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# The Alliance for Grassland Renewal: A Model for Teaching Endophyte Technology

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***Abstract*****—**To the author's best knowledge, there are no published reports of effective methods for teaching fescue toxicosis and grass endophyte technology in the USA. To address this need, a group of university scientists, industry representatives, government agents, and livestock producers formed an organization called the Alliance for Grassland Renewal. One goal of the Alliance was to develop a teaching method that could be employed across all regions in the USA and all sectors of the agricultural community. The first step in developing this method was identification of experts who were familiar with the science and management of fescue toxicosis. The second step was curriculum development. Experts wrote a curriculum that addressed all aspects of toxicosis and management, including toxicology, animal nutrition, pasture management, economics, and mycology. The curriculum was created for presentation in lectures, laboratories, and in the field. The curriculum was in that it could be delivered across state lines, regardless of peculiar, in-state recommendations. The curriculum was also unique as it was unanimously supported by private companies otherwise in competition with each other. The final step in developing this teaching method was formulating a delivery plan. All experts, including university, industry, government, and production, volunteered to travel from any state in the USA, converge in one location, teach a 1-day workshop, then travel to the next location. The results of this teaching method indicate widespread success. Since 2012, experts across the entire USA have converged to teach Alliance workshops in Kansas, Oklahoma, Missouri, Kentucky, Georgia, South Carolina, North Carolina, and Virginia, with ongoing workshops in Arkansas and Tennessee. Data from post-workshop surveys indicate that instruction has been effective, as at least 50% of the participants stated their intention to adopt the endophyte technology presented in these workshops. The teaching method developed by the Alliance for Grassland Renewal has proved to be effective, and the Alliance continues to expand across the USA.

***Keywords*****—**Endophyte, *Epichloë coenophiala*, ergot alkaloids, fescue toxicosis, tall fescue.

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## I. Introduction

FESCUE toxicosis is the most devastating forage-based livestock disorder in the eastern United States, where the most widely grown perennial grass is tall fescue [*Lolium arundinaceum* (Schreb.) Darbysh.] (Fig. 1) [1]. Fescue toxicosis is caused by common strains of *Epichloë coenophiala* [(Morgan-Jones & W. Gams) C.W. Bacon & Schardl, comb. nov.], a fungal endophyte [2] that colonizes the intracellular regions of leaf sheath, stem and seed of tall fescue (Fig. 2). Common *Epichloë* produces ergot alkaloids (Fig. 2), which have severe effects on animal health and livestock production [3].

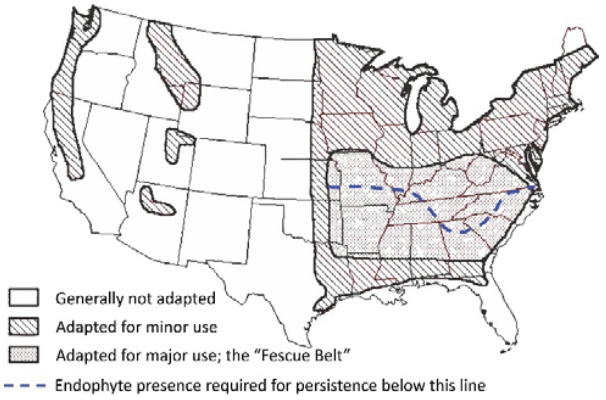


Fig. 1 Regions in the USA where tall fescue is the dominant pasture grass. The region where tall fescue is adapted for major use is called the "Fescue Belt"

Symptoms of fescue toxicosis include immunosuppression, vasoconstriction (Fig. 3), and poor thermoregulation [1], [4], [5]. Animals suffering from fescue toxicosis suffer from heat stress, lameness, poor reproduction, decreased milk production, and low rates of gain. Fescue toxicosis affects 8.5 million cows on 35 million acres in the USA and costs the nation's livestock industry an estimated $1 billion annually [1].

### *A. Solutions to Fescue Toxicosis*

In the 1980s and 1990s, plant breeders proposed a solution to fescue toxicosis by producing cultivars that contained no *Epichloë* [6], [7]. These cultivars, called "endophyte-free" tall fescue, provided an effective remedy to fescue toxicosis [4], [8]. However, the endophyte-free cultivars did not persist in the field. Stands were susceptible to drought stress, insect pests, and microbial pathogens. It was later determined that the endophyte was required for the tall fescue plant to

withstand a wide range of biotic and abiotic stresses [1], [9], [10].

