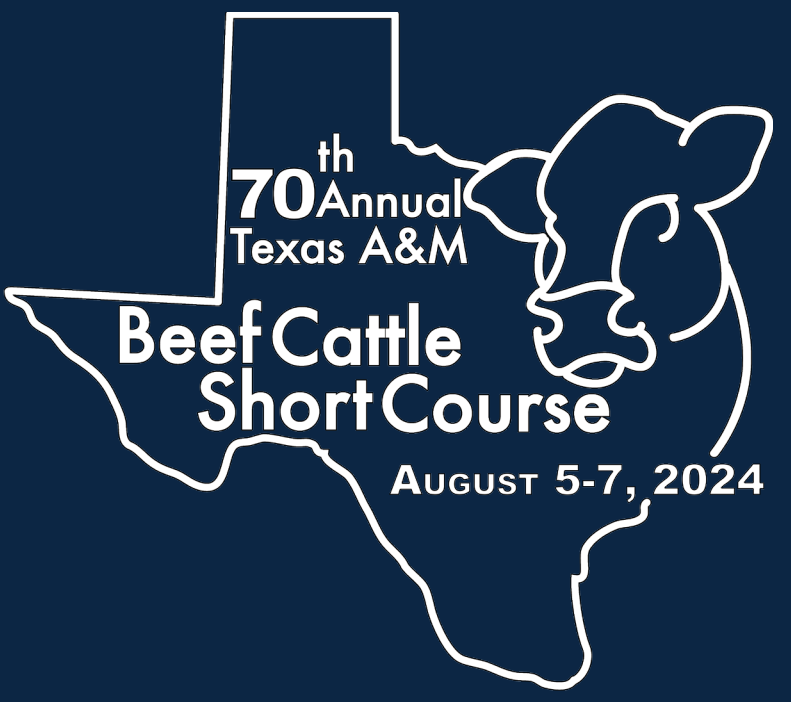
From Ground to Grazing: Mastering Soil Fertility & Forage Excellence

Coordinators: Dr. Vanessa Corriher-Olson
Dr. Larry Redmon
Dr. Monte Rouquette



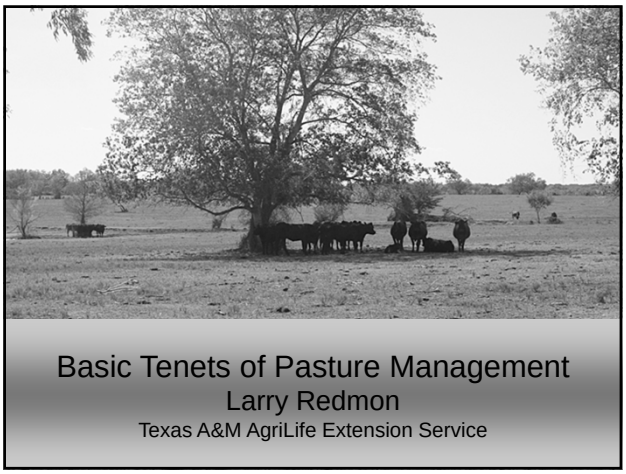
CORTEVA™ agriscience

LONE STAR®

Texas A&M AgriLife Extension

From Ground to Grazing: Mastering Soil Fertility and Forage Excellence

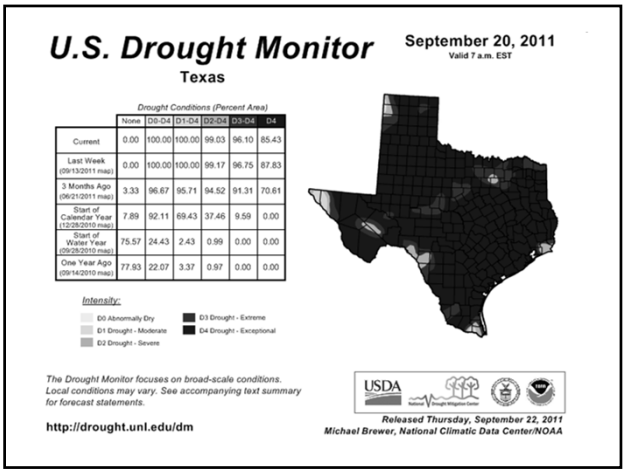
CAPITAL FARM CREDIT



Basic Tenets of Pasture Management

Larry Redmon
Texas A&M AgriLife Extension Service

1



U.S. Drought Monitor
Texas

September 20, 2011
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	99.03	96.10	85.43
Last Week (09/13/2011 map)	0.00	100.00	100.00	99.17	96.75	87.83
3 Months Ago (06/21/2011 map)	3.33	96.67	95.71	94.52	91.31	70.61
Start of Calendar Year (12/28/2010 map)	7.89	92.11	69.43	37.46	9.59	0.00
Start of Water Year (09/28/2010 map)	75.57	24.43	2.43	0.99	0.00	0.00
One Year Ago (09/14/2010 map)	77.93	22.07	3.37	0.97	0.00	0.00

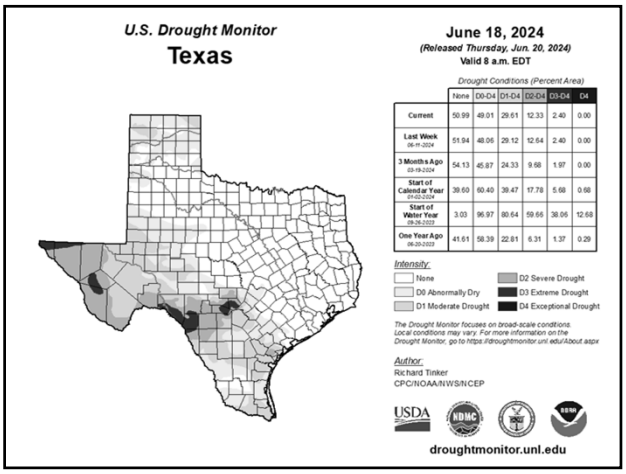
Intensity:
D0 Abnormally Dry
D1 Drought - Moderate
D2 Drought - Severe
D3 Drought - Extreme
D4 Drought - Exceptional

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://drought.unl.edu/dm

Released Thursday, September 22, 2011
Michael Brewer, National Climatic Data Center/NOAA

2



U.S. Drought Monitor
Texas

June 18, 2024
(Released Thursday, Jun. 20, 2024)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	50.99	49.01	29.61	12.33	2.40	0.00
Last Week 06-11-2024	51.94	48.06	29.12	12.64	2.40	0.00
3 Months Ago 03-19-2024	54.13	45.87	24.33	9.68	1.97	0.00
Start of Calendar Year 01-02-2024	39.60	60.40	39.47	17.78	5.68	0.68
Start of Water Year 09-26-2023	3.03	96.97	80.64	59.66	38.06	12.68
One Year Ago 06-20-2023	41.61	58.39	22.81	6.31	1.37	0.29

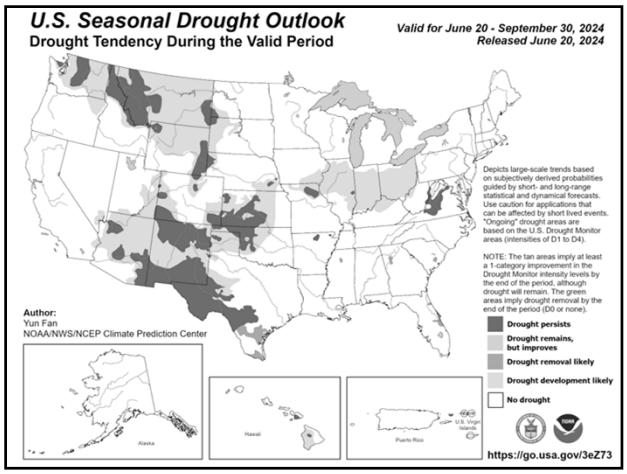
Intensity:
None
D0 Abnormally Dry
D1 Moderate Drought
D2 Severe Drought
D3 Extreme Drought
D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

