphids and insects off the young plants. I feel that this is very important. In years past, I have seen when we have had a very good stand of young plants and that little shot of insecticide just gave it a rapid growth boost. We have never harvested a fall seeded stand until the next spring. Our 2003 seeding was extremely large and should have been harvested. We considered it with our '04 seeding but the weather turned cool in the late fall, slowing growth. The fields were also too soft for the equipment. By fall seeding, we are able to get a full year's production starting the next spring.

In the spring, we scout for alfalfa weevils very early. In southern Logan County, if we have warm temperatures in late February and early March, we will have weevils. We take a preventative instead of a curative method with alfalfa weevils. Most years we do a split application of insecticide to give us complete control.

We cut all of our alfalfa with 946 John Deere mower-conditioner with urethane rollers. We have operated two of these 14 ft machines in the past and will begin to use 3 machines in 2005. When the weather conditions are right and the crop is good, we want to be able to cut the alfalfa quickly. We will spread some and windrow some depending on the weather and the density of the crop. As simple as it may seem, we have not figured out the raking or windrow merging. There are so many variables with the crop and the weather. We use a Kuhn rotary rake, a New Holland 12 wheel rake, 2 New Holland row bar rakes with a caddie and a New Holland windrow inverter.

We make haylage out of all of our alfalfa. It is chopped with a John Deere 7300 chopper and bagged in 10 ft. silage bags. This chopper gives us a lot of flexibility in length of cut. 1½ inches seems to store and feed better than a longer cut. An inoculant is applied to the crop at the feed rolls of the chopper. We will chop alfalfa at 30-50% dry matter. We would prefer to have it all in the 45% DM range.

Now what we have harvested and stored the alfalfa haylage, I will back up and address the cutting schedule, herbicide, insecticide and fertility program. 2004 was a very challenging year to harvest alfalfa but quality was good. Granted, it is easier for us to make haylage than it is for any producer to make dry hay. Our biggest concern with all the moisture with 2004 is that we were in the fields with heavy equipment on several occasions when the soil was too wet. We are very interested in alfalfa varieties that can handle traffic under these conditions. Our cuttings were made in '04 as follows:

1st	4-25 to 5-5
2nd	5-25 to 6-1
3rd	6-22 to 7-11
4th	7-26
5th	8-23
6th	9-15
7th	11-15

The long period after the fall cutting was because of the dry weather in September, the cool temperatures in October, and then wet weather in late October and early November.

7-10 days after each cutting, we apply 3 gallons of 3-18-18 with micronutrients, ¾ rate of insecticide, with 5 gallons of water, giving us an 8 gallon spray rate. We want to leave as much of this treatment as possible on the tissue of the plant. We feel like this program is really giving the regrowth a big kick. We follow this for the first 6 cuttings.

14-21 days after the third cutting, we will use a post-emergence grass herbicide where needed to control johnsongrass and crabgrass. In the fields where broadleaves are a problem, we will use Pursuit or Raptor which will give us residual control for the rest of the season. It is very important for forage quality and dry matter intake into the cows that these alfalfa fields are free of weeds and grasses. We work hard and spend a lot of money on herbicide programs on our grain and tobacco crops and it is equally or more so important with alfalfa.

We will soil test in the fall and apply fertilizer impregnated with Sencor in late January when the alfalfa is dormant. This mix is applied with an air truck and we have very little crop injury because there is little material on the plant. This program controls winter annuals and the first cutting is clean to improve quality.

Our nutrition program for our lactating dairy cows is built around alfalfa haylage and corn silage. We feed a total mixed ration that consists of alfalfa haylage, corn silage, whole cottonseed, and a grain mix. The grain mix consists of 30% dry shelled corn, 18% soybean meal, 20% soybean hull pellets, and 32% of high energy concentrate. There are 2 concentrates, high energy and low energy, 2 grain mixes , and four TMR mixes fed to the eight different production groups. The second grain mix is 30% dry shelled corn, 15% soybean meal, 20% of soybean hull pellets, and 35% of a low energy concentrate. The production groups are as follows:

Group 1	50-75 head	00-30 DMI
Group 2	90 head	30-80 DMI
Group 3	170 head	100 DMI
Group 4	175 head	140 DMI
Group 5	175 head	210 DMI
Group 6	175 head	300 DMI
Group 7	20 head	Bedded pack lame cows
Group 8	20 head	Dump pen

The TMR is balanced at 46 lbs. DM and increased on consumption. DMI range from 46 lbs. to 60 lbs. The TMR average on a DM basis is 10 lbs. alfalfa haylage, 14 lbs. of corn silage, 25 lbs. grain mix, as fed, and 3 lbs. whole cottonseed.

Alfalfa quality ranges from 20-25% protein on the 1-3 year old stands, and 18-20% on the 3-6 year old stands. TDN's range from 58-67%. Our best cuttings were on 8-23-04 at 24.7% protein and 67% TDN. The November 15 was 23% protein and 66% TDN.

Dry matters are checked daily to insure that rations are delivered to the cow properly. Chris and Adam use a Koster Crop Tester. Haylage varies much more than corn silage. Corn silage is tested weekly. The grain to forage ratio is also off which is not economically sound, but even more dangerous, is the risk of LDA's and the possibility of hemorrhagic bowel syndrome or clostridiums from slug eating and drastic rumen pH changes, resulting in cows off feed or dead.

Forage nutritional quality is an economic issue. Forage condition quality is a dry matter intake issue. Cows are most productive in milk, reproduction and health when both are maximized.

HISTORY OF ROUNDUP READY® ALFALFA

Mark McCaslin
Forage Genetics International

In late 1997 Forage Genetics International (FGI) and Monsanto began a joint project to develop Roundup Ready alfalfa. FGI collaborated with Montana State University to produce the first transgenic Roundup Ready alfalfa plants. The same CP4 glyphosate tolerance gene that has been effectively used in developing multiple other Roundup Ready crops, was successfully inserted into an elite FGI alfalfa plant in early 1998.

