Impact of Tall Fescue Toxicosis on Beef Operations: How much can we live with?

Joe Bouton
Emeritus Professor
Institute of Plant Breeding Genetics, and Genomics
University of Georgia

The University of Georgia

The Theme of This Talk

“People need to be reminded much more than they need to be instructed” ---- Dr. Samuel Johnson (1709-1784)

“Emphasize Fundamental Principles”

“Success is neither magical nor mysterious. Success is the natural consequence of consistently applying the basic fundamentals”.

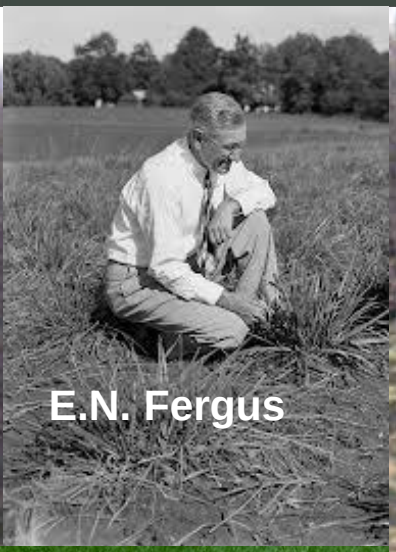
Jim Rohn

Historical Trends

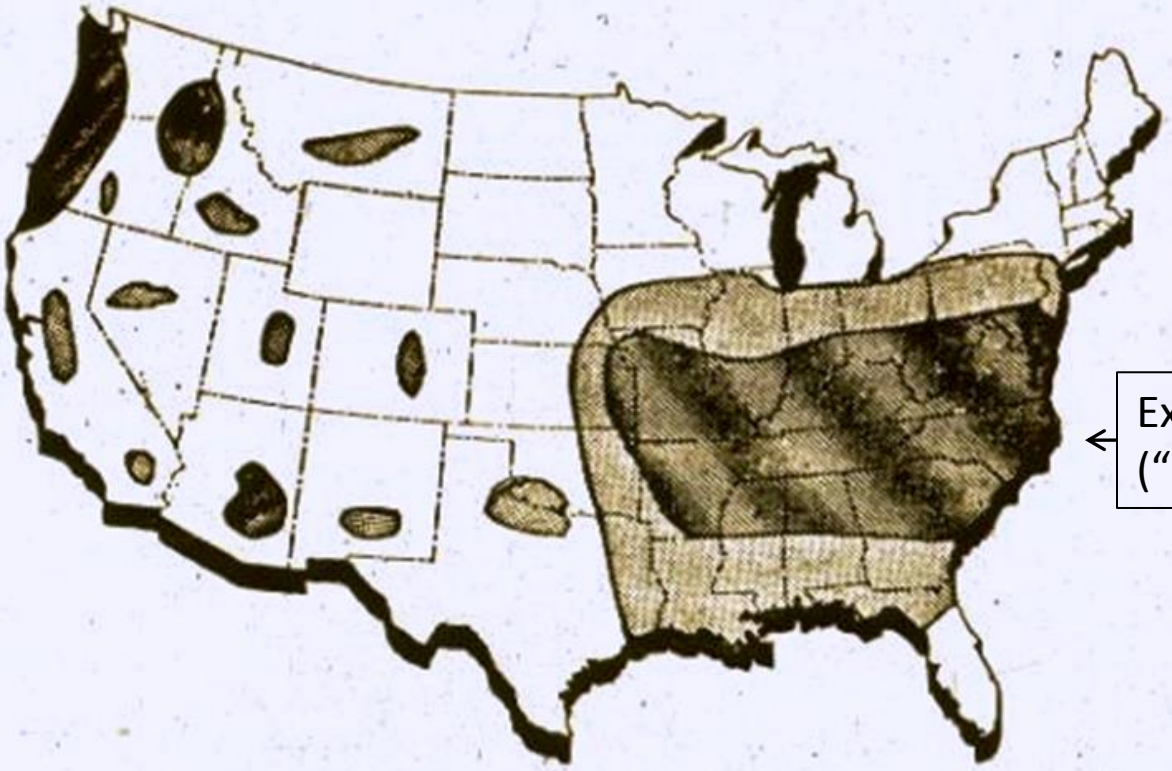


- **Overuse as cropland led to severe erosion in most areas of eastern USA.**
- **Re-vegetation as pasture and woodland to stop this erosion became the mission Soil Conservation Service (SCS; now NRCS).**
- **These re-vegetation programs coincided with the release and promotion of 'Kentucky 31' Tall Fescue.**
- **Why: It was persistent (long lived) and dependable and a great "gulley stopper" and succeeded as such!!**

‘Kentucky 31’; Selected by E.N. Fergus on William Suiter Farm, Manifee County, KY, in 1931!


E.N. Fergus

By 1973; over 40 million acres is use for erosion control, turf, and general pasture.



Extensive use ("Fescue Belt")

FIG. 28.1. Tall fescue–producing areas of the U.S.

From Buckner and Cowan, 1973

Problems! “Fescue Toxicosis”

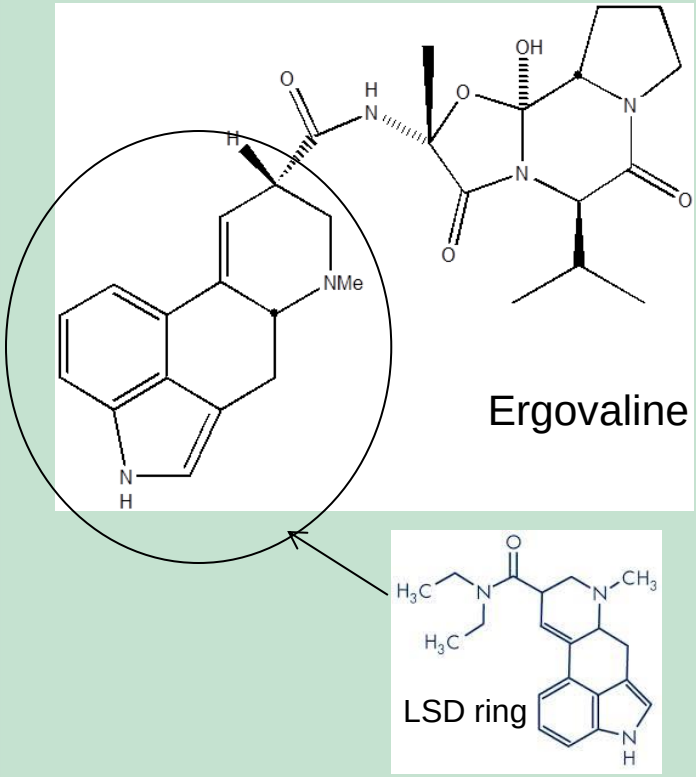
(“fescue foot”, “summer slump”, etc)