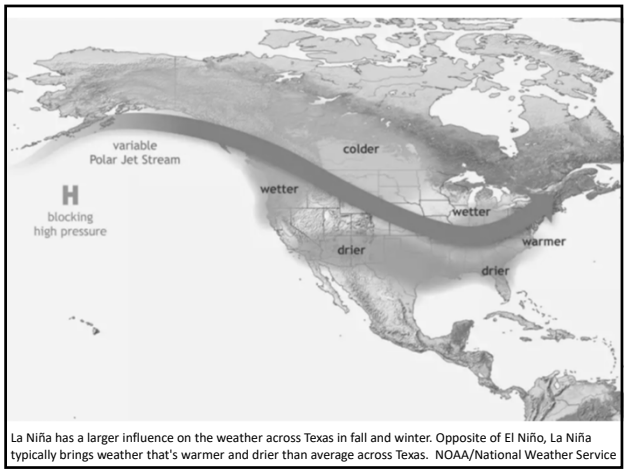
Author:
Richard Tinker
CPC/NOAA/NWS/NCEP

droughtmonitor.unl.edu

3



4



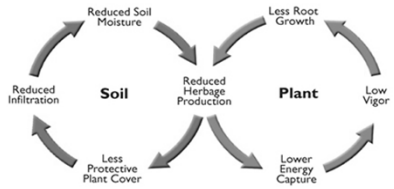
La Niña has a larger influence on the weather across Texas in fall and winter. Opposite of El Niño, La Niña typically brings weather that's warmer and drier than average across Texas. NOAA/National Weather Service

5

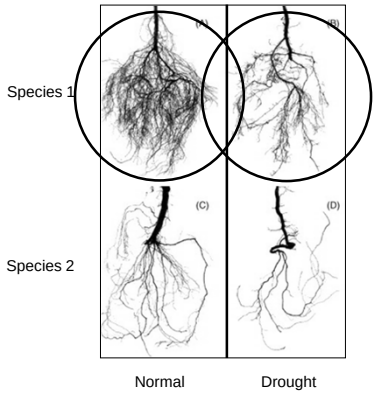
6

7

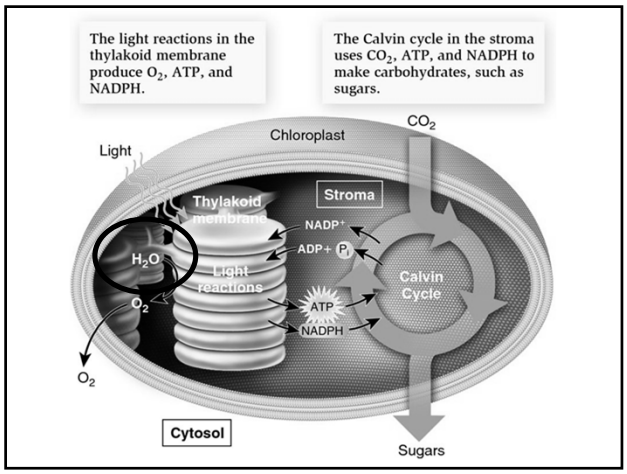
NOTE: Root systems are devastated due to drought…recovery involves rebuilding the root system.



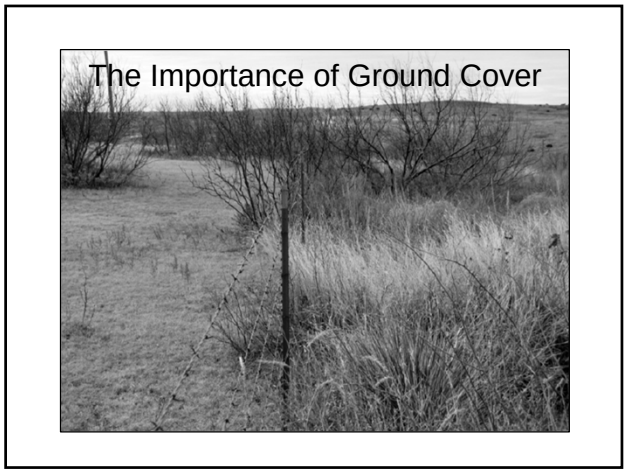
8



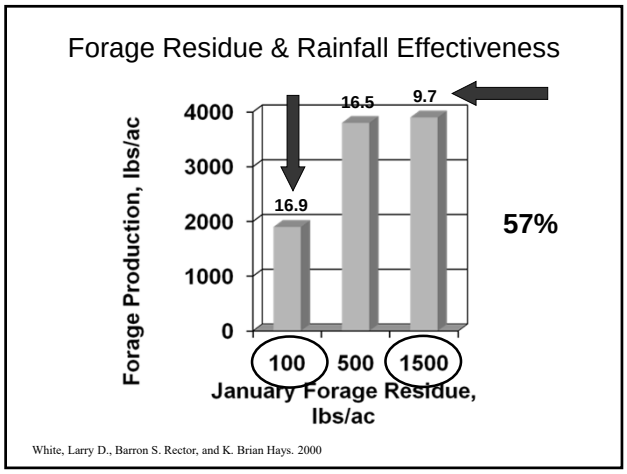
9


The light reactions in the thylakoid membrane produce O_2, ATP, and NADPH.
The Calvin cycle in the stroma uses CO_2, ATP, and NADPH to make carbohydrates, such as sugars.
Chloroplast
CO_2
Light
Stroma
Thylakoid membrane
NADP+
ADP+ P_i
H_2O
Light reactions
Calvin Cycle
ATP
NADPH
O_2
O_2
Cytosol
Sugars

10


The Importance of Ground Cover

11


Forage Residue & Rainfall Effectiveness
Forage Production, lbs/ac
4000
3000
2000
1000
0
16.9
16.5
9.7
57%
100
500
1500
January Forage Residue, lbs/ac
White, Larry D., Barron S. Rector, and K. Brian Hays. 2000

12

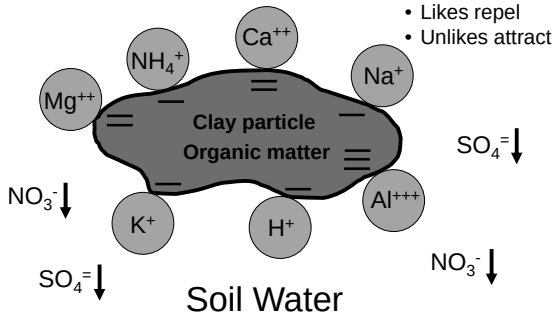
13

14

Effects of Soil Texture on Water Movement in Soil			
Soil Texture	Permeability	Water Retention	Inherent Fertility
Sand	**High**	**Low**	**Low**
Loam	Medium	Medium	Medium
Silt	Low	High	Medium
Clay	**Low**	**High**	**High**

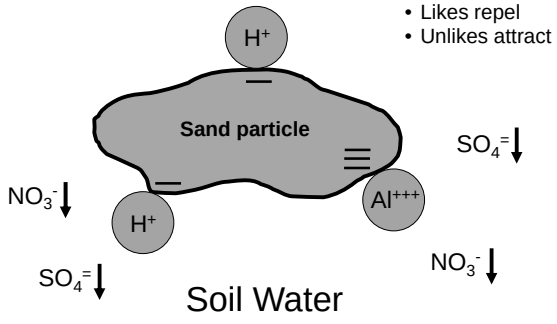
15

Cation Exchange Capacity (CEC)
(Nutrient Supplying Power of Soil)



16

Cation Exchange Capacity (CEC)
(Nutrient Supplying Power of Soil)

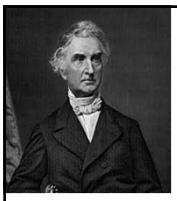


17

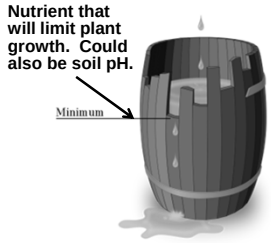
Recent Fertilizer Prices

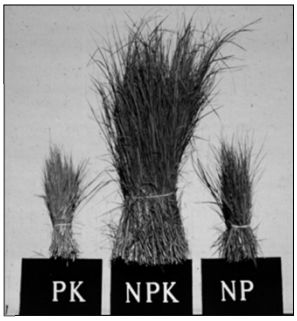
- Ammonium Nitrate (34-0-0) $530.00/ton (up $10)
- Urea (46-0-0) $620.00/ton
- DAP (18-46-0) $860.00/ton (down $40)
- Potassium (potash, 0-0-60) $515.00/ton
- Urea ammonium nitrate (32-0-0) $355/ton (up $75)
- KMAG $530/ton

18



Liebig's Law of the Minimum (*circa* 1828)





19

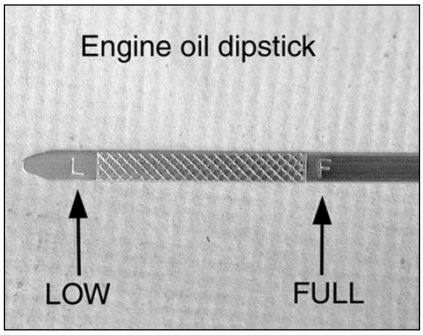
Can we do anything about the high cost of fertilizer?