EVENT SORTING

A transgenic event is the insertion of a transgene (e.g. CP4) into the plant genome. The physical location of a transgene insertion in the genome is relatively random, and location of the insertion can have a strong influence on transgene expression. For that reason, hundreds of Roundup Ready transformants, called T0 plants, were produced in the laboratory and were screened for tolerance to Roundup® herbicide, in order to find elite events. The T0 plants that exhibited Roundup tolerance were transplanted to field nurseries at four FGI research stations for evaluation of agronomic performance. This began a two year process called "event sorting", where multiple transgenic events were evaluated to identify a few T0 plants that combined agronomic performance equal to the original clone plus commercial tolerance to Roundup herbicide. Two events were ultimately selected for deregulation and commercialization.

TRAIT INTEGRATION

In late 1998 about 50 Roundup tolerant T0 plants were crossed with numerous elite FGI clones representing a wide array of conventional germplasm from very winterhardy (fall dormant 3) to non-dormant (fall dormant 9) types. A modified backcrossing program ("forward breeding") was used to integrate the Roundup Ready trait into the best FGI FD3 to FD9 germplasm. In each crossing cycle, plants that contained events that were dropped in the event selection process were eliminated and destroyed. By the time the final two commercial events were selected in 2000, the events had been backcrossed for several generations into elite dormant and non-dormant breeding populations. These populations were screened for multiple pest resistance and established in FGI breeding nurseries in Wisconsin, Indiana, Iowa, Idaho and California. Elite plants selected from these nurseries became parents for the first generation Roundup Ready cultivars.

Product development

The term “trait purity” is used to quantify the % of plants in a specific seed lot which express the Roundup Ready trait. The target threshold for minimum trait purity for Roundup Ready alfalfa was established at 90%. For crops with diploid inheritance this level of trait purity can be achieved by simply incorporating the trait in a conventional breeding program using a single transgenic event. The more complex genetics and autotetraploid inheritance of alfalfa required a different approach. FGI developed a marker-assisted breeding system using two independent transgenic events to accomplish the development of Roundup Ready alfalfa varieties with >90% trait purity. All first generation Roundup Ready cultivars will contain both of the commercially registered CP4 events.

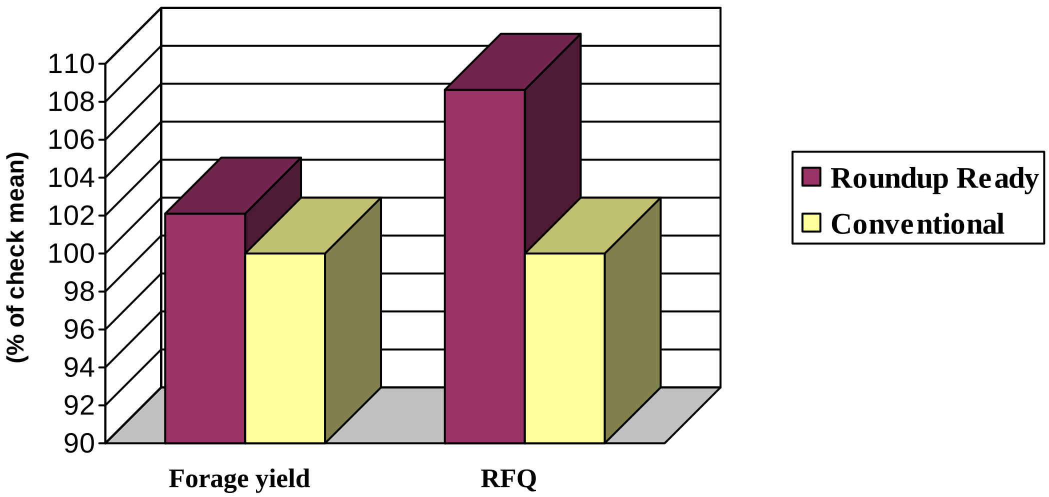
Parents for Roundup Ready cultivars were selected from FGI breeding nurseries for high forage yield, superior forage quality, persistence and tolerance to multiple applications of Roundup herbicide at the maximum labeled rate. Greenhouse crosses were made between plants containing one of each of the two commercial events, and molecular markers were used to identify progeny containing both events (i.e. dihomogenic). The dihomogenic progeny from a particular cross were shipped to Idaho for the production of Syn1 Breeder seed. Varieties produced ranged from FD3 to FD8 types with two or more varieties adapted to each major alfalfa production area in the U.S.

Experimental Variety Testing

Various tests were initiated to evaluate the first group of Roundup Ready alfalfa experimental varieties. Multiple pest resistance, fall dormancy and winter survival were evaluated using standard tests. Forage yield trials were established at multiple locations to compare agronomic performance of the Roundup Ready varieties to a set of commercial check cultivars. Trials comparing forage yield with and without Roundup application were established to monitor crop safety. In these trials the “Roundup treatment” had maximum proposed labeled rates of Roundup herbicide applied at establishment and three times during the first harvest year. The conventional treatment used a conventional herbicide at establishment, with no herbicide treatment thereafter. All Roundup Ready varieties had equivalent performance when treated with Roundup as compared to conventional weed control treatments in these crop safety tests.

Across trials at six locations, 2004 mean performance of the Roundup Ready alfalfa varieties was competitive with the commercial check cultivar mean for forage yield and forage quality (Figure 1).

Figure 1. Performance of RR and conventional alfalfa cultivars



PRODUCT CONCEPT TRIALS

Product concept trials have been established to compare the Roundup Ready system with conventional methods of weed control in alfalfa and to develop regionally relevant "best use" recommendations for the technology. These trials, initiated in 2000, were conducted by university weed scientists and/or forage agronomists. The results of these trials have been used to formulate time and rate application recommendations for Roundup herbicide applied to Roundup Ready alfalfa, establish management options for stand take-out and volunteer management, and provide comparison data on the value of the technology compared to current weed control practices. Data from some of these trials has been published by the scientific collaborators. A summary of these data is available in a revised Roundup Ready Alfalfa Technical Update bulletin. The bulletin is available on-line at http://www.monsanto.com/monsanto/content/media/pubs/alfalfa_tech.pdf.