Costs to industry=$600 million per year
(Fribourg and Waller, 2004)

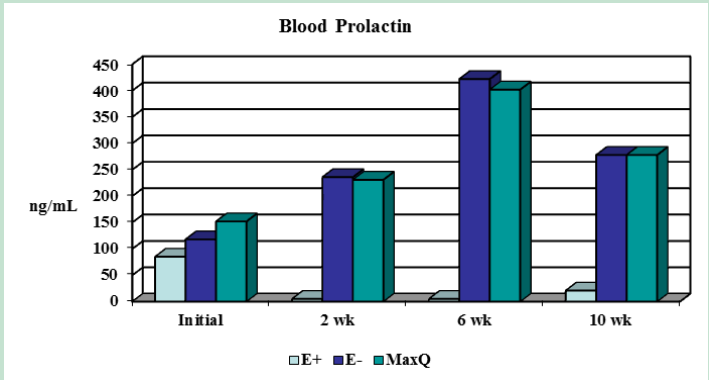
Cost per cow in “fescue belt” states=$79 per head
(estimated by Bouton!)


Mycelia of fungal endophyte
(Neotyphodium coenophialum)
in tall fescue seed.

Ergot Alkaloids



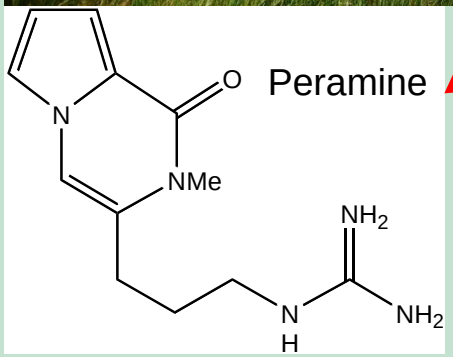
- A group of alkaloids with ergovaline in the highest percentage and thought to be the most damaging.
- Is chemically an "LSD" compound!
- Blood vessel constriction (leads to "fescue foot"; hooves and tails falling off) Failure to slough-off winter coat ("rough hair coat").
- Body temperature regulation problems ("summer slump"; animals spend less time grazing and more time cooling themselves off).
- Depressed blood prolactin levels (can result in milk production problems especially in horses).



The answer: Remove the fungus!


Unfortunately, removing the fungal endophyte also reduced its persistence.
KY31−
KY31+

Why do endophytes make tall fescue more persistent?

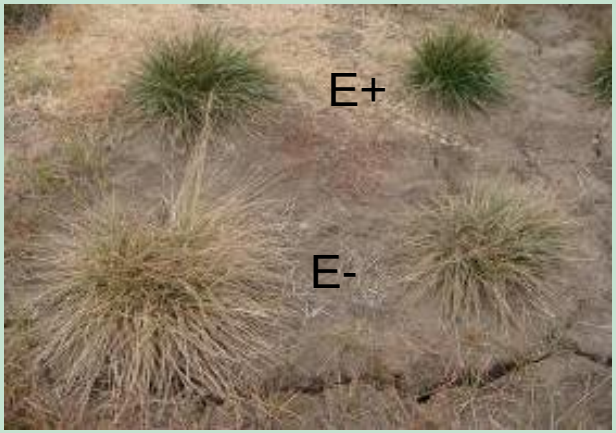


Reduced grazing due to toxic ergot alkaloids during late spring allows **better forage accumulation** leading to good summer survival.

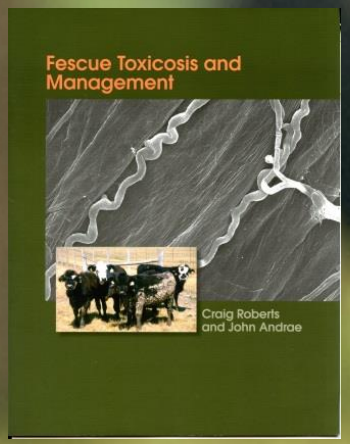
All alkaloids produced are **not bad** (**peramine** has **anti-insect** properties).

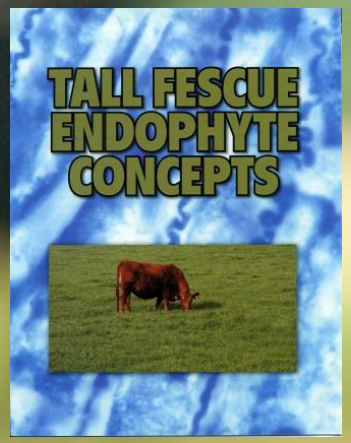
Endophytes produce **plant growth hormones** that result in better plant tillering and production.

Endophyte infection results in increased leaf rolling leading to **better drought tolerance** (mechanism unknown).



Classic dilemma: Animal health vs. pasture persistence





Answer: Increased research and extension efforts to inform producers and solve the problem.

Approaches to “Mitigate” Toxicity

- **Animal treatment**
- **Pasture management**
- **Cultivar and/or endophyte improvement**

Animal Treatment

Rescue efforts; treating the “symptoms” and not the problem

- Pharmacologic agents: metoclopramide, domperidone, etc.
- Feed treatment and additives: ammoniation of hay or supplementation with thiamin, selenium and copper, seaweed extract, etc.
- Animal breeding: selection for better performance when grazing toxic tall fescue forage.
- Immunologic protection: vaccines (proposed).