But, we can do something about how efficiently we use fertilizer.

NO

20

The simple, yet profound, dipstick



21

Use the soil “dip stick”…

- Soil Test!
  - Fertilizer needs to be out before the rain…
- Without soil testing you:
  - Over-apply expensive nutrients,
  - Under-apply needed nutrients,
  - Never apply the correct amount.

22

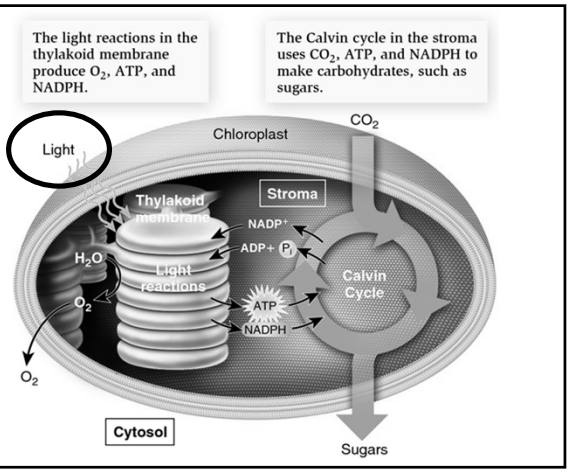
Consider your forage base

- Bahiagrass, dallisgrass, kleingrass, natives, others…
  - Persistent under low-input management
  - Will not support the stocking rate as well-managed bermudagrass
  - With hay harvest, all species must be fertilized based on soil-test recommendation; might as well keep bermudgrass for hay

23

Protection

24



25

Protection from Weeds

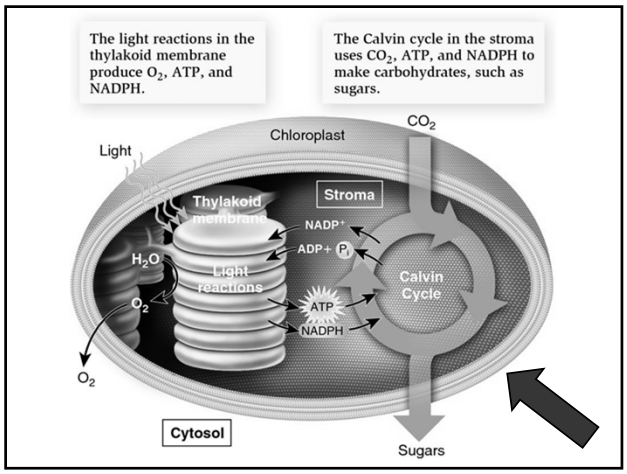
- Heavy weed pressure:
  - Inhibits photosynthesis, which requires sunlight and green leaf tissue.
  - Reduces **recovery** potential due to competition for sunlight, moisture, nutrients…
  - With good growing conditions, use herbicides; otherwise mow.

26

Protection from Winter Pasture

- Failure to remove
  - Inhibits photosynthesis.
  - Can slow emergence.
  - Can destroy warm-season grass.
- **Remove** winter pasture before greenup!
  - Bermudagrass begins active growth when nighttime temperatures are consistently 60°F.
  - Graze or bale.

27



28

Protection from Grasshoppers

- Dimilin
  - Applied to young hoppers
  - Has ~30-day residual
  - 1-day haying restriction, no grazing restriction
- Malathion + Sevin XLR
  - 4 oz of each product/ac
  - **14-day** grazing or haying restriction
  - Only apply **2X** per year
- Mustang
  - No grazing or haying restriction
- Tombstone
  - No grazing or haying restriction
  - Pyrethroid
- Lambda-Cy
  - No grazing restrictions; 7-day haying restriction

Vantacor – FMC – no grazing or haying restrictions.

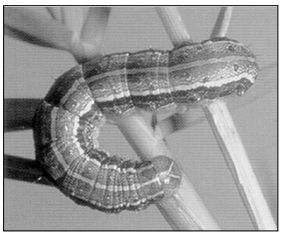
29

30

31

Protection from Fall Armyworms

- Grizzly
  - Pyrethroid
  - No grazing restriction, 7-day haying restriction
- Malathion + Sevin XLR
  - 4 oz of each product/ac
  - **14-day** grazing or haying restriction
  - Only apply **2X** per year
- Mustang
  - No grazing or haying restriction
- Tombstone
  - No grazing or haying restriction
  - Pyrethroid product
- Lambda-Cy
  - No grazing restrictions; 7-day haying restriction



Vantacor – FMC – no grazing or haying restrictions.

32

Protection from Livestock

- **Remain destocked, maintain the reduced stocking rate, or consider further reductions**.
  - Consider drought management as part of the overall strategy.

33

Root-growth stoppage resulting from defoliation of grass. 1955. Franklin J. Crider

Table 1

	% Root Growth Stoppage Three Days After Forage Removal			
% Forage Removal	Test 1	Test 2	Test 3	Test 4
90	100	100	100	100
80	100	100	91	81
70	78	97	77	76
60	50	80	54	36
50	2	8	38	13
40	0	0	0	0
30	0	0	0	0
20	0	0	0	0
10	0	0	0	0
0	0	0	0	0

This represents four tests with three different grass species. From Crider, 1955.
Note that somewhere between 40% and 50% of the forage can be removed without stopping root growth.

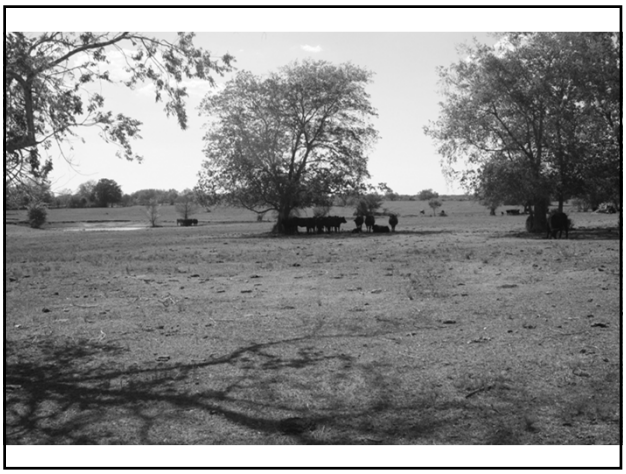
34

Figure 2. From Franklin Crider 1955- As grazing pressure increases, root mass decreases. Notice the second plant from the left has about 50% of its top growth removed, and root development is relatively unaffected, but a small increase in grazing pressure leads to a dramatic loss of root development for the 2 plants on the right..

35

A Tale of Two Grazing Philosophies

36



37

38

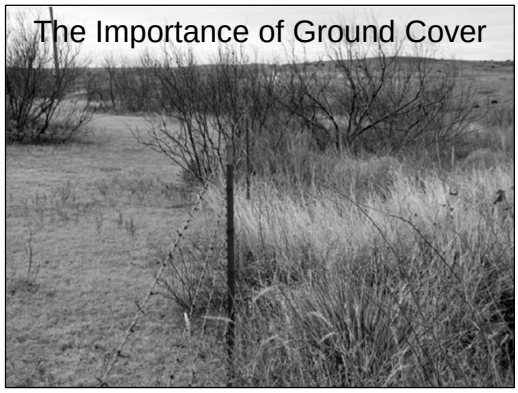
Be slow to increase stocking…

Impacts of drought take a while to recover from.

Plants need time to re-establish adequate root systems.