TRAIT STEWARDSHIP

Trait stewardship generally includes those elements required to insure that a new biotech trait is commercialized using best available practices to minimize potential disruption to current markets. New biotech traits are typically regulated by one or more agencies of the U.S. Federal government, which may include the USDA, EPA, and FDA. Commercialization of biotech traits in the U.S. is only possible after the appropriate agencies have all determined that the technology is safe and therefore the trait can be deregulated. Many other countries have a similar regulatory structure in place for biotech traits in crop plants. A cornerstone of the RR alfalfa stewardship program has been to insure the trait has been deregulated for feed and food use in the U.S. and for key alfalfa hay export markets. Other important components of the Roundup Ready alfalfa stewardship plan have included: developing a science-based plan for managing pollen-mediated gene flow in commercial seed production (www.foragegenetics.com); availability of simple "protein-based test strips" for determining the presence of the Roundup Ready trait in seed and hay; and, the development of best practices for seed production and processing.   The trait stewardship program for Roundup Ready alfalfa is based on programs that have been successfully implemented with other biotech crops and from suggestions and feedback provided from various stakeholders in the alfalfa industry.

SUMMARY

The development of Roundup Ready alfalfa has been an eight year process, which started in 1997 with transformation experiments in the laboratory and which is anticipated to culminate with a 2005 commercial release of elite Roundup Ready cultivars. Concurrent with the technical evaluation activities associated with new product development, FGI and Monsanto have implemented the necessary programs to support U.S. and international regulatory approvals of key importers (e.g., Japan, Mexico, Canada), developed and implemented trait stewardship protocols, and developed practical technical use guidelines for growers. The Roundup Ready alfalfa team at Forage Genetics includes Jose Arias, Holly Deery, Doug Elkins, Sharie Fitzpatrick, Mark McCaslin, Peter Reisen, Stephen Temple, and Joe Waldo. Tom McCoy and Pam Border at Montana State University conducted the Roundup Ready alfalfa transformation. The Roundup Ready alfalfa team at Monsanto includes Dan Foor, Tom Helscher, Bill Hiatt, Louis Meyer, Jennifer Ralston, Carlos Reyes, and Glen Rogan.

ALFALFA: CROP FOR THE FUTURE

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ABSTRACT

Alfalfa use by dairy cattle has decreased in recent years because of excessive non-protein nitrogen and low fiber digestibility. Ideal attributes for plant modification of alfalfa may include those that increase milk potential per acre and/or per ton, enhance digestible NDF, improve protein content and amino acid balance, improve agronomic traits for insect protection (safer forage supply), herbicide tolerance, virus resistance, drought tolerance, cold tolerance, improved mineral availability and enhanced yield. Progress in attaining these attributes will accelerate with the use of biotechnology. Livestock and hay enterprises will benefit from alfalfa that is less prone to contain mycotoxins or toxic weeds, or to induce bloat; have improved nutrient utilization for milk and meat production; and produce less animal wastes resulting in improved efficiency, profitability, and a better environment. Value-added traits of alfalfa are needed to provide farmers new high value profitable products. Processing alfalfa to obtain value added products includes three different fractionation methods: 1) wet fractionation; separation into juice fraction and a fiber fraction, 2) dry fractionation; separation into leaves and stems, and 3) fractionation by passage of the whole herbage through the digestive systems of ruminant animals, leaving a high fiber residue. Phytase from transgenic alfalfa has been tested in poultry and swine rations. Alfalfa hay can be fractionated to yield stems and leaf meal. Alfalfa leaf meal has been shown to be acceptable supplement to replace a portion of alfalfa hay and soybean meal in diets of lactating dairy cattle, replace protein supplement in beef cow diets, finishing steer diets and diets of growing turkeys. The fiber portion of alfalfa can produce lactic acid, ethanol or a bioadhesives for use in plywood.

Key Words: alfalfa, protein, fiber digestibility, fractionation, transgenic, and Phytase

INTRODUCTION

In 2004 U.S. farmers harvested 24.7 million acres of alfalfa. Alfalfa hay and haylage yielded 83.9 million tons valued at $8.4 billion, ranking behind only corn, soybeans and wheat. Alfalfa hay supports dairy, beef, sheep, and horse production in the U.S. as well as a growing export market. Alfalfa acreage has remained somewhat constant but hay production has declined in recent years. Alfalfa hay production is moving west with the rapid growth of the dairy industry. Dairy farm numbers are declining most rapidly in dairy regions of the Midwest. Beef cow-calf production remains relatively constant on U.S. farms. Farms with horse and ponies have increased as well as animal numbers (3.6 and 3.0 million, 2002 and 1997, respectively). Lactating dairy cattle and horses require a range in qualities of alfalfa based on performance requirements; high-quality hay and haylage demands premium prices for dairy, but alfalfa with lower relative nutrient content demand equally high prices from horse owners. Dairy operators primarily use alfalfa haylage or hay and corn silage. Corn silage production has been increasing on many dairy farms. In addition, dairy farm size is expanding which increases animal density and the concentration of manure nutrients. Expansion of alfalfa production and use will depend on the demand from dairy, beef, and horse managers. As new government regulations require nutrient management plans for soils high in nitrate nitrogen and or phosphorus, the need for crops that remove excessive nitrate or phosphorus become more important. Alfalfa can remove excessive nitrate levels reported under corn and soybean crop rotations. Alfalfa in comprehensive nutrient plans holds potential for increasing alfalfa hay acreage. However, cash crop farmers do not have equipment to harvest alfalfa nor are the profit potentials attractive unless new value-added products from alfalfa can be developed. Novel traits to improve alfalfa are available. Redesigning alfalfa to reverse declining amounts in diets and from acreages will improve alfalfa for other livestock uses. We will discuss new novel concepts being investigated with alfalfa, which have potential to increase acreage, add product value and offer new products. Major factors of increased utilization are yield enhancement, forage quality improvements, environmental enhancements, and new products.

ALFALFA UTILIZATION BY DAIRY CATTLE

High quality alfalfa is palatable and often maximizes intake and production of dairy cows. Alfalfa is low in fiber and high in protein compared to other forages, which makes it an excellent complement for grains and other forages in dairy rations. Although there are genetic differences in nutritional value among alfalfas, currently the nutritional quality of alfalfa is established primarily by harvest management. Although there are differences among seasons and cuttings, the composition and dry matter digestibility (DMD) of alfalfa is related to plant maturity. Alfalfa hay composition in Table 1 was derived from relationships among chemical components obtained from several data sets (Mertens, 1973; Onstad and Fick, 1983; Fick and Onstad, 1988) and analyses obtained from ten commercial forage testing laboratories that were used to develop standards for reporting hay market prices (Mertens and Getz, 2004). The crude protein, ash, crude fat, fiber, and lignin values in Table 1 agree with those of similar quality found in the Dairy NRC (2001). The forage quality descriptions in Table 1 are relative and may not reflect the economic or nutritional value of the alfalfa in a given situation. For example, exceptional quality hay as described in Table 1 may provide too much protein and not enough aNDF in a particular dairy ration and its value may not be exceptional. As with corn silage, a holistic approach for the specific dairy enterprise should be taken when selecting the traits for the ideal alfalfa.