From Stuedemann and Thompson, 1993

Pasture Management

Treating the “symptoms” and not the problem

- Avoidance: switching to different pasture species and/or using hay of different forage species during vulnerable periods.
- Manage current E- tall fescue cultivars: summer management/rest.
- Inter-planting with legumes: dilution or nutrition?
- Remove E+ seedheads: close grazing, periodic clipping, or herbicide treatment.

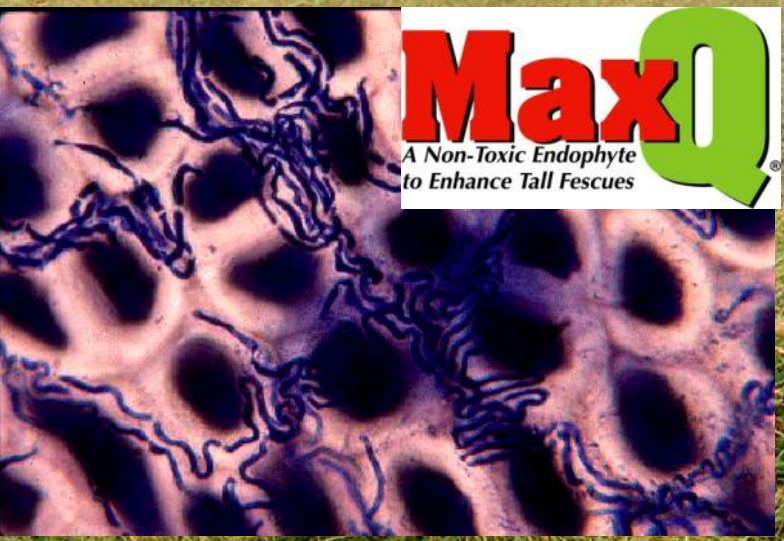
From Ball, 1997

Cultivar/Endophyte Improvement

Attacking the underlying problem

- Develop persistent E- cultivars.
- Reduce alkaloid levels to near zero via selection within current E+ plant/endemic strains populations.
- Selection and re-infection of naturally occurring, non-toxic (zero level) strains ("Novel" or "Friendly Endophytes") into elite tall fescue cultivars.
  - Goal: Remove toxic alkaloids (zero level in seed!); but retain stand persistence and productivity.

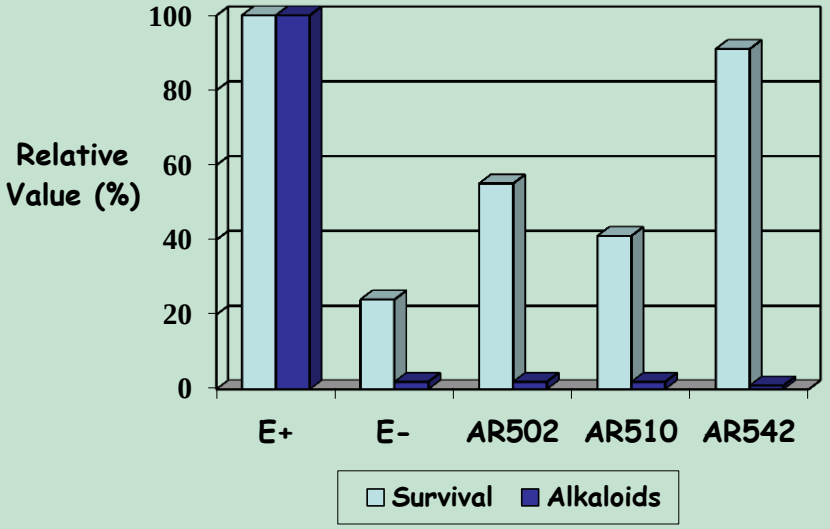
A non-toxic (“Novel”) strain was found that when re-infected into ‘Jesup’ tall fescue (a summer active, KY31 type) removed all measures of toxicosis and allowed the plant to remain persistent. The best strain (AR542) became MaxQ™.



MaxQ®
A Non-Toxic Endophyte to Enhance Tall Fescues

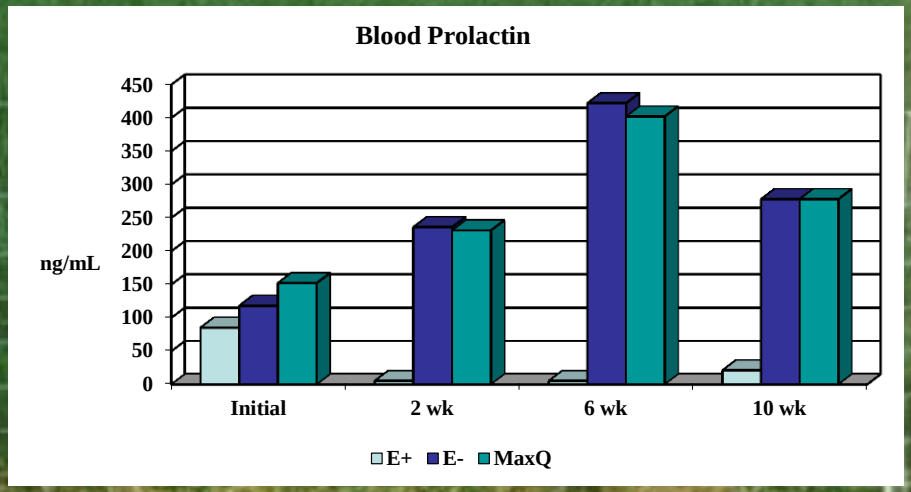

Why Jesup?
It was simply better than Kentucky 31 Over a Wide Geographic Area.