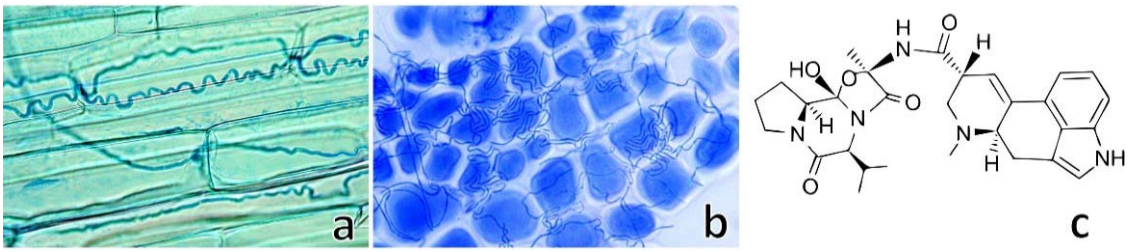


Fig. 2 Mycelia of *Epichloë coenophiala*, an endophytic fungus that colonizes the tall fescue leaf sheath (a) and seed (b). Strains of *Epichloë* that produce ergot alkaloids, such as ergovaline (c), are called "common, toxic endophytes." Strains that produce little or no ergot alkaloids are called "novel endophytes"


Fig. 3 Vasoconstriction in cattle: Normal blood flow (a) compared to restricted blood flow (b) caused by ingestion of toxic tall fescue. Photo by Dr. Terry Swecker

Soon after endophyte-free cultivars were released, mycologists isolated exotic strains of *Epichloë* that produced little or no ergot alkaloids. These strains were physically injected into immature seedlings of endophyte-free tall fescue. The resulting cultivars were beneficial [11], as they proved to be non-toxic to cattle [12]–[18]. Because they were now infected with an endophyte, these cultivars exhibited improved persistence, much like the common toxic cultivars [1], [19]. Beneficial endophytes are most often known as "novel endophytes".

### *B. Problems with Adoption of Technology*

The technology known as "novel endophytes" offers a well-vetted solution to the most devastating forage-livestock disorder in the eastern USA. Novel endophyte cultivars became available in 2000 [1]. However, the technology has not been widely adopted in the USA. Similar technology has been used for perennial ryegrass, which has seen widespread adoption in countries like New Zealand [20].

The primary reasons for the lack of adoption have been documented as establishment cost and the process of pasture renovation [21]. However, there are other reasons.

Adoption of novel endophyte technology has been hampered by ineffective communication. Messages from researchers and educators have been confusing. An example can be seen in early definitions of fescue toxicosis, which included the term "fescue toxicity" within the definition; "fescue toxicity" was listed as one of three syndromes of fescue toxicosis [22]. In addition, messages have been conflicting, as universities and seed companies have recommended seeding rates and planting methods that are highly variable. Also, messages from experts have been incomplete, as management recommendations have been piecemeal rather than systematic.

A final reason for lack of adoption relates to lack of quality assurance. Seed with novel endophyte cost at least twice as much as seed with common, toxic endophyte. Yet the producer has been given no assurance that the expensive seed contained a viable, novel endophyte. For many decades, quality assurance of crop seed has been provided through seed certification programs. Yet, no such program has existed for monitoring strains of endophytes.

In the absence of a quality assurance program, it has been possible to purchase seed advertised as containing a novel endophyte when it actually contained the toxic endophyte. The result of planting such seed would be a vigorous stand of toxic tall fescue. Further, it has been possible to plant seed that contained a novel endophyte, yet the endophyte would not be viable. In this case, the emerging seedlings would be endophyte-free, which would die in the field within a few years.