Immature alfalfa is high in protein, but the protein is rapidly fermented in the rumen to ammonia and not used efficiently. Because alfalfa protein is used inefficiently, dairy rations containing predominantly alfalfa forage are formulated to contain 1 to 3 %-

units more protein. When used as the sole forage source, the high protein and low fiber concentrations in immature alfalfa can make it difficult to formulate rations that meet the protein, energy and fiber requirements of dairy cows. As alfalfa matures, the proportions of crude protein and NFC decrease. The main NFC in alfalfa is pectin of which 10 to 20% is not extracted by acid detergent causing the difference between aNDF and ADF to underestimate hemicellulose in alfalfa. Because pectin ferments rapidly and completely without a decrease in ruminal pH (Hatfield and Weimer, 1995), it may be desirable to maintain or increase its proportion in alfalfa because alfalfa is relatively deficient in rapidly fermentable carbohydrates when compared to corn silage.

Table 1. Typical composition (% of dry matter) of alfalfa hays varying in fiber content (adapted from Mertens, 2002).

Forage description	CP[a]	EE[b]	Ash	NFC[c]	Star[d]	Pec[e]	aNDF[f]	ADF[g]	ADL[h]
Exceptional quality	25.4	2.7	10.4	31.5	3.1	14.2	30.0	24.0	4.53
Very high quality	24.0	2.6	9.9	29.4	2.9	13.2	34.1	27.0	5.38
High quality	22.5	2.5	9.5	27.4	2.7	12.3	38.2	30.0	6.23
Good quality	21.0	2.4	9.1	25.3	2.5	11.4	42.2	33.0	7.08
Fair quality	19.5	2.2	8.7	23.2	2.3	10.5	46.3	36.0	7.93

[a] Crude protein
[b] Ether extract or crude fat
[c] Nonfiber carbohydrates calculated by difference (NFC = 100 – CP – EE – Ash – aNDF)
[d] Starch
[e] Pectin, estimated from NFC
[f] Amylase-treated neutral detergent fiber determined with sodium sulfite and amylase
[g] Acid detergent fiber
[h] Acid detergent lignin using 72% sulfuric acid

As in other forages, the proportions of fiber and lignin increase with maturity in alfalfa. Alfalfa fiber contains a high proportion of lignin relative to grasses resulting in low digestibility relative to grasses. Whereas, 60 to 80% of grass fiber is potentially digestible, the potential extent of digestion of alfalfa fiber is only 40 to 60% due to its high lignin content. However, alfalfa has a great advantage over grasses because the rate of digestion of its potentially digestible fiber is 2 to 3 times that of grasses. It also appears that the indigestible fiber in alfalfa disintegrates into particles that rapidly pass out of the rumen. The higher intake and digestibility often observed with alfalfa based diets compared to those containing grass is not due to greater digestibility of alfalfa fiber, but due to alfalfa's low fiber content and the rapid rates of digestion and passage of that fiber.

PROPORTION OF ALFALFA SILAGE AND CORN SILAGE

An experiment was conducted to determine if there is an optimum mix of alfalfa and corn silage in a dairy ration in terms of animal performance (Dhiman and Satter, 1997). The experiment started at calving and lasted until cows completed 44 weeks of lactation. Forty-five mature cows and 29 first lactation cows were randomly assigned before calving to one of three treatments according to calving date. Cows were fed diets containing 50% forage and 50% concentrate. The forage portion of the diet was either all alfalfa silage (AS), 2/3 alfalfa silage and 1/3 corn silage (2/3 AS), or 1/3 alfalfa silage and 2/3 corn silage (1/3 AS).

Milk production totals, unadjusted for milk fat content for mature cows for the 305-day lactation for the AS, 2/3 AS, and 1/3 AS treatments were 21,148, 22,422 and 22,100 lb; and for first lactation cows were 17,911, 18,546, and 18,008 lb, respectively. From the point of view of animal performance only, the 2/3 alfalfa silage-1/3 corn silage diet was optimal, but not much better than the 1/3 alfalfa silage-2/3 corn silage treatment. The important point is that while there appears to be an optimum blend of the two forages, the difference in milk production is modest when comparing different proportions of the two forages.

Less total protein was fed when the diets contained corn silage, but more supplemental protein was required. Feeding a blend of low-protein corn silage with the high but easily degraded alfalfa protein enabled more efficient utilization of protein in the rumen. This resulted in less nitrogen excretion per unit of milk produced when the forage mixture was used. It is suggested that dairy producers feed a minimum of 1/3 alfalfa (hay or silage) and 1/3 corn silage, and let the remaining third be distributed between the two forage sources according to what works best for the dairy producer's particular situation.

PLANT MODIFICATIONS OF ALFALFA

Over the past fifty years great advances have been made in the development of varieties with improved winter hardiness and pest resistance (insects, nematodes, and pathogens), providing even greater potential utilization in modern farming systems. To develop alfalfa varieties with physical and biochemical properties that fit the needs of the high producing dairy cow (i.e., greater cell wall digestibility, less protein degradation during ensiling, increased by-pass protein, increased yield without quality loss, insect and pathogen resistance, herbicide tolerance, reduced bloat, and winter hardiness) requires input from several disciplines. Strategies that embrace traditional genetic selection methods as well as precision breeding and other tools biotechnology may be needed in a timely manner to move a desirable trait into the elite germplasm in a timely manner. The goal is to have alfalfa varieties that can meet the needs of the dairy enterprise and at the same time maximize their use in farming systems that improve the ecological environment (N fixation, excellent nutrient sink, stand longevity, etc.). Developing alfalfa that could retain nutrition quality with few cuttings, increased yields, and better water use efficiency would be a major improvement in the profitability of alfalfa production.