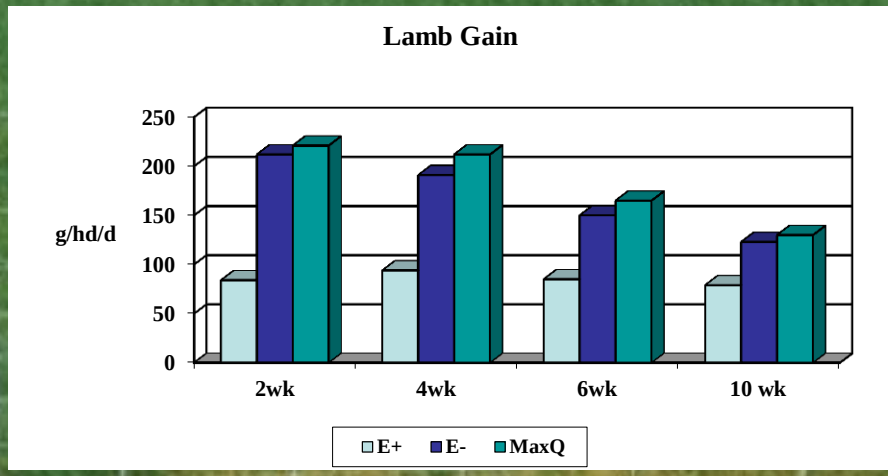
Proof of Concept: Strain Testing and Survival



Proof of Concept: Animal Safety Trials (Lambs)

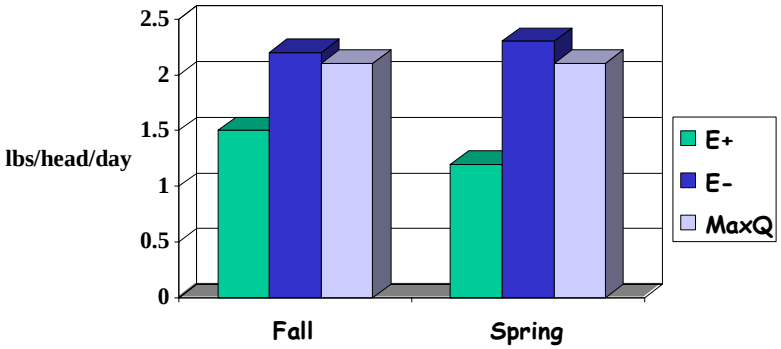
E +

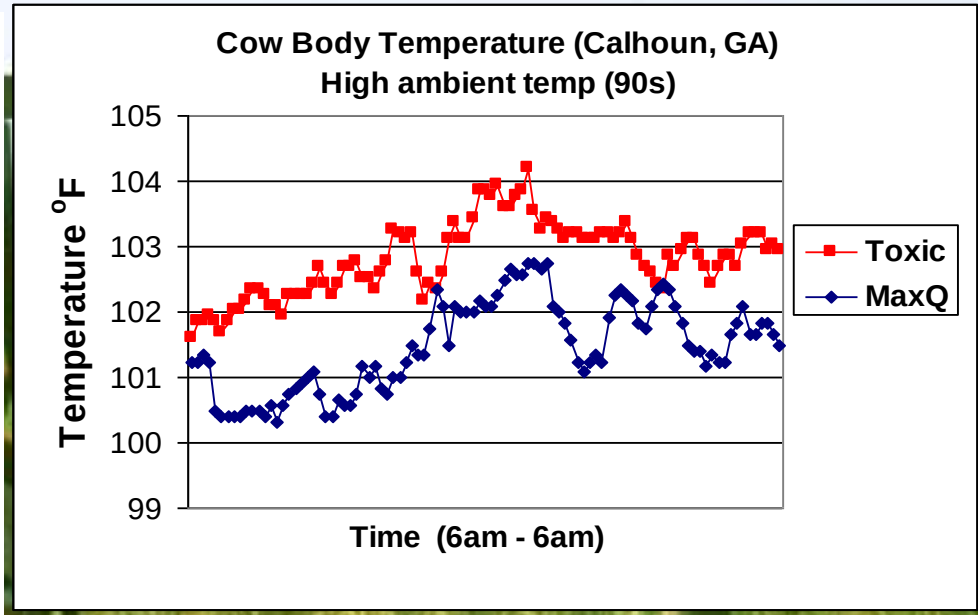




Proof of Concept: Beef Cattle

Gain of Beef Steers Grazing 'Jesup' Tall Fescue with Different Endophyte Strains in Central Georgia (2000-01)





TEXOMA

MaxQ II™

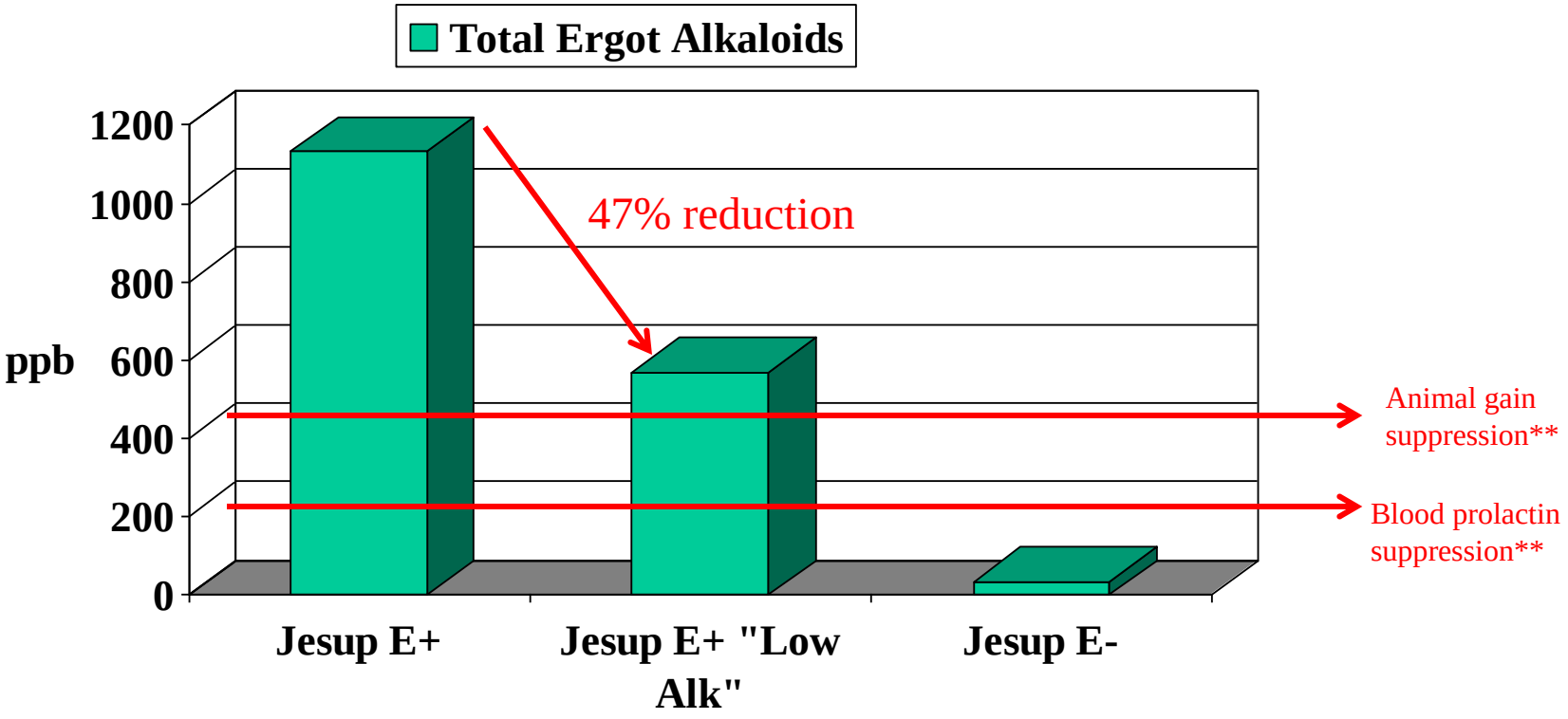
A Non-Toxic Endophyte to Enhance Tall Fescues