## II. Formation of an Alliance

### *A. First Year Activity*

In 2011, a group of stakeholders began exploring possible ways to facilitate the adoption of novel endophyte technology. The group was comprised of colleagues from all sectors—university, government, seed industry, nonprofit organizations, and the farming community. Over the next 12 months, the group named itself, developed a brand, drafted by-laws, formed a board of directors, elected officers, registered with the federal government for nonprofit status, developed quality control standards, scheduled workshops, and launched a website. The group also agreed upon an annual funding model, with universities contributing $1,500 USD and private

companies contributing $5,000 USD per year.

*B. Subsequent Activity*

The stakeholder group decided on the name, "the Alliance for Grassland Renewal." By 2019, the Alliance grew to include all seed companies, domestic and international, that owned or sold a novel endophyte; these companies were headquartered in the U.S., Denmark, New Zealand, and the Netherlands. The Alliance expanded to include six land grant universities, two nonprofit organizations, one government agency, two livestock producers, and two additional companies. One of the additional companies, Agrinostics, LTD, agreed to serve as the seed standardization laboratory for the Alliance. At present, the Alliance Board of Directors includes stakeholders from all sectors who are located in the Fescue Belt and in Oregon, the major area of grass seed production in the USA (Fig. 4).

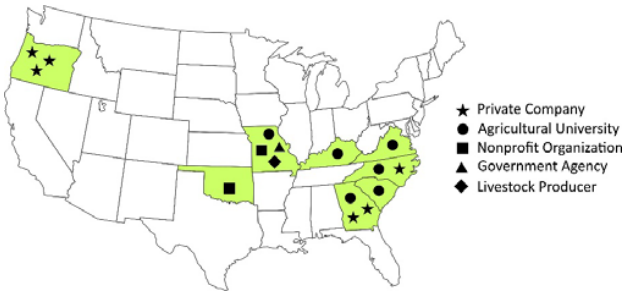


Fig. 4 Sectors of the agricultural community who serve on the Alliance for Grassland Renewal Board of Directors. Board members are located in regions of grass seed production (Oregon, far northwestern USA) or incidence of fescue toxicosis

TABLE I
CURRICULUM FOR WORKSHOPS HELD BY THE ALLIANCE FOR GRASSLAND RENEWAL

| Presentation | Speaker |
|---|---|
| Fescue Toxicosis: An Overview | University |
| Economics | University |
| DEMONSTRATION: Microscopic Analysis | Nonprofit Organization |
| Establishment of Novel Endophyte Tall Fescue | University |
| DEMONSTRATION: No-till Drill Calibration | Host University |
| Seed Quality and Testing | University and Private Company |
| Pasture Management | University |
| DEMONSTRATION: Novel Endophyte Plantings | Host University |
| Producer Panel | Livestock Producers in Host State |
| Novel Endophyte Products Available | Private Companies |
| Incentives | Government Agency |

## III. ALLIANCE EDUCATION

The Alliance for Grassland Renewal began with four objectives: 1) education, 2) quality control, 3) incentives, and 4) promotion. The following discussion will focus on the first objective, education.

*A. Expert Instructors*

The Alliance designed workshops to be small scale versions of national scientific symposia. The Alliance board members persuaded the nation's leading authorities to volunteer as expert instructors. Their areas of expertise were endophyte testing, microbial molecular genetics, forage quality, animal nutrition, and agricultural economics. Expert instructors agreed to travel to "hot spots," converging in locations where fescue toxicosis was problematic, and then hold 1-day workshops.

Expert instructors joined with other stakeholders who were willing to travel and volunteer their time as well. These included representatives from private companies, agents in the federal government, and livestock producers with novel endophyte experience. When assembled, the full teaching team was able to provide accurate scientific answers to almost every question, as well as reliable advice to livestock producers interested in the technology. The teaching team was also able to write and revise a curriculum for the entire Fescue Belt.