ATTRIBUTES OF IDEAL ALFALFA

An ideal alfalfa would contain a better balance of protein and rapidly fermentable carbohydrate. At an optimum aNDF concentration of about 40% (DM basis), it would be desirable to have about 18% crude protein, less ash and about 30% NFC. It would also be beneficial to have a better balance of amino acids in the protein and with a slower rate of degradation in the silo or rumen to minimize its losses as ammonia. Increasing the fat to 4% might also be energetically advantageous to dairy cows. The rate of digestion and passage of alfalfa fiber is excellent when compared to other forages and nothing should be done to diminish these attributes. However, it might be desirable to improve the potential extent of fiber digestion by modifying lignin content or characteristics. For grazing or green chop purposes, removal or suppression of the bloat causing properties would be beneficial. Above all, the yield of alfalfa should be enhanced with a reduction in the number of cuttings needed to produce dairy-quality alfalfa forage.

Yield: Although quality has improved, alfalfa yield has not kept pace with corn. This is becoming more of an issue as land, labor, and energy costs continue to rise placing a greater burden on obtaining sufficient value from the harvested crop. Developing germplasm with greater pest resistance, improved winter hardiness and increased quality under a frequent cutting regime has made recent gains in yield. There would seem to be sufficient genetic diversity to select for much larger plants that would provide significantly higher yields per acre (JoAnn Lamb, personal communication), but forage quality cannot be sacrificed. There are other opportunities for improving total biomass production that involve specific tissues of the alfalfa plant such as leaves and stems.

Reducing leaf loss has potential for enhancing biomass and quality. One of the problems with large plants in a typical seeding pattern is the loss of leaves that are shaded in the lower portions of the crop canopy. A solution to the problem could involve genetic selection for increased leaf retention or possibly using a molecular approach to disable genes that are responsible for leaf drop. This would require identification of specific cell wall hydrolases involved in the disruption of cells in the attachment area of alfalfa leaves to the stem. For other plants it has been shown that cellulases and pectinases are critical for leaf drop. If plants could maintain leaves after they have passed senescence this would increase total biomass. The animal would readily utilize the digestible cell walls of leaves even though the senesced leaves would not contain much protein or soluble carbohydrate. Increasing the mechanical strength of leaf attachment may also improve harvest recoveries of leaves.

Harvesting techniques can greatly impact biomass recovery. Harvest losses with conventional hay-making equipment are typically in the range of 6 to 19 percent. Utilizing haylage versus hay probably has the greatest single impact both in terms of preserving total biomass and quality. Even though more alfalfa haylage is being produced in the Midwest as a rain damage alleviator, production and marketing of haylage outside the dairy enterprise is difficult. There are technologies being developed such as hay maceration (US Dairy Forage Research Center) that will improve hay production to preserve biomass and improve quality at the same time. A macerator mat harvestor could keep harvest losses well below the 6 to 19% loss (Koegel et al., 1992).

Weeds in alfalfa are a major challenge. They can inhibit successful stand establishment, reduce yields, lower forage quality, reduce stand life and be toxic to livestock. Current weed control products have a narrow window of application, relatively long preharvest intervals, risk crop injury, have requirements for soil incorporation, narrow weed control spectrum, and there are crop rotation restrictions. With the development of Roundup Ready® alfalfa, like other Roundup Ready crops, growers can spray alfalfa fields with Roundup herbicides to control more than 200 species of weeds without injuring the alfalfa crop or negatively affecting the quality of the forage. This product should be available for commercialization in 2006.

Fiber Digestibility: Fiber digestibility is an important component of forage having an impact on intake and digestibility by the dairy cow. Hatfield et al. (1999) provides background, on the molecular basis for improving forage digestibilities, Barrièrer et al. (2004) on the genetic and molecular basis of grass cell wall biosynthesis and degradability, and Ralph et al. (2004) on lignins. Lignin is a phenolic compound found in most plant secondary cell walls, is indigestible, and cross-links with other cell wall components resulting in decreased cellulose digestibility. Lignin content increases, and cell wall digestibility decreases as alfalfa plants mature. Almost every enzyme involved in the synthesis of lignin monomers has been investigated in one species or another (http://www.psb.ugent.be/research/molgen/lignin_details.htm) with variable impacts upon the concentration of the final lignin polymer deposited within the cell wall matrix. Some have had dramatic effects upon the total lignin (>50% reduction), but producing a phenotype that is fragile and with poor agronomic qualities. Dixon's group (Guo et al., 2001)) at the Noble Foundation have altered the lignin pathway in alfalfa by decreasing the expression of two genes which are involved in the biosynthesis of coniferyl and sinapyl alcohol, the main building blocks of lignin. The changes in lignin were on the order of 20% reduction (Guo et al., 2001) that translated into increases in digestibility of 2-5%. This improvement can be compared to conventional breeding where over 15 years selection has resulted in a 2-3% increase in cell wall digestibility.

An alternative way to improve digestibility is to selectively increase specific carbohydrates that make up alfalfa cell walls such as pectin. Alfalfa stems typically contain 10-12% pectin as a component of the cell wall matrix. Pectic polysaccharides are rapidly degraded by rumen microbes producing acetate and propionate, but do not result in acidosis like rapidly fermented starch (Hatfield and Weimer, 1995). The US Dairy Forage Research Center has been involved with a consortium made up of alfalfa breeding companies to select for increased concentrations of pectin in alfalfa stems. Through two cycles of selection the total stem pectin concentration has been increased by 15-20% (Hatfield et al., unpublished data). Preliminary results indicate that in vitro total dry matter digestibility was increased. However, additional work must be done to determine what other changes have occurred within the plant because an increase in one component requires the decrease in some other component. It is encouraging that selection can be made for specific cell wall components.

Alfalfa cell walls also contain xylans and cellulose with vastly different digestibilities (Hatfield and Weimer, 1995). The xylans in alfalfa stems (20-25% of total) have a slow rate and low extent of digestion. Replacing at least part of this cell wall fraction with another polysaccharide could have major impacts upon total fiber digestion. Increasing the cellulose content without increasing lignin should result in a wall matrix that has a greater extent of degradation. The impact of manipulating xylan or cellulase upon the function of the alfalfa plant is unknown at this time. Precision breeding techniques allow altering a gene and determining its impact in a relatively short period of time. In this way one can determine right away if altering a particular component is going to improve plant function or be detrimental. With the exception of cellulose, the genes involved in xylan and other cell wall polysaccharide biosynthesis have not been identified, which eliminates this approach as a way to test the hypothesis of altering specific polysaccharides. It may be possible to use this approach with cellulose; however, most plants appear to have relatively large families of cellulose synthase genes making this approach difficult.