Texoma is continental type (summer active, KY31 type) tall fescue containing AR584 (more robust and long lived in the seed) novel endophyte that is more persistent after summer drought in western adaptation zones.

Cultural Change: "Grass is grass, right" and "I do not think I have a problem so why take a risk of replacing my pasture"?

What Alkaloid Levels Are You Willing to Accept?

Ergot Alkaloid Production Spring Average (1998-2000)*



*From Hill et al., Crop Sci, 2002)

**From Stamm et al. 1994

Reducing Alkaloid Levels in E+ Tall Fescue by Selection and Breeding

Cultivar	Sheep Avg. Daily Gain	Body Temp. *	Blood Prolactin
	g/head/day	*^{0} F*	*ng/ml*
Jesup E+	69 c	104.9	<1
Jesup E-	130 a	103.0	228
Jesup E+ "LowAlk"	100 b	105.6	<1

* Sampled on 2 May 2000.

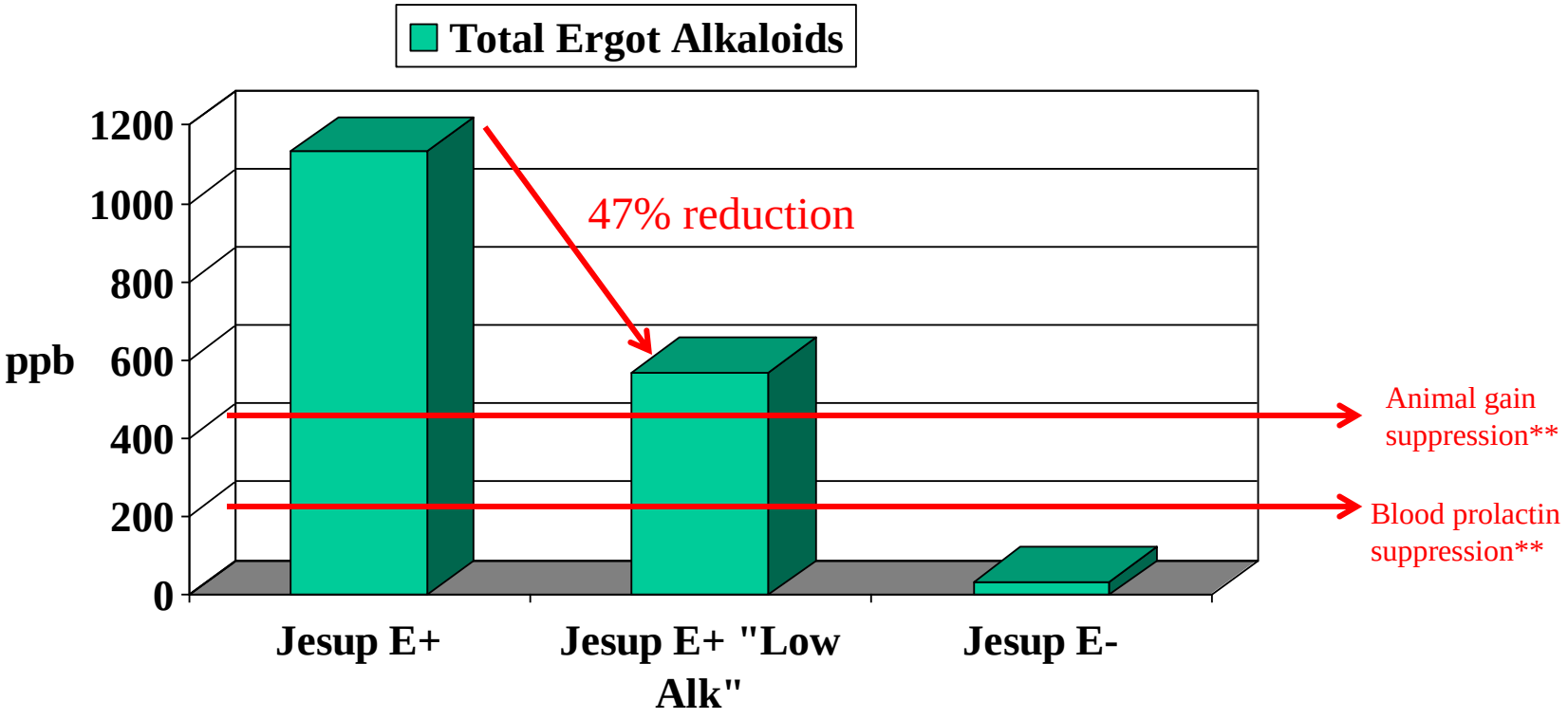
From Hill et al., Crop Sci, 2002)