*B. Robust, Focused Curriculum*


Fig. 5 Seed lots that met quality standards set by the Alliance for Grassland Renewal contained viable, non-toxic *Epichloë*. These seed lots were tagged with the Alliance logo (top left) and a label that reads, "This seed lot has been tested and determined to contain at least 70% novel (selected) endophyte and no more than 5% off-type endophyte"

The curriculum began with five scientific presentations (Table I). The first talk was an overview of fescue toxicosis. In this presentation, toxicosis was defined clearly, with terms that describe problems in animal health and livestock production. A second presentation covered economics. Its focus was the cost of pasture renovation and estimates of time for cost recovery, which continue to be major concerns for livestock producers. The economics presentation was based on analysis by university researchers and educators from six states across the Fescue Belt. Expert instructors also wrote a presentation to teach producers how to eradicate stands of toxic pasture and plant novel endophyte tall fescue. Establishment methods included herbicide spray regimes, smother crops, and no-till drilling. The curriculum continued with a discussion of seed quality and testing. This discussion assured the producer that novel endophyte seed lots were adequately tested for viable,

non-toxic strains of *Epichloë*. The seed quality talk explained the Alliance standards for seed quality, which if met, authorized seed lots to be tagged with an Alliance logo (Fig. 5).

The fifth and final scientific presentation discussed pasture management. This session presented management in three sections: 1) how to manage a new stand of novel endophyte tall fescue, 2) how to manage the existing stand of toxic tall fescue, and 3) how to manage the entire grazing system. This approach was necessary, as conversion from toxic pastures to novel endophyte pastures normally occurs over a period of years. During these years, called "transition years," livestock producers must see their farms as complex systems.

The five scientific talks were coupled with demonstrations. One demonstration was microscopic viewing of *Epichloë* mycelia in seed and sheathes of tall fescue (Fig. 6). The microscope allowed producers to see firsthand the organism responsible for poisoning their cattle. It brought a tangible dimension to the workshop.


Fig. 6 Alliance for Grassland Renewal workshops included both indoor and outdoor demonstrations. One demonstration (a) allowed the producer to visualize *Epichloë* mycelia infecting leave sheaths and seed of tall fescue. Another demonstration (b) taught livestock producers how to calibrate a no-till drill

Other demonstrations were calibration of a no-till drill (Fig. 6) and a tour of novel endophyte plantings. These last two demonstrations were crucial, as many attendees were livestock producers who were unfamiliar with no-till practices and apprehensive about pasture renovation methods.

In addition to the scientific presentations, the curriculum included talks from non-university stakeholders. The most popular of these was the producer panel; the panel consisted of 2 to 3 livestock producers who described their experiences in converting toxic pastures to novel endophyte pastures and in improved animal performance on their farms. Other stakeholder presentations included overviews from private seed companies; each company representative was given 7 minutes to tell the audience about products available in the upcoming year. The final presentation was from a government agent who could offer financial assistance for new plantings of novel endophyte tall fescue.

### *C. Effect of Alliance Workshops*

Within 8 years, the Alliance workshops have reached most of the Fescue Belt (Fig. 7). The areas not yet covered are the northern extremes of Alabama and Mississippi, as well as southern counties of Illinois, Indiana, Ohio, and West Virginia.

Impact from these workshops is currently being quantified. The most direct measure of impact would be increased sales of seed with novel endophytes. Such data are not disclosed, as sales records are confidential. What is known, however, is that all companies have increased sales, and the increase averaged across all companies easily exceeds 50%.

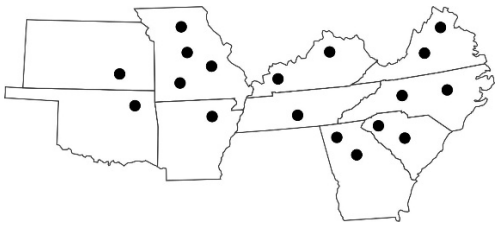

Fig. 7 Locations of Alliance for Grassland Renewal workshops in the USA. Locations represent most of the regions known to experience fescue toxicosis

Adoption of novel endophyte technology continues to increase. Adoption rates have been forecasted by questionnaires given at the end of each workshop. Since 2017, at least 50% of the respondents to those questionnaires stated that they planned to adopt novel endophyte technology.

## IV. Conclusion

The Alliance for Grassland Renewal has proved to be an effective model for teaching livestock producers about novel endophyte technology. The Alliance unites all stakeholder sectors involved in the technology, including research, education, commerce, advocacy, and production. The Alliance is effective because its message is science-based, vetted, uniform, focused, easy to understand, and confirmed by classroom and field demonstrations. Because the Alliance is

having a substantial impact on the adoption of novel endophyte technology, it will continue to expand.

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