Protein: The full benefit of alfalfa protein is not realized due to its poor utilization by the animal. Ruminal microbes degrade alfalfa protein too rapidly resulting in excessive excretion of nitrogenous waste by the animal. In addition, protein breakdown during ensiling can be extensive. This loss is due to plant proteases degrading 44 to 87% of forage protein into ammonia, amino acids and small peptides during silage fermentation resulting in losses of up to $28 per acre for alfalfa. Decreasing protein degradation during the silage making process and in the rumen would decrease the need for supplemental protein and decrease the loss of nitrogen to the environment on the dairy farm.

Red clover has been found to have up to 90% less proteolysis than alfalfa during ensiling (Papadopoulos, 1983). This observation suggests that red clover should be an ideal legume for ensiling. Yet the widespread use of red clover is limited due to its poorer agronomic characteristics such as low stand persistency, yield, and its slow drying rate in the field. Lower extent of proteolysis is not due to differences in the inherent proteolytic activity in red clover versus alfalfa, but rather related to the presence of a soluble polyphenol oxidase (PPO) and *o*-diphenols in red clover (Jones et al., 1995a; Jones et al., 1995b; Jones et al., 1995c). This conclusion was initially based on several observations including: 1) red clover contains factors that can rapidly (<0.25h) inhibit proteolysis in both red clover and alfalfa, as determined by mixing experiments; 2) red clover leaves contain >250-fold higher levels of PPO activity than alfalfa leaves; 3) red clover contains abundant *o*-diphenol PPO substrates which are depleted as proteolysis is inhibited; 4) one of the factors involved in proteolytic inhibition is heat labile (consistent with involvement of a proteinaceous factor); and 5) proteolytic inhibition is O_2-dependent. Recently, the US Dairy Forage Research Center has been able to successfully test the hypothesis that PPO and *o*-diphenols inhibit proteolysis in plant extracts. Researchers have further demonstrated the role of PPO in proteolytic inhibition in plant extracts using a transgenic alfalfa system.

Although alfalfa has at least one gene encoding PPO, expression has not been detected in any tissues except developing seedpods. Further, significant PPO activity in alfalfa leaves and neither stems nor significant amounts of *o*-diphenol substrates have been detected. Thus, alfalfa is an ideal model system to explore the role of PPO/*o*-diphenols in inhibition of post-harvest proteolysis. To demonstrate the role of PPO and *o*-diphenols in inhibition of proteolysis, a cloned red clover PPO gene (*PPO1*) was constitutively expressed in transgenic alfalfa (PPO1-alfalfa). Proteolysis was inhibited in leaf extracts of the PPO1-alfalfa when the *o*-diphenol caffeic acid was added (Sullivan et al., 2004), Figure 1. No inhibition was observed when caffeic acid was omitted. Substantial proteolysis was observed in leaf extracts of control alfalfa lacking a PPO transgene, even if caffeic acid was added to the extract, indicating that caffeic acid alone does not result in in vitro proteolytic inhibition. The extent of proteolytic inhibition seen for PPO1-alfalfa extracts with added caffeic acid was comparable to that seen for red clover extracts. These results clearly demonstrate the major role of PPO and *o*-diphenols in post-harvest proteolytic inhibition in red clover and that expression of the PPO gene in other forages can inhibit proteolysis when an appropriate o-diphenol is added.

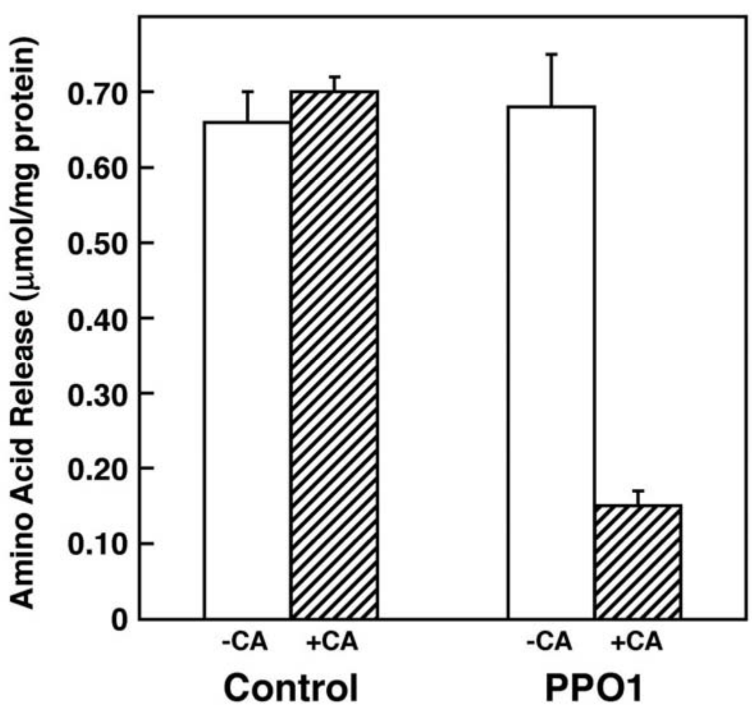

Figure 1. PPO inhibits postharvest proteolysis in an o-diphenol-dependent manner. Amino acid release during a 4-hour incubation at 37C was used to measure proteolysis in extracts of control or PPO1-expressing alfalfa as indicated in the presence (+CA) or absence (-CA) of 3 mM caffeic acid. (Sullivan et al., 2004).

Slowing the rate of alfalfa protein degradation in the rumen is difficult to address from the alfalfa plant. There is some evidence that PPO generated o-quinones interact with proteins in red clover providing some protection in the rumen creating greater bypass protein. It is clear that tannins provide protection of plant proteins from ruminal degradation. Tannins are phenolic compounds that generally bind with proteins, decreasing the rate and extent of protein digestion. Forage legumes (e.g. birdsfoot trefoil) that produce tannins in leaves or stems have increased stability of the protein in the rumen, thus more protein escaping degradation in the rumen. Unfortunately, alfalfa does not produce tannins except in the seed coats. With new knowledge about tannin biosynthesis (Dixon group, Noble Foundation) it may be possible to engineer alfalfa to produce tannins that provide protein protection in the rumen and may also lead to less bloat. The plant is already producing many of the "raw materials" needed to produce the building blocks of tannin polymers; it's just a matter of diverting some of these into a new pathway. Another approach is to have alfalfa produce proteins containing increased concentrations of sulfur containing amino acids whereby more disulfide bonds are present which are known to be less degradable in the rumen. Tabe et al. (1995) used a biotechnological approach to insert a gene from a sunflower plant into alfalfa that resulted in the production of a sunflower seed storage protein, rich in cysteine and methionine, in alfalfa leaves.