Reducing Alkaloid Levels in E+ Tall Fescue by Selection and Breeding

Cultivar	Stand Survival	Yield
	%	*kg/ha*
Jesup E+	49 a	5697 ab
Jesup E-	11 c	5101 bc
Jesup E+ "LowAlk"	30 b	5450 abc

From Hill et al., Crop Sci, 2002)

Ergot Alkaloid Production Spring Average (1998-2000)*

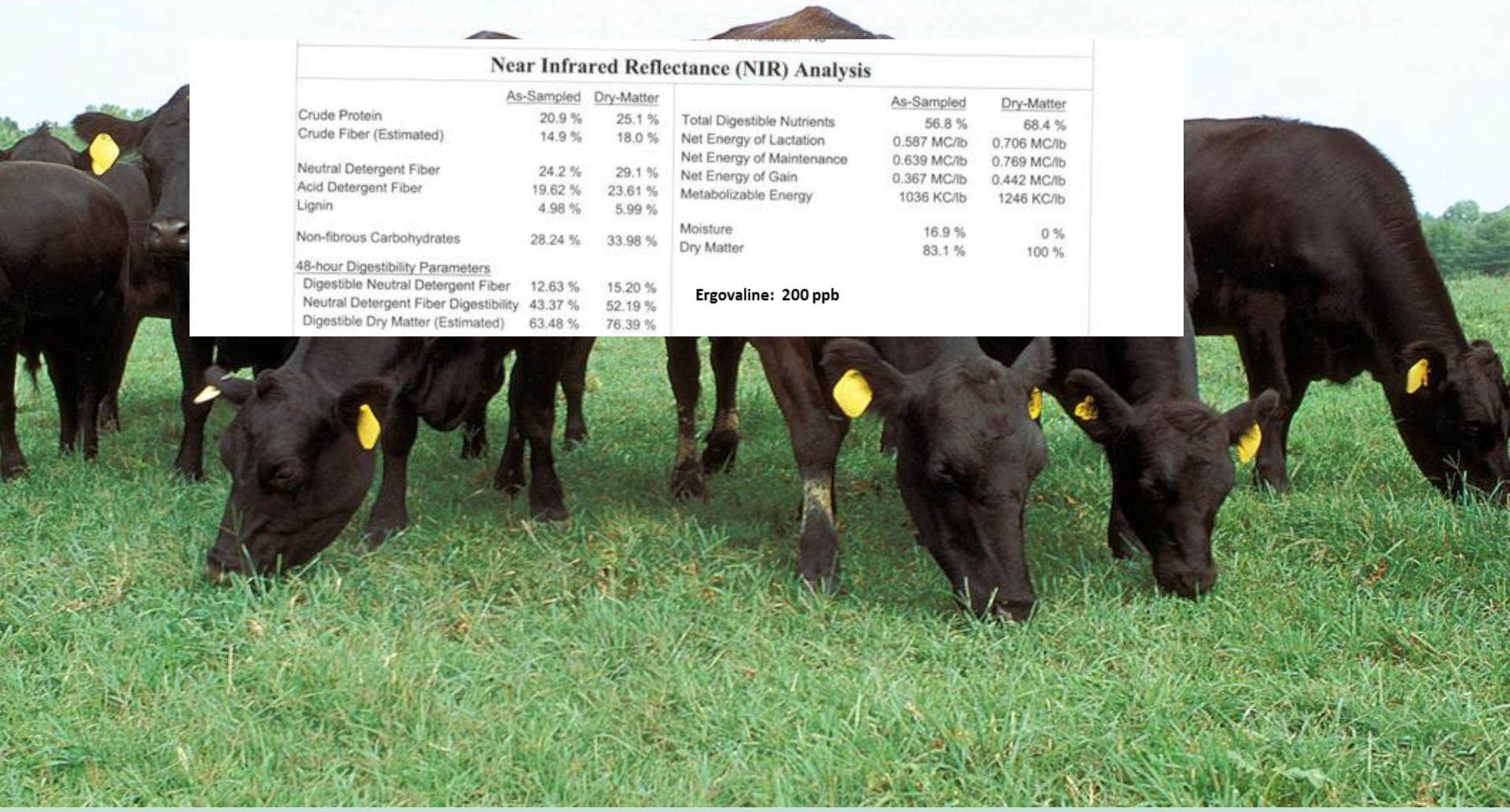


*From Hill et al., Crop Sci, 2002)

**From Stamm et al. 1994

"Our cattle producers have stated they want more research done with fescue. In doing so alkaloids need to be more of a parameter than infection level".
----Mark McCann

1. **We need more research to establish accurate "threshold" alkaloid levels.**
2. **We need to make ergovaline analysis a part of standard forage reports?**



Near Infrared Reflectance (NIR) Analysis

	As-Sampled	Dry-Matter
Crude Protein	20.9 %	25.1 %
Crude Fiber (Estimated)	14.9 %	18.0 %
Neutral Detergent Fiber	24.2 %	29.1 %
Acid Detergent Fiber	19.62 %	23.61 %
Lignin	4.98 %	5.99 %
Non-fibrous Carbohydrates	28.24 %	33.98 %
48-hour Digestibility Parameters		
Digestible Neutral Detergent Fiber	12.63 %	15.20 %
Neutral Detergent Fiber Digestibility	43.37 %	52.19 %
Digestible Dry Matter (Estimated)	63.48 %	76.39 %

	As-Sampled	Dry-Matter
Total Digestible Nutrients	56.8 %	68.4 %
Net Energy of Lactation	0.587 MC/lb	0.706 MC/lb
Net Energy of Maintenance	0.639 MC/lb	0.769 MC/lb
Net Energy of Gain	0.367 MC/lb	0.442 MC/lb
Metabolizable Energy	1036 KC/lb	1246 KC/lb
Moisture	16.9 %	0 %
Dry Matter	83.1 %	100 %

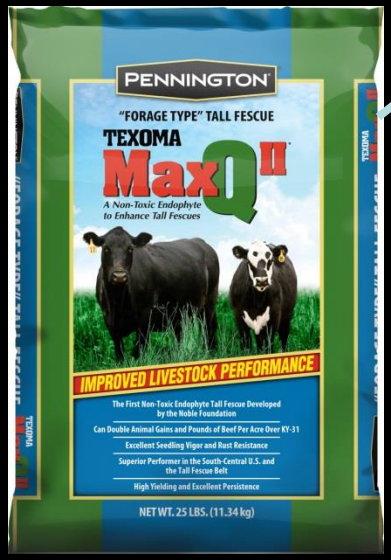
Ergovaline: 200 ppb

What Alkaloid Levels Are You Willing to Accept?