39

The Importance of Ground Cover

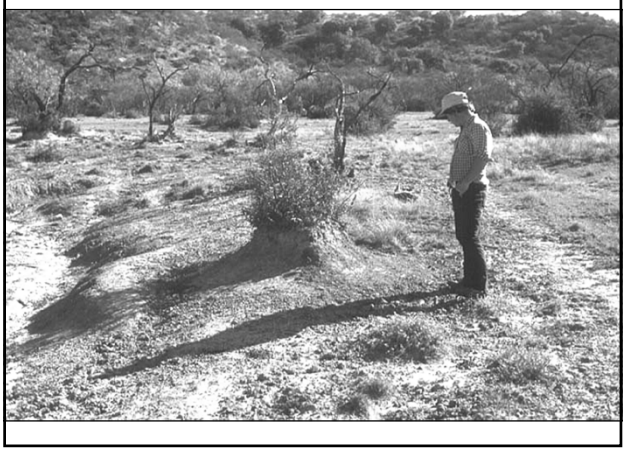


40

Finally…protect the soil…

- Without adequate ground cover besides losing water, you **lose:**
  - **Topsoil**
    - Hundreds to > 1,000 years to create 1”
  - **Fertilizer nutrients**
    - Money *literally* goes down the creek
  - **Organic matter**
    - We’re working hard to capture carbon…
  - **Bacteria**
    - Primary source of waterbody impairment in Texas

41



42

Is re-establishment necessary after the drought?

- Is livestock production still of interest?
- Is there a desire to change enterprises?
  - Different livestock species?
  - Move to hay production?
  - Transition to wildlife management?
- Is there a desire to change forage base?

43

Assess the Damage

- How extensive is the damage?
- Has adequate precipitation occurred or is occurring at the location?
- What is the potential for recovery?
  - Has the stocking rate been adjusted appropriately?
  - What is the forage base? Variety?
  - Resources available to the producer?

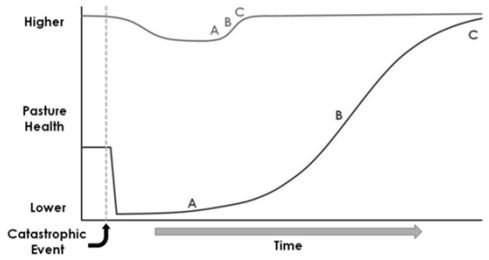
44

Establishment/Re-establishment

- Species
- Timing
- Seedbed Preparation
- Pre-plant Fertilizer
- Planting Depth
- Planting Rate
- Post-plant Fertilizer
- Post-plant Management
  - Grazing/harvest/weeds/insects

45

A Tale of Two Pastures: Pasture Response to Catastrophic Events[1]



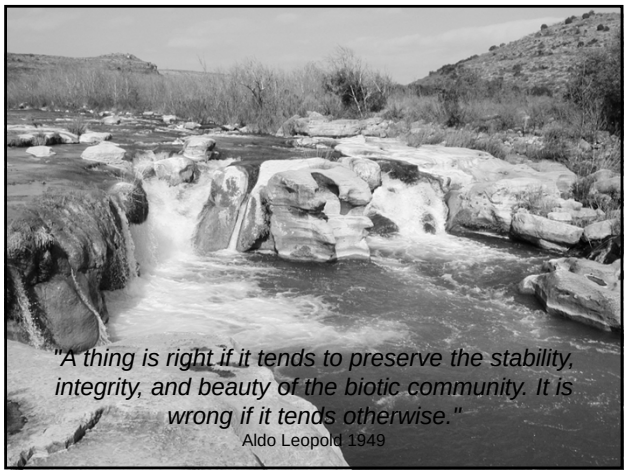
[1] Justin Morris and Linda Poole, Producers Voice, April 2022

46

Summary

- Adequate moisture
- Fertility
- Protection
  - From grazing livestock, weeds, winter pasture, insects
  - Soil protection
- Re-establishment may be necessary

47



48

Think forage…

TEXAS A&M AGRILIFE EXTENSION

Questions?

49

Forage Legumes for Texas 2023

G. R. Smith and F. M. Rouquette, Jr.
Texas A&M AgriLife Research
Overton, Texas

The successful use of forage legumes in Texas livestock production systems and as supplemental forages for Texas wildlife is influenced by: seasonal rainfall; competition with grasses and weeds; soil type; drainage; and ecoregion location.

Grasslands are primarily composed of grasses and legumes. Forbs and shrubs are also part of the grassland ecosystem on rangeland. Species in the grass and legume families are divided into annuals, perennials, and biennials and each of these categories is further divided into cool- and warm-season forages. Annuals germinate, grow, and mature in one growing season and therefore must be established from seed each year. Perennials have the ability to live more than one year under appropriate climatic conditions. They usually die back (go dormant) sometime during the year and then initiate new growth from roots, rhizomes, or stolons. Biennials require two growing season to complete their life cycle with the first season devoted to vegetative growth and flowering occurring in the second season. Warm-season forages begin growth in the spring and die or go dormant in the autumn with the first killing frost. Cool-season forages generally begin growth in autumn and mature or go dormant in late spring or early summer. A general description of each forage legume class and adaptability of each species and a list of varieties follows.

Cool-Season Annual Legumes

Cool-season annual legumes are the most extensively used legumes in the southeastern United States. They are usually overseeded on warm-season perennial grasses either alone or in mixtures with annual ryegrass. In addition to providing forage with high nutritive value during the spring they can add nitrogen to the pasture system through N_2-fixation in association with Rhizobium bacteria. Other benefits are spring weed control, nitrogen source for organic farming systems, and as supplemental forages for wildlife. They are more soil specific than grasses and generally require a minimum soil pH of 6.0. They must establish from seed each autumn but some of the species have a high percentage of hard seed that permits volunteer reseeding if managed properly.

Annual Medics - The annual medics are a group of species belonging to the Medicago genus that are native to the Mediterranean region. They are annual relatives of alfalfa. Most species are best adapted to soils with a pH of 7 and higher and persist in lower rainfall areas than most clover species if rainfall occurs in late autumn and winter. Annual medics are more active winter growers than most annual clovers but most annual medic species also lack cold tolerance, which limits their northern adaptation. They produce small yellow flowers that mature into pods. Some of the species found in the United States form

spines of various lengths and some do not. Individual plants may produce over a thousand seed pods.

Annual medics are dependable reseeders because they produce a high level of hard seed and have excellent seedling vigor. This excellent seedling vigor makes them one of the easiest winter annual legumes to establish. Annual medics can easily establish with a light disking, broadcast seeding, and then dragging the pasture to cover the seed. These hard seed can remain viable in the soil for several years. Annual medics do have a high bloat potential. However, this can be overcome by proper management of livestock and providing other forage to the grazing animals such as frosted mature grass, hay, or planting ryegrass with the medic.

Annual medics are excellent winter forages for domestic livestock and wildlife. One thing that makes medics well adapted as a grazing crop is that they generally have a prostrate growth habit and will flower and set a good seed crop even under heavy grazing pressure. Most commercial varieties in the world have been developed in Australia, and as a general rule, most Australian varieties lack winter hardiness needed to persist in Texas.

Burr medic, or burr clover, *(M. polymorpha*) was introduced sometime in the ninetieth century and has become naturalized in South Texas and the West Coast. 'Armadillo' burr medic, was selected from a naturalized ecotype in South Texas, and was released by the Texas Agricultural Experiment Station at Beeville in 1998. Armadillo is adapted south of I-20 in Central and South Texas. Recommended seeding rates are 5 to 10 lbs per acre. Armadillo does well when grown with bermudagrass and kleingrass providing the perennial grasses are managed to be grazed short in the autumn to allow the seedlings to establish.

Barrel medic (*M. truncatula*) is less winter hardy than Armadillo burr medic, but some Australian varieties perform well in South Texas. The barrel medics are somewhat better adapted to the high pH sandy soils of Central and South Texas than Armadillo burr medic. The old variety 'Jemalong' has been recommended in South Texas for 10 or more years. There is a new cultivar, 'Jester', that was selected out of Jemalong and it has been performing nearly like Jemalong. Jester and Jemalong mature about 2 weeks later than Armadillo and is recommended from about Austin southward. Another cultivar that is only recommended in deep South Texas is Parabinga. Parabinga is a very active winter grower and matures 2 weeks before Armadillo, so has performed well in the hot drier areas of deep South Texas. Recommended seeding rates on barrel medic are similar to Armadillo.

Spotted burr medic (*M. arabica*) is more cold tolerant, better adapted to sandy soils that are slightly acid than most other medics. At the present time there are no commercial varieties available.