NOVEL ALFALFA PRODUCTS

Two important conditions must be met for alfalfa fractionation to be feasible and sustainable: 1) the total value of the resulting products must be greater than the original forage plus the cost of processing; and 2) all fractions must have an economic value to avoid creating a waste stream. Three methods of forage fractionation exist: 1) wet fractionation; separation into juice fraction and a fiber fraction, 2) dry fractionation; separation into leaves and stems, and 3) fractionation by passage of the whole herbage through the digestive systems of ruminant animals, leaving a high fiber residue.

Wet fractionation of forage crops allows biomass to be produced at very competitive prices due to the high values of the co-products. The fractionation process consists of expressing juice from fresh herbage (Koegel et al. 2000). The resulting fibrous fraction is high in cell wall constituents (cellulose, hemicellulose, and lignin). It is suitable for combustion, gasification, or enzymatic hydrolysis and fermentation to ethanol or organic acids (e.g. lactic) (Sreenath et al. 2001a, 2001b).

The juice fraction contains 25 to 30% of the dry matter in the original herbage depending on the severity of processing. It is high in protein and solubles and is almost fiber free. It can be used to produce both food-grade and feed-grade protein concentrates as well as other high-value products (xanthophylls for pigmenting poultry products; enzymes such as phytase, cellulases, lignin peroxidase and α-amylase and biodegradable plastics, all from transgenic alfalfas).

Koegel et al. (1999) reported feeding growing chicks with alfalfa-produced phytase, which at appropriate levels can totally replace the inorganic P supplementation. Replacing inorganic P with phytase resulted in a reduction of P concentration in poultry feces to less than one-half. They further reported that alfalfa phytase in the form of fresh juice; dried juice or leaf meal was all-effective. The quantity of phytase, which can be produced in transgenic alfalfa is on the order of 200 X 10^6 units/acre/year, equivalent to an amount able to treat 500 tons of poultry ration. At current cost of inorganic P supplementation, the value of phytase would be $750 - $1500 per acre-year. The value of xanthophylls and protein content of alfalfa as well as the environmental benefits would be in addition to this.

Dry fractionation of alfalfa hay. Dry fractionation of alfalfa hay into leaf meal and stems used as the Minnesota Valley Alfalfa Producers (MNVAP), Granite Falls, Minnesota and Northern States Power (NSP), Minneapolis, Minnesota (Martin and Oelke, 1996), pioneered solid fuel. The research effort to produce 75 MW of electrical energy from alfalfa stems via gasification was initiated in 1993 by Department of Energy, University of Minnesota, MNVAP and several power generation partners. The project was cut short of construction of a new power generation plant in May 1999 due to negation of the original power purchase agreement between MNVAP and NSP. NSP was under legislative mandate to generate power from a closed-loop farm grown biomass system by 2002.

Minnesota researchers (DiCostanzo et al., 1999) concluded that ALM is a suitable substitute for hay and soybean meal in diets of lactating dairy cows, although some question remains as to the performance and body weight response to ALM supplementation during a whole lactation. As a component of starter diets, ALM has the potential to enhance intake and gain when constituting 12% of the starter DM. At greater inclusion proportions, ALM may reduce intake in young ruminants. In dairy calves (aged 4 to 40 d), this reduction in intake may or may not be accompanied by a reduction in weight gain. The latter was the case when suckling calves were offered creep feed for 80 d before weaning. In receiving (growing beef animals after shipment) diets, DMI enhancement may not be accompanied by a gain response; thus, feed DM required/kg gain may increase. This effect does not appear to carry over into the finishing period. In fact, finishing steers fed 9% of their diet DM as ALM had faster gains at greater intakes. The most “adequate” inclusion level for ALM appears to be between 7 and 12% of the diet DM in beef cattle. Effects of ALM on incidence of liver abscess in feedlot diets are somewhat inconclusive and warrant further study. Similarly, efforts to enhance the value of ALM through heating to render a bypass protein source must focus on reducing exposure time or temperature.

CONCLUSIONS

Alfalfa is a key forage dairy, horse and beef operations. Enhancing the nutrient utilization of alfalfa in dairy diets offers potential new products and expanded acreage. Past progress relying on traditional breeding has been slow in enhancing the quality and attributes of forages. With the recent tools of biotechnology, rapid advancement in forages with improved agronomic and nutritional traits may be possible leading to more efficient and environmentally friendly dairy enterprises.

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ALFALFA: THE QUEEN OF FORAGE CROPS
IT DON'T GET ANY BETTER

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For anyone who has grown or used alfalfa, there is no question but that alfalfa is the best forage crop they have dealt with. Perhaps that is one reason that we in professional agriculture have given so much special interest to the crop and why it is held in such high esteem and the position it demands in research and refinement investments over the years at the private and public sectors.

The one overriding fear all growers have is that alfalfa is an easy crop to kill. So through the years, researchers (especially plant breeders) have developed varieties that are 'miss-management-resistant'. The breeders talk disease and insect resistance when really their main objective is to have healthier thus more tolerant plants. Then, educators and marketers place these materials in regions and programs that give the best benefits to growers.

There have been some remarkable changes in alfalfa production and management refinements since the crop was first introduced in the late 1700's in America. Some remarkable changes have occurred over many generations. But most of the really big changes have taken place in the past three to four decades. Even today as in the future, changes will continue as more and better information and materials come forward.

SOME OF THE MORE IMPORTANT DEVELOPMENTS

1. **Better, more disease and insect resistant varieties.** Yield and persistence is at a standstill unless better adapted, more disease and insect resistant varieties are developed and used by growers. Thirty years ago we were dealing with some 10-12 recognized varieties around the USA. Today, there are 270 certified varieties on the U.S. market. Of these, well over 100 can be grown in Kentucky. What once was a simple variety selection process, (mainly just finding out what a neighbor was planting or what the local seed dealer had on hand), today, a grower has many options. If he looks hard enough and has good information, he can select a variety or a variety group that exactly fits his individual farming program and his special needs.

2. **Selecting deep well drained soils.** Selecting good soils is the first rule if growers are to succeed with alfalfa. Very seldom do even 'first-timer's'

attempt to establish alfalfa on shallow poorly drained soils knowing that a long life expectancy is doomed. Yet when less than ideal soils is all they have to choose from, many often plant alfalfa knowing that the fewer years they have the land in alfalfa is better than the next best alternative crop for hay and grazing.

3. **Revising pH and elevating P and K. The availability of localized s**oil testing and quick personal amendment recommendations have made it easy for farmers to get good soil information and treatment. Soil testing has shown that amending soil pH is not an overnight program. Also by using follow-up testing, growers discover the high removal level phosphorus and potassium and replacement needs when the crop is harvested and removed as hay or silage.

4. **Timing plantings** to blend with the best early growing seasons. In much of Kentucky, the preferential time for seeding has changed from late summer-early fall to springtime. Mainly this change was the matter of more dependable springtime rainfall. Also this change took place to avoid Sclerotinia crown and stem rot that often occurred in fall seedings especially when new plantings did not get off to an early vigorous start/growth.

5. **Seeding depth** to attain uniform stands of alfalfa. Once a grower has buried his seeding more than ¼ to ½ inch in most soils or ¾ inch in sandy soils, he has learned his lesson. Learning to adjust planting equipment and soil preparation and taking the time to get it right is a must. But still, this is a problem that causes entirely too many early stand failures.

6. **Recommended seeding rates** to produce uniform-longer lasting alfalfa stands vary widely from state to state and may vary from farm to farm. The 'standard' seeding rate on most Kentucky farms is 15-18 pounds per acre.

7. **Modify harvest systems** to improve quality, yield, and maintain stand persistence. This change has been largely due to better, more resilient, faster recovering varieties. For the most part, farmers on the 'cutting-edge' have moved from the three to the four cut system. In a few instances, a few have moved to five harvests. But seldom do these (five-cut) producers have as added net value of the current crop and persistence over time.

THE RECENT YEARS SOME REALLY BIG CHANGES HAVE BEEN MADE.

Better disease, insect resistant and specific fall dormancy varieties are available to growers all across the America. Since the initial breakthrough that virtually eliminated Bacterial wilt as a producers problem, a grower can select varieties with resistance to four other prominent diseases, three primary insects and up to eight nematodes. There have been some major improvements in resistance to four other diseases, and four to five insects. But most of these pests have been very elusive but should be resolved in due time. Unfortunately for growers in Kentucky (and much of the humid-eastern sections of the USA), plant breeders have not been able to produce varieties that are resistant to the European Alfalfa Weevil.

Revising seeding methods and the introduction of No-Till has had a major impact on plantings. Perhaps the biggest breakthrough has been spring-early summer seeding into killed winter-grain cover crops. The introduction and use of Roundup and Gramaxone have caused this planting procedure to become a real boon to growers especially in this region.

Even though seeding alfalfa into an established grass stand has not been used as widely as it should have been used, it is one of the most potentially financially resourceful programs for beef and dairy farmers in Kentucky and surrounding states.

Producing grazing tolerant alfalfa is no longer just a dream of farmers who want high monetary returns from grazing beef and dairy, it is a reality. Since the introduction of Alfagraze in 1990 and the acceptance by the 'plant breeding community' that grazing tolerance is a specific trait, a growing number of new varieties have been developed from this basic germplasm. We have known for years that the acreage of alfalfa has been stagnant or dropping throughout the USA, and yields have been increasing slightly. Also, farmers, especially dairy farmers are switching to other sources of stored forage, especially corn silage, to replace alfalfa.

For generations, we in Kentucky and surrounding states have known that legumes and grass for pasture is a more profitable grazing than grass alone. Our search has been to find a legume that will live more than a year or two and produce high grazing yields even during the summer months. Grazing tolerant alfalfa fills that spot. Yet, still all too many farmers fear bloat perhaps even more than they fear bloat when grazing white clover.

Resistance to mechanical damage is a reality. On the heels of the release of grazing tolerance, it was discovered by scientists (in Japan at first) that these varieties were quite tolerant to mechanical abuse. Since that time, several alfalfa varieties have been developed from the Alfagraze germplasm base that have proven to be truly abuse resistant with higher yielding ability plus maintaining and improving pest resistance.

Coating to improve inoculation and stand performance. Alfalfa **s**eed coating began in America in 1975. Through the years, this treatment has insured an ideal habitat for bacteria thus inoculation. Consequently, no longer do farmers who use these products have to worry about inoculating seed. So long as a recommended seeding rate is used, (15+ pounds per acre or more), research has found that even though coating is added, the resulting stand will be equal with and without coating even though the coating represents a significant proportion by weight of the product.

Higher yields are due primarily to use of better land, harvesting procedures and better more pest resistant varieties. **For the past 20-30 years, fertilizer studies have lagged well behind the development of new and better varieties and for the most part have been non-existent in many states.** The only time we see impressive continued high yields is not on research plots but on aggressive farming operations and added fertilizer application based on previous soil test results.

ABOUT THE FUTURE

Better, higher yielding varieties will continue to be developed from recurrent selection process. More attention will be placed on specific needs and specific locations.

Hybrid alfalfa will become a reality.

Biotechnology is going to play a big role in the near and distant future. We keep hearing about some of the big breakthroughs that are coming and we can rest assured that biotech will have a big role in variety development, weed control, and bloat resistance to name a few advancements.

Producers wanting higher yields will demand more soil fertility research. No longer will aggressive farmers be satisfied with 'ordinary hay yields' or anything less than 2.5 pounds of daily gains on beef cattle grazing improved pastures. Water use studies must be geared to soils and plant needs to attain satisfactory yields and persistence and minimize exploitation.

SUMMARY

These are some of my thoughts dealing with alfalfa, present, past, and future. You have a great group of leaders who will lead you well into the 21st Century. I wish you the best possible success in all that you do for yourself and the future of Kentucky.