Answer: Manage to keep levels as low as possible

1. **sample pastures for current levels,**
2. **replace those pastures with toxic levels, and**
3. **when replacing use seed with zero level!**

How can I replace my toxic pastures?



"Spray-Spray-Plant" MaxQ Planting Protocol

Dr. John Andrae – UGA and Clemson Univ

- No seedheads in Spring
- Spray glyphosate 4-6 wks before planting
- Respray at planting
- Plant MaxQ no-till

Implementing new replacement protocols: A producer success story

Slide courtesy John Andrae, Clemson Univ


Slide courtesy John Andrae, Clemson Univ


Slide courtesy John Andrae, Clemson Univ

Slide courtesy John Andrae, Clemson Univ

Common concerns when replacing toxic tall fescue

Will stands "revert" back to toxic tall fescue?

Stands will retain a high % of non-toxic plants as long as:

1) Novel endophyte-infected stands are managed to maintain vigorous plants
2) Toxic seeds are not present in seedbank or introduced to field.

Slide courtesy John Andrae, Clemson Univ

Common concerns when replacing toxic tall fescue

How long do viable endophyte-infected seed remain in the soil?

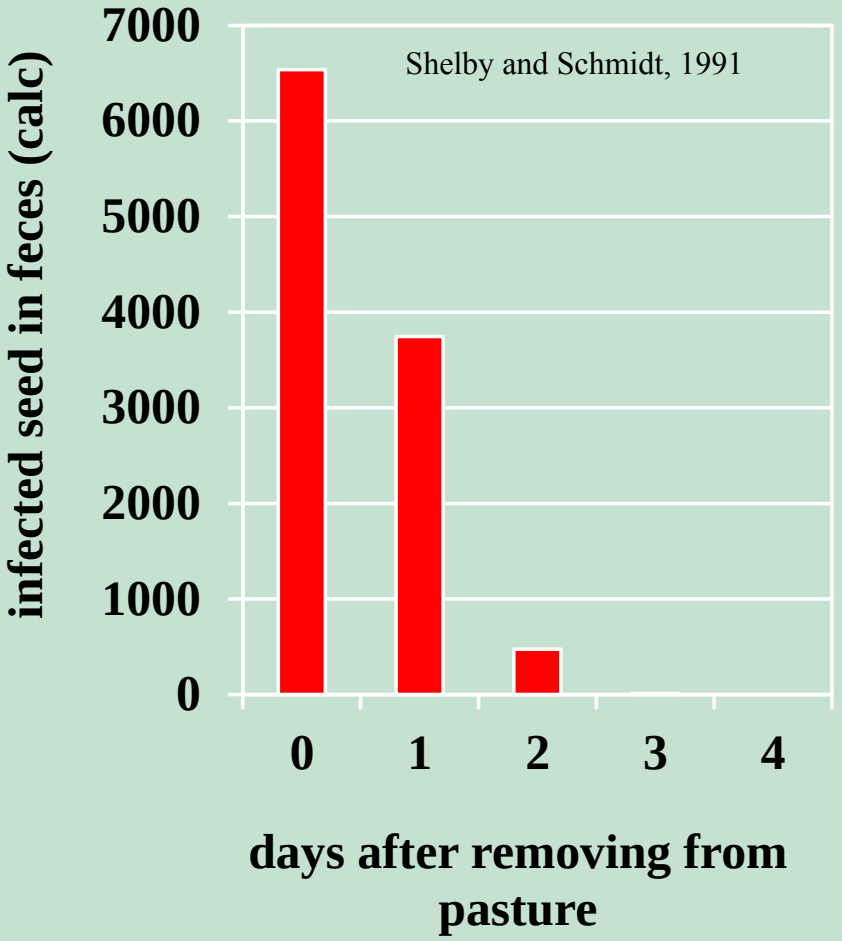
- Tall fescue seed appear to be viable for 15-18 months (Pedersen et al., 1984).
- Prevention of seed formation during spring of establishment year should minimize or eliminate seed contamination.

Slide courtesy John Andrae, Clemson Univ

Common concerns when replacing toxic tall fescue

Can toxic seed be imported in animals?

- Viable endophyte-infected seeds can be passed in feces of cattle for three days following removal from pasture.
  - Cleanout period of 2-3 days recommended.
  - Only an issue when seedheads are present