Black medic (*M. lupulina*) is common from South Texas north to Canada. It is the predominant annual medic on much of the blackland soils of Texas. Black medic develops a smooth black cluster of pods with normally only one seed per pod. The only commercial varieties currently available are not well adapted to Texas as they were developed for more northern regions. However, if you

have a naturalized stand of black medic, it can be encouraged to contribute to your winter and spring forage base if you manage to allow it to reestablish itself in the autumn.

Button medic (*M. orbicularis*) has a large flat smooth pod and is best adapted to the north central Texas. 'Estes' button medic is currently being marketed for North Central Texas. A problem that is unique to this species is that the pod is very large and fleshy, and it is highly palatable to deer. Nearly complete removal of all pods has been observed when using this legume in deer food plots.

Little burr medic (*M. minima*) has become naturalized in the Texas Hill Country and have smaller leaves and smaller seed than most medics. The pods have long spines and the plant is very pubescent. Devine little burr medic was released in 2005 by Texas Agricultural Experiment Station at Beeville. Devine originated from a kleingrass pasture near Devine, TX, and is best adapted in the I-35 corridor from south of San Antonio to nearly the Oklahoma border. Recommended seeding rates are 3 to 5 lbs per acre. Devine grows well with most perennial grasses provided the grasses are managed to be grazed short in the autumn to allow the seedlings to establish.

Arrowleaf clover (*Trifolium vesiculosum* Savi) is one of the major annual clover species grown in the southeastern U.S. It has large white flowers with a pinkish cast and can grow over 4 ft tall if not grazed or cut. Arrowleaf clover is best adapted to well drained loam and sandy soils but is more sensitive to soil pH than other legumes with a preference of 6.5 to 7 pH. Iron chlorosis can be a problem on soils with a pH above 7.5. Arrowleaf clover is the latest maturing, and usually the highest yielding annual clover with growth continuing through June if moisture is adequate. Seedling growth is slow with seedlings staying in a rosette stage until late February. This results in very little forage production until early March. Arrowleaf clover has excellent reseeding potential with up to 90% hard seed. Volunteer stands may be poor the first reseeding year because of the low percentage of soft seed. Only scarified seed should be planted at 8 to 10 lb/acre. Planting an additional 4 to 5 lb/acre of scarified seed the first reseeding year will ensure that an adequate amount of soft seed is present to obtain a good stand.

Virus diseases are a major problem with older varieties like Yuchi. Leaves of affected plants will be crinkled, have a light and dark green mosaic pattern, and a chlorotic appearance. Root rots have also been a problem. Early symptoms are poor stands in the autumn because of seedling loss. Surviving plants will do poorly during the winter because of root damage and may die when grazing begins. Leaves of arrowleaf clover may turn red because of stress due to disease, low temperatures, or other environmental factors. Early planting from mid-September to mid-October has also improved seedling survival against these diseases. 'Apache' arrowleaf released in 2001 has tolerance to bean yellow mosaic virus disease. 'Blackhawk' arrowleaf clover was released in 2012 and is tolerant to both bean yellow mosaic virus and fungal seedling diseases. Both Apache and Blackhawk are recommended varieties.

Ball clover (*Trifolium nigrescens* Viv.) has small ovate leaflets and small white to yellowish-white flowers. If not cut or

grazed, stems can grow up to 3 feet and are prostrate to partially erect, often forming a thick mat. This prevents using ball clover for hay and makes harvesting seed difficult unless it is grazed before flowering. Seed are very small (approximately 1,000,000 per lb) with a recommended seeding rate of only 2 to 3 lb/acre. Ball clover does best on loam and clay soils but has done well on relatively level sandy soils near creek or river bottoms that maintain good soil moisture. It does not have good drought tolerance and growth will be reduced in a hot, dry spring. It prefers a soil pH of 6 or higher. Ball clover can tolerate wet soils but not as well as white clover. It is medium maturity, flowering about a month later than crimson with yields usually slightly less than crimson.

Ball clover has excellent reseeding. Hard seed content is about 60% and it will produce some flowers even under close grazing. Ball clover does have a high bloat potential and should be managed accordingly. Since there are no commercial varieties at this time only common ball clover seed is available.

Berseem clover (*Trifolium alexandrinum* L.) also called Egyptian clover, is believed to have originated in Syria. It was introduced into the Nile Valley in Egypt in the 6th Century and is now grown on half the cultivated land in that country as a winter cover and green manure crop. It has oblong leaflets, hollow stems, large white flowers, and can grow up to 2.5 ft. tall. Berseem clover is not as cold tolerant as the other annual clovers. Bigbee berseem, a joint release by the USDA and the Mississippi Agricultural and Forestry Experiment Station in 1984, has improved cold tolerance. However, even Bigbee berseem is considered less cold hardy than most of the other annual clover species.

Berseem clover is well adapted to river bottoms and clay soils with a pH of 6 to 8. Berseem clover has medium size seed with 207,000 seed/lb. Recommended seeding rate is 12 to 16 lb/acre. Bigbee berseem has excellent seedling vigor with growth 8 to 10 inches tall by December if planted on a prepared seedbed in late September or early October along the Gulf Coast. Grazing should begin when it is 6 to 8 inches tall to stimulate tillering and limit frost damage. Bigbee berseem clover begins flowering in late April. It does well under irrigation in southern California. Bloat potential of berseem clover is low but animal losses due to bloat have been reported. It lacks hard seed and therefore is a poor reseeder. Berseem clover has poor drought tolerance.

Crimson clover (*Trifolium incarnatum* L.) is native to Europe and is the most widely adapted annual clover species grown in the southeastern United States. It has scarlet or deep red flowers and is used extensively for roadside stabilization and beautification throughout the southeastern United States. Crimson clover grows on soils ranging from sands to well-drained clay soils with a pH of 5.5 to 7. Best growth occurs at a pH of 6 to 7. Iron chlorosis has been a problem on calcareous soils at a pH of 7.3 or higher. Recommended seeding rate is 16 to 20 lb/acre. Crimson clover is one of the larger seeded annual clovers with 150,000 seed/lb and has excellent seedling vigor. If planted early, it can produce some forage in the autumn and has earlier forage production in the spring than the other clover species. However, winter temperatures about 15°F or lower have caused some top kill that will reduce early spring growth.

Crimson clover is the earliest maturing annual clover. The combination of good seedling vigor and early maturity makes it ideal for overseeding warm-season perennial

grasses. Present crimson clover varieties are considered poor reseeders because hard seed levels are only about 10%. Most soft seed germinate with the first rain after seed matures in May. Range in maturity of present varieties is about 12 days. Flame and AU Robin are early varieties and Tibbee and Dixie are late varieties.

Persian clover (*Trifolium resupinatum* L.) is native to Asia Minor and the Mediterranean region. The actual time of introduction into the United States is not known, but it was found growing in Wilcox County, Alabama in 1923. Common Persian clover has small leaves and reaches a height of 8 to 12 in. with small, light purple flowers. It is found on loam and clay soils, especially on poorly drained soils with soil pH of 6 to 8. Seedling growth is best at a pH of 7 to 8. Persian clover spreads during flooding because the calyx swells at seed maturity and serves as a float, allowing the seed to move to other flooded areas. It does have high bloat potential. Recommended seeding rate is 6 to 8 lb/acre. The seed are small with 600,000 seed/lb. The only available varieties are from Australia.

Rose clover (*Trifolium hirtum* All.) is native to the Mediterranean region and Asia Minor and is one of the few clover species that is adapted to lower rainfall areas. Most of the rose clover acreage is on the California rangelands that receive at least 10 in. of rain during the winter growing season. Overton R18 was selected for climatic and soil conditions in the southeastern US at the Texas A&M University Agricultural Research and Extension Center at Overton. It matures 4 weeks later with twice the production compared to the early varieties grown in California and Australia. Rose clover is adapted to all soil types with a pH of 5.5 or higher but does not tolerate poorly drained soils. Some iron chlorosis problems have been reported on calcareous soils with soil pH near 8.0. Optimum pH for seedling growth is 5.5 to 7.0. Recommended seeding rates are 12 to 16 lb/acre. Rose clover has a medium size seed with 164,000 seed/lb. Poor seedling growth and nodulation is a major limitation of rose clover that results in later spring growth than the other legume species.

The greatest success with rose clover has been in North Central Texas and Central Oklahoma where the annual rainfall is 25 to 30 in., which limits the growth of most other clovers. The good drought tolerance is due to a deep rooting depth. Rose clover is an excellent reseeder because of a hard seed percentage of 90%. California data have shown that if volunteer clover stands are lost to drought or insects several years in a row, there would still be sufficient hard seed remaining to reestablish the rose clover stand.

Subterranean clover, also called subclover, is native to the Mediterranean region. Subterranean clover is the common name for three Trifolium species, subterraneum, brachycalcycinum, and yanninicum. Most varieties grown in the United States are subterraneum species. Subclover is best adapted to soils ranging from a fine sandy loam to clay with a pH from 5.5 to 7. Like arrowleaf, it usually becomes chlorotic and stunted on soils with a pH above 7.3. The brachycalycinum species of subterranean clover is adapted to soil pH's above 7.0 but has less cold tolerance. Subclover has a low growth habit which forms a dense sod that seldom exceeds a 10-in. height. Its short height is deceiving. Forage yield of a 5- to 6-in. high subclover pasture is similar to a 12-in. high arrowleaf clover pasture. Reseeding of subterranean clover is generally poor in Texas.

Annual Sweetclover (*Melilotus albus* Medik.) is not a true clover but is an excellent forage legume. At one time, it was the most widely grown forage legume in the United States. It is one of the most drought-tolerant legumes and was grown for forage and soil improvement, particularly in the Great Plains and the Corn Belt. Sweetclover will grow almost anywhere there is a minimum of about 17 in. of rainfall and soil pH is 7.0 or higher. The three general cultivated types of sweetclover are biennial yellow flower, biennial white flower, and annual white flower. Hubam and Floranna are annual white flower types that were grown in the southern USA. In the late 1940's and early 1950's, over 9 million pounds of sweetclover seed were produced in Texas annually. The advent of cheap nitrogen fertilizer after World War II and the spread of the sweetclover weevil (Sitona cylindricollis) eliminated most of the sweetclover acreage in the United States. However, it is still grown in Canada. Both white and yellow flower types are found growing along roadsides throughout the United States.

Sweetclover can be planted in the southern states in October at 12 to 16 lb seed/acre. Successful stands have been obtained in Central Texas when seeded in late January and February. It has a medium seed size with approximately 260,000 seed/lb. Sweetclover plants are 3 to 7 feet tall at maturity depending on variety. Annual sweetclovers are late maturing, flowering from May through June in the southern United States. Sweetclovers contain coumarin that causes a bitter taste to which animals become accustomed. If sweetclover is baled at too high a moisture level and fungal molds develop, the coumarin changes to dicoumarol, a blood anticoagulant. Cows eating the moldy hay can die of internal bleeding. Dicoumarol is not a problem when sweetclover is grazed by cattle or browsed by deer. Dicoumarol can cause toxicity problems only when high coumarin sweetclover is consumed as moldy hay or silage.

Genes for low coumarin have been found in a wild sweetclover type but none of the annual sweetclover varieties contain the low coumarin gene. A breeding program has been initiated at Texas A&M University Agricultural Research and Extension Center at Overton to transfer the low coumarin gene to annual sweetclover. Seed increases and evaluations of low coumarin experimental cultivars are in progress.

Silver River is a new, rust resistant cultivar of white-flowered, annual sweetclover (Melilotus albus Medik.) developed by Texas A&M AgriLife Research at Overton with excellent adaptation to south and central Texas. Sweetclover rust (Uromyces striatus Schroet.) causes a range of plant disease symptoms, including leaf drop, reduced seed and forage yield, and premature plant death. The evaluation of Silver River for rust resistance was conducted at Beeville, TX under severe epiphytotics of sweetclover rust. Two cycles of mass selection at Beeville were used to improve the rust resistance of a sweetclover plant introduction line from Uruguay. The original plant introduction population had 21% rust resistant plants. Silver River averaged 91% resistant plants at Beeville in 2014 and 2015, compared to ‘Hubam’ with a 2-year average of 7% resistance. Silver River is similar to Hubam in forage yield and maturity. This new cultivar will improve the reliability of annual sweetclover in cattle grazing systems and wildlife supplemental forage plantings in south and central Texas. Silver River was released in 2016.

Vetch (*Vicia* spp.) There are many different species of vetch including 15 that are native to the US. Cold-hardy vetch species such as hairy vetch are adapted over a wide area of the US. Common vetch is less cold-hardy and is limited to areas with mild winters such as the Gulf Coast area. Vetch is adapted to a wider range of soil types and pH's than most other forage legumes. It grows on sand, loam, and clay soils from pH 5 to 8. It also has excellent seedling vigor because of its large seed. There are approximately 16,000 seed/lb for hairy vetch with a recommended seeding rate of 20 to 25 lb/acre. Optimum planting depth is 1 to 2 inches because of the large seed. Stems bear leaves with pinnate leaflets and terminate in tendrils that attach themselves to stems of other plants. White or purple flowers, depending on the species, are borne in a cluster or raceme. Hairy vetch flowers during April and May. Seed and pod characteristics vary with species.

The main use for vetch is for a green manure crop because it maintains a high nitrogen concentration through plant maturity. A mature crop of hairy vetch will contain about 150 lb nitrogen/acre. Vetch does not tolerate close grazing and should not be grazed shorter than 6 in. Insects are the main disadvantage of vetch. Pea aphids, corn earworm, fall armyworm and spider mites can be problems. The vetch bruchid or weevil destroys the interior of the seed reducing seed yields, which is the main reason for poor reseeding.

Austrian Winter Peas (*Pisum sativum*) may produce a moderate amount of dry matter used for grazing, as a hay crop, or as a green manure. Winter peas are often used as companion crops with cereal grains and are high in nutritive value. Winter peas are easily established on well-drained loam or sandy loam soils and should be planted during September or October at 20 to 30 lbs of seed/acre in mixed stands with cereal grains or ryegrass and 30-40 lbs/acre in pure stands. Austrian winter peas are adapted to low pH soils.

Cool-Season Perennial Legumes

A few cool-season perennial legume species are grown in the southern United States. Their acreage in the southern United States is limited by preference for loam and clay loam soils. Perennial clovers often act like annuals in this region because of poor summer survival.

Alfalfa (*Medicago sativa* L.) is the best-known forage legume in the United States and is referred to as the "Queen of the Forages". It is the only forage known to have been cultivated before the era of recorded history. Although classified as a cool-season legume, it grows throughout the summer if moisture is available. Because of this long growing season it has the capacity to produce large yields of high quality forage. It is best adapted and grown most extensively in the mid-west US. However, varieties have been developed that are adapted to most climates throughout the United States.

Alfalfa does best on deep, well-drained loam to clay loam soils with a pH of 7.0 or higher. In the eastern half of Texas, the optimum sites are well-drained river bottoms of the Brazos, Colorado, and Red Rivers. Alfalfa can be grown on any soil with good internal drainage and a subsoil pH of 5.5 or higher. Lime can be added to raise the surface soil pH to near 7 and nutrients limiting for optimum growth can be applied. When sandy acid soils are limed to pH 7, boron is critical for alfalfa if soil boron is less than 1.0 ppm. Autumn planting dates are

preferred over spring because of fewer weed problems. Recommended seeding rates are 16 to 20 lb/acre planted at ¼ in. depth in clay soils to ½ in. depth in sandy soils in a clean, firm seedbed.

Alfalfa can be a very profitable forage crop, but it requires a high level of management. Chemical weed control is required to obtain good clean stands. Most disease problems have been solved by selecting for resistance. Alfalfa weevil and three-cornered alfalfa hopper are the main insect problems but all can be controlled with insecticides. Its primary use is hay for dairy cows and horses. With the development of grazing tolerant varieties, more alfalfa is being used for grazing.

Red clover (*Trifolium pretense* L.) is a weak perennial with stands lasting 2 to 3 years in the northern 2/3 of the United States but usually only 1 year in the Lower South (35 N latitude southward). Red clover is best adapted where summer temperatures are moderately cool to warm with good soil moisture conditions. It prefers loam to clay loam soils as long as they are well drained. It will grow on flat sandy soils (flatwoods) with good moisture. Soil pH needs to be above 6. In the South, red clover reaches a height of 2 to 2.5 ft. with numerous leafy stems rising from the crown. Hairs are present on both leaves and stems. Flower color varies from light pink to rose purple to magenta. It has a tap root that gives it some drought tolerance on loam soils but red clover is sensitive to low soil moisture on sandy soils.

Recommended seeding rate is 10 to 12 lb/acre planted at a ¼ to ½ in. depth. Red clover will grow into June and July if moisture is available. Cherokee red clover is the only variety developed in the South so it begins spring growth earlier than other varieties. Red clover can be used for both hay and grazing but does not tolerate close grazing.

White clover (*Trifolium repens* L.) is a perennial legume grown in the eastern half of the US. While perennial in nature, white clover in the southeastern US generally persists as a re-seeding annual. There are small, medium, and large (ladino) white clover types. Although a shorter stature, short and medium types are better seed producers than large types, which is important for reseeding in the south. Recommended varieties are Louisiana S-1, Neches and Durana. White clover requires good soil moisture, is usually found on clay loam, bottomland soils, and is not productive under droughty, upland conditions.

White clover is often planted at 3-4 lbs/acre into existing tall fescue or bermudagrass stands. Best production will be obtained on fertile, well-drained soils if rainfall is favorable. White clover will tolerate wet soil conditions better than most legume species. Because it is often found on wetter sites, white clover may survive a drought during the summer months better than other forage legumes.

White clover does not exhibit the same erect growth habit as red clover and mixed grass-clover stands should be grazed at a 4 to 6 inch height to prevent competition for sunlight from becoming a limiting factor in white clover production. When cattle graze pure stands of white clover, bloat potential may be reduced using Bloat Guard blocks, feeding grass hay or grown in grass mixtures.

Warm-Season Annual Legumes

Both annual and perennial warm-season legumes are used more for wildlife than livestock. It is difficult to grow warm-season legumes in association with warm-season perennial grasses because the warm-season grasses are so well adapted and competitive.

Cowpea (*Vigna unguiculata*) is an annual viney plant with large leaves. The species is fairly tolerant of drought, heat, low fertility, and moderate soil acidity. Cowpeas, however, do require adequate levels of P and K to be productive. Forage nutritive value is generally high and plants are easily established from May through June. Many times cowpeas are used as a warm-season food plot for white-tailed deer to offset the negative effects of summer stress. Cowpeas do not cause bloat in ruminants, but are not found immediately palatable by cattle.

'Ace' is a small seeded (9000 seed/lb) cultivar of forage cowpea developed for use in wildlife supplemental plantings, cover cropping systems and legume hay production. Ace was developed in the Texas A&M AgriLife Research Forage Legume Breeding Program at Overton and released in May 2018. Ace was evaluated at Texas A&M AgriLife RECs at Overton and Vernon, TX. Ace has full season forage production and flowers in late August.

'Iron & Clay' is an old forage-type cowpea cultivar (technically a variety mix) that remains vegetative during most of the summer and flowers in mid September. Both Ace and Iron & Clay are recommended for Texas.

Lablab (*Lablab purpureus* [L.] Sweet) is a vining, annual tropical legume with high nutritive value as a forage for cattle and goats and browse for deer. The qualities of this tropical forage include: drought tolerance, high palatability, high nutritive value, excellent forage yields and adaptation to diverse environmental conditions.

Currently, seed of the Australian lablab cultivar 'Rongai' is imported into the US primarily for supplemental forage plantings for white-tailed deer. Rongai was released by the New South Wales Department of Agriculture in 1962. Rongai is very late maturing and generally does not flower in northeast Texas before frost.

'Rio Verde' lablab was developed through selection for tolerance to defoliation, forage production potential and Texas seed production. Rio Verde was developed at the Texas A&M University Agricultural Research and Extension Center at Overton, Texas and released by the Texas Agricultural Experiment Station (TAES) in 2006. Rio Verde was the first lablab cultivar developed in the US. Currently (2020) no Rio Verde seed are produced in Texas due to anthracnose disease in west Texas seed production areas. Texas A&M AgriLife Research at Overton has identified resistance in lablab to this foliar and stem blight but new cultivars are still in evaluations.

Soybean (*Glycine max*) is a temperate grain legume that can be used as a grazing and hay crop. This plant is not as tolerant of heat and drought as cowpea and lablab and does not regrow well after defoliation. Soybean is better adapted to heavy clay soils and wet soils relative to cowpea and lablab. There are forage type soybean varieties that require short days (late fall) to flower and mature. They remain in a vegetative stage during the summer in contrast to grain-type soybeans that begin to flower 2 to 3 months after planting. 'Tyrone' is the best adapted forage soybean variety for the southern states.

Warm-Season Perennial Legumes

Bundleflower: There are several species of bundleflower (Desmanthus) that are native to Texas and surrounding states. Two species have been commercialized for use in Texas. 'Sabine' Illinois bundleflower (Desmanthus illinoesis) is adapted to North and Central Texas from about Austin northward. 'BeeWild' bundleflower (D. bicornutus) was developed at Beeville and released by the Texas Agricultural Experiment Station in 2003. BeeWild is consists of four (4) different cultivars that are produced as monocultures for seed production purposes, and then blended to produce BeeWild. The four different cultivars have a 100% range in seed size, and a broad range in flowering and seed maturation time. BeeWild is best adapted south of about Waco in Central Texas. All bundleflowers are poorly adapted to acid sandy soils, so their use is restricted to soils that are sandy clay loams and heavier with a pH near neutral and above. All bundleflowers contain tannin which reduces palatability and essentially eliminates the potential for bloat. Recommended seeding rates for bundleflower is 3 to 5 lbs per acre.

More Information

Contact Dr. Gerald R. Smith for more information. (g-smith@tamu.edu; 903 834-6191; aggieclover.tamu.edu)

RWFM-PU-402
March 2023

UNDERSTANDING HERBICIDE TERMINOLOGY AND RESOURCES FOR USE IN RANGELAND AND PASTURE MANAGEMENT

Megan K. Clayton[1], Stephen J. DeMaso[2], Stacy L. Hines[3], Vanessa A. Corriher Olson[4], & Shannon E. Barron[5]

Land management often requires the reduction of undesirable plants to promote those more aligned with the goals of the property. We have several tools to change plant communities, including prescribed fire and mechanical, chemical, and biological tools, such as grazing. Properly selecting and integrating these control options is much easier when recommendations are easy to understand!

Though herbicides are widely available, understanding the terminology around their use is not always clear. There are resources available to help simplify herbicide use on rangelands and pastures. However, technology is always advancing and changing as more products come to the market and research is conducted. Read on to learn more about herbicide terminology and where to find additional information to support your land management goals.

GENERAL TERMS

Though this list is limited to the most basic, general herbicide terms, it provides an introduction to those most commonly used by pesticide applicators.

Pesticide: The Environmental Protection Agency (EPA) defines pesticides as "any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest. It can also include substances intended as plant regulators, defoliants, or desiccants and any nitrogen stabilizer" (EPA, *"What is a Pesticide?"*).

Pest: The United States Department of Agriculture (USDA) defines a pest as "any organisms (including plants and animals) that pose health, environmental, economic, or aesthetic risks. An organism that is a pest in one environment may be benign or beneficial in others" (USDA, *"Integrated Pest Management"*).

Herbicide: A chemical or chemical mix used to control or suppress unwanted plants. While herbicides are pesticides, pesticides also include insecticides, fungicides, rodenticides, etc.

Control: A term often used interchangeably with "plant kill." For example, after an herbicide application, one could expect __% control or apparent plant kill.

[1] Professor & Extension Range Specialist, Texas A&M AgriLife Extension Service
[2] Monitoring and Coastal Grassland Restoration Incentive Program (C-GRIP) Coordinator, Gulf Coast Joint Venture, U.S. Fish & Wildlife Service
[3] Assistant Professor & Rangeland Habitat Management Specialist, Texas A&M AgriLife Extension Service
[4] Professor & Extension Forage Specialist, Texas A&M AgriLife Extension Service
[5] Wildlife Biologist, Texas Parks & Wildlife Department

Suppression: When an herbicide does not kill (or control) the entire plant but top-kills the plant or temporarily delays growth.

Herbicide Label: The label on the herbicide container or packaging, also found online, outlines the legal information behind the use and precautions associated with that herbicide. Sometimes there are "supplemental labels" that have additional uses for the herbicide, typically allowed for a predetermined period of time. Labels can be specific to certain states and can be searched online at the *CDMS website*.

LABEL TERMS

The pesticide label includes all the regulatory and safety information to use an herbicide appropriately. Always read the entire label before purchasing or applying an herbicide.

Active Ingredient: The chemical(s) in herbicide products that kills or controls plants.

Common Name: The shortened version of the active ingredient's chemical name. While people often refer to specific product names, referring to the common name allows for the easy comparison of generic herbicides with the same active ingredients as a name brand.

Product Name: The trade name or name brand of the herbicide product. For example, Roundup PowerMAX is a product name with the common name glyphosate.

Generic Herbicide: This is often not the original herbicide product name released on the market, as some companies may produce replicas of the original, name-brand herbicides after the patent has expired (often 20 years or so).

Use Rate: The amount of herbicide needed to control a particular plant, found either on the herbicide label or in research-based publications. The herbicide use rate will be specific to the plant species and possibly the application timing. The use rate may be given as the amount of product per acre (e.g., 32 oz/acre) or the percentage for individual plant treatments (e.g., 1% in solution).

Acid Equivalent: This refers to the amount of active ingredient that is the parent acid or could be converted into the parent acid of an herbicide. The percent of the active ingredient in a container is often compared to other generic options when the acid equivalents should be compared instead. The percent of active ingredient(s) relative to "other" ingredients in the container could vary depending on what else is in there, which is why comparing the acid equivalents (or true amount of parent

acid herbicide) is more reliable. If included, acid equivalents are found on the container's front label, just under the percent compositions.

Use Site: Where the herbicide can be legally applied. This information is usually found on the top of the label, underneath the logo(s). Active ingredients may be sold under different trade names for completely different use sites. Examples of potential use sites include rangeland and permanent grass pastures, rights-of-way, non-hayed perennial grasslands managed as rangeland, and Conservation Reserve Program (CRP) acres.

Buffers/Downwind Adjustments: The amount of area to remain unsprayed either on the downwind property/field boundary or near label-defined areas, such as external fence lines or shared bodies of water. These adjustments help to reduce the likelihood of pesticides drifting outside of the spray area.

Personal Protective Equipment (PPE): Equipment worn to minimize exposure to pesticides. The herbicide label will dictate exactly what PPE is required by law, though you may want to add additional PPE for added safety and cleanliness. Examples of PPE include nitrile gloves, N95 masks, chemical-proof aprons, and goggles/eye protection. All of the range and pasture herbicides require long pants, long-sleeve shirts, closed-toe shoes, and socks as a minimum.

Toxicity Signal Words: The pesticide label will have a large signal word to alert the user to any toxicity characteristics that need to be known. "CAUTION" is lower in toxicity, though this does not mean it is "safe." The potential human acute toxicity increases with the words "WARNING," "DANGER," and "DANGER–POISON."

HERBICIDE CHARACTERISTICS

Understanding how herbicides work, their physical properties, and safety information are important to handling and applying herbicides properly.

Safety Data Sheet (SDS): The International Hazard Communication Standard mandates that chemical manufacturers provide a safety data sheet outlining a chemical's properties, health and safety information, and storing and use information. It is best to have the SDS printed and readily available for all chemicals in use. The SDS was previously called—and is sometimes still referred to as—Material Safety Data Sheets (MSDS) and are available online along with product labels.

Formulation: Rangeland herbicides on the market are not usually pure herbicide molecules but are typically combined with salts, solvents, or surfactants to make a formulation that can be combined with a carrier, such as water or diesel. Most commonly used herbicides are solutions that dissolve in water, but there are also other types of products, including dry flowables, wettable powders, and even some granules.

Mode of Action: The way the herbicide acts on the plant at the tissue or cellular level to affect normal plant growth and development. Some common modes of action include growth regulators, amino acid synthesis inhibitors, seedling growth inhibitors, photosynthesis inhibitors, etc. Using products with different modes of action over time may help reduce herbicide resistance in plants.

APPLICATION TERMS

Various terminology is used to describe the application, or spraying, of herbicides. These terms are important for using herbicides in their intended way and applying them successfully!

Pesticide Applicator License: Pesticides in Texas are regulated through the Department of Agriculture (TDA). Anyone may apply non-restricted herbicides if they are following the label requirements. To apply restricted-use or state-limited-use herbicides, the applicator needs to have a Pesticide Applicator License and maintain it by acquiring the required number of continuing education units. Licenses may be for private applicators (applying on their own or managed property), commercial applicators (applying on others' property for compensation), or non-commercial/non-commercial political applicators (typically applies as a job duty or government worker). For information on license types and how to obtain a license, visit the *"Outdoor Pesticide Licenses"* section of the TDA's website.

Continuing Education Units (CEUs): Pesticide applicators in Texas must receive continuing education to meet license requirements. Currently, 15 CEUs are needed every 3 years for private applicators, and 5 CEUs are needed every year for commercial/non-commercial applicators. CEUs can be obtained by contacting your local county Extension office for events, which can be found on the *AgriLife county offices webpage*. Online courses are also available through *AgriLife Learn*. Always keep a copy of CEU certificates for your records.

Target Plant: The herbicide application is applied to control the target plant(s) and to reduce the effect on desirable, non-target plant species. The specific target plant does not have to be listed on the label to apply the product lawfully, but the herbicide does have to be applied at the appropriate use site.

Individual Plant Treatment (IPT): The application of herbicides through the leaf (foliar), stem (basal), or cut stump method to single plants as opposed to a broadcast method. The herbicide mix is typically applied with a hand-wand sprayer. IPT rates are given as percentages (e.g., 1%).

Broadcast Treatment: The application of herbicides in a swath or larger area by either ground broadcast (boom or boomless nozzles) or aerial broadcast (helicopter or airplane) as opposed to an individual plant treatment (IPT) method. Broadcast rates are given as an amount of herbicide per acre (e.g., 32 oz/acre).

Spray Volume per Acre: The amount of herbicide mix applied per acre to control the target plant(s). For example, 20 gallons of herbicide mix per acre (20 gal/ac). The spray volume desired may vary but can often be found on the label and is usually somewhere between 10 to 30 gallons of mix per acre. For broadcast applications, the spray nozzles and the speed the sprayer equipment is driven will determine the amount of spray volume applied.

Calibration: The process of determining how much spray mix volume comes from the spray equipment per acre to apply accurate rates of the chemical. Calibration also includes making sure that the output from each spray nozzle is consistent on a spray boom. Calibration trials are performed with plain water.

Application Timing: The season, growth stage of the target plant, weather conditions, or other criteria that ideally need to be met to get the best control (plant kill) with the herbicide application.

Adjuvant: An additional substance added to herbicide mixes to improve the herbicidal activity or application effectiveness. Most adjuvants are surfactants or crop oil concentrates. Though only a small amount is typically added to the herbicide mix, they can greatly increase the effectiveness of the application. Herbicide labels often dictate what adjuvants are best to mix with a given herbicide.

Non-ionic Surfactant (NIS): A common type of surfactant used in herbicide mixes to reduce the surface tension of the spray droplets on plant leaves and increase herbicide absorption.

Cut Stump Treatment: An individual plant treatment (IPT) method used on most hardwood species. The tree is cut off as flat and close to the ground as possible. The remaining stem and the cut stump surface are sprayed immediately after cutting with the recommended herbicide mix. This treatment method can be done at any time of the year.

Foliar (leaf) Applications: Individual plant treatments (IPT) or broadcast applications where a plant species' specific chemical mix (with a water carrier) is sprayed on all the leaves of the target plants. Application timing is critical for optimal control (plant kill). For example, healthy, mature green leaves actively conducting photosynthesis and transporting carbohydrates to the plants' roots are necessary for optimal control.

Basal (stem) Applications: An individual plant treatment (IPT) method used on most hardwood species. Each basal stem of the plant is sprayed with the recommended chemical mix 12 to 18 inches high and down to the ground. This treatment method can be done any time of the year, though it may work best when the tree is actively growing.

RESOURCES

These web-based resources are available as a quick reference to help decide the best herbicide method to meet rangeland and pasture management goals.

- *CDMS Herbicide Label Search*
- *REPK-PU-010: Chemical Weed and Brush Control Suggestions for Rangelands*
- *SCSC-PU-170: Quick Reference for Common Rangeland and Pasture Herbicides*
- *RWFM-PU-075: Broadcast Sprayer Calibration Guide*
- *Forage Fax website