Slide courtesy John Andrae, Clemson Univ

Common concerns when replacing toxic tall fescue

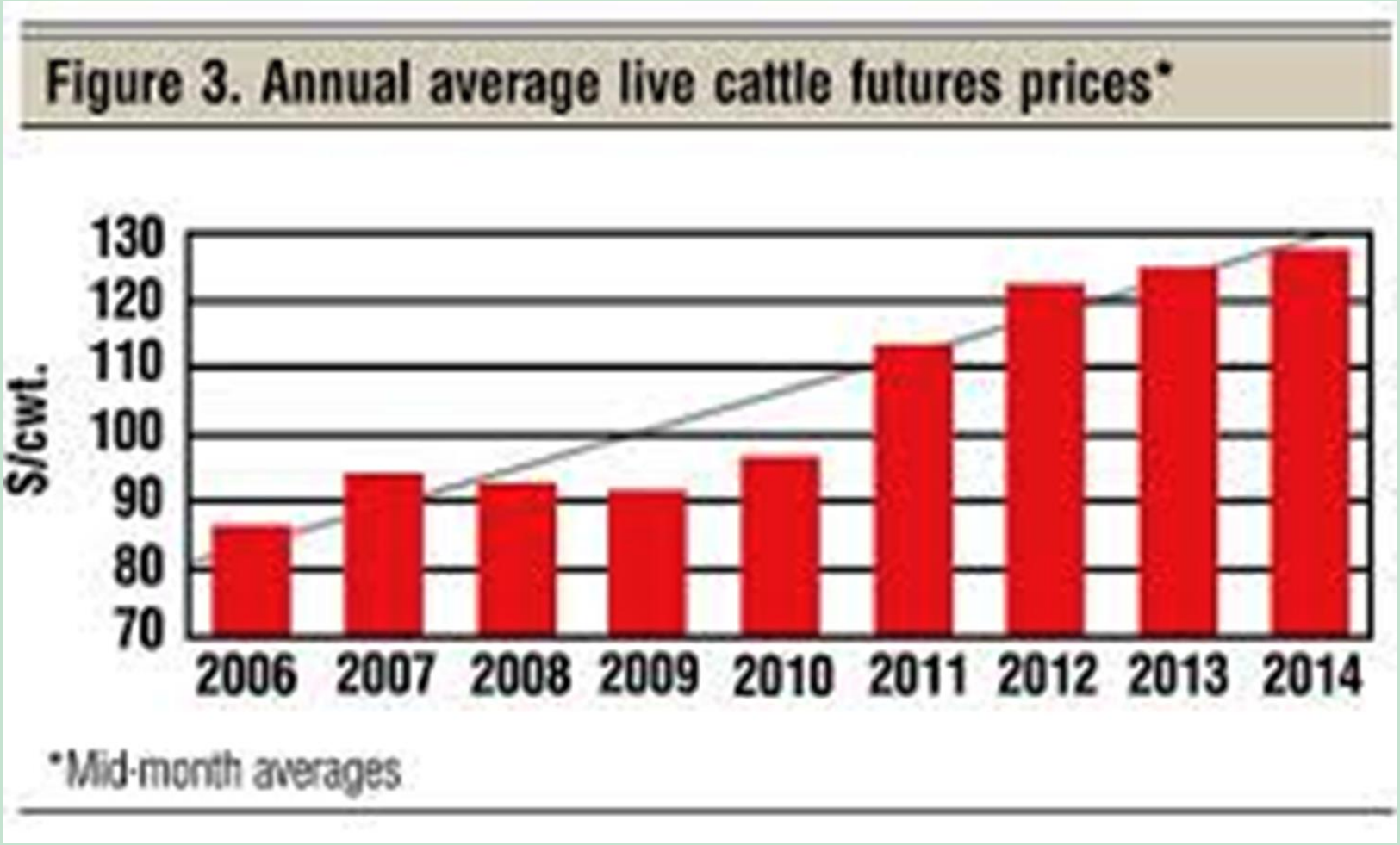
Can toxic seed be imported in hay?

- Overly mature hay can contain viable infected seed.
  - Hay feeding areas are normally disturbed and fertile
  - Feed toxic hay on toxic pasture only!

Photo by D. Barker, Ohio State

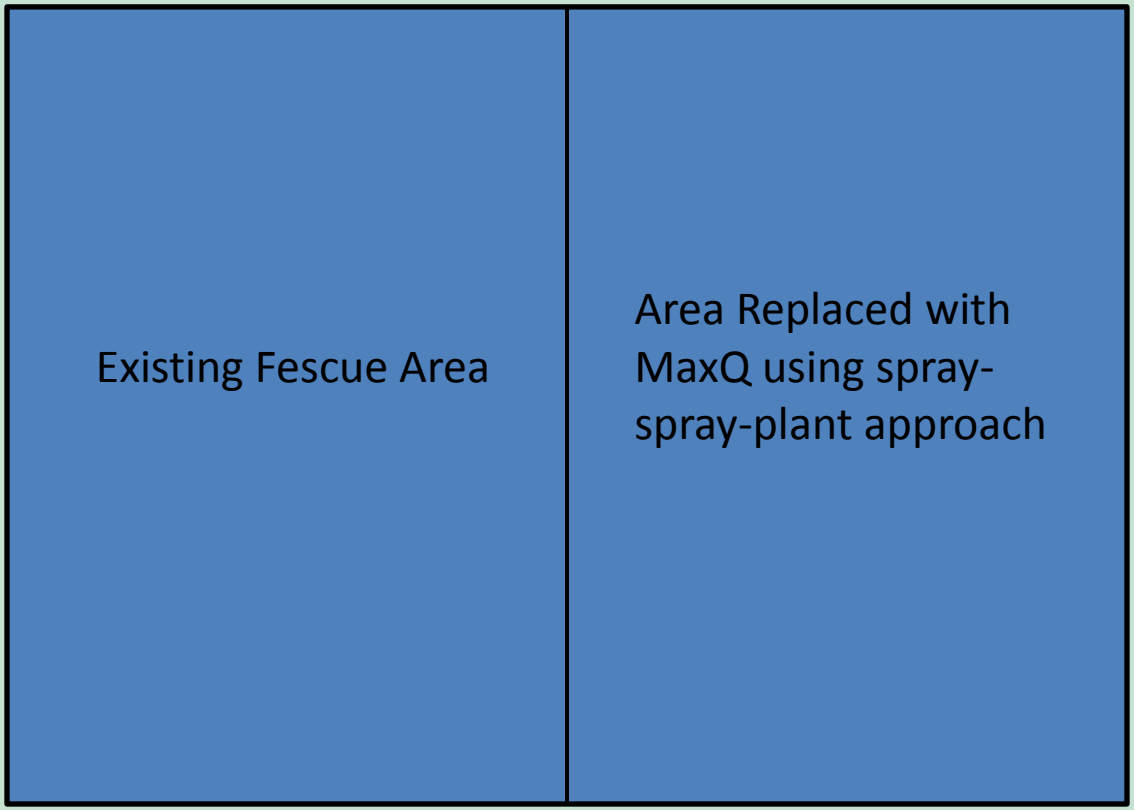
Slide courtesy John Andrae, Clemson Univ

With prices being good are toxic alkaloids costing you in lost income?



Source: beefmagazine.com

Still not convinced! "Do it yourself", on-farm trial
Strip planted in same pasture



Measurements to take and things to show

- Groups of matched animals assigned to each area
- Animal behavior supplemented with ergovaline reports and performance data
- Visible pasture "strength" supplemented with yield and persistence measures (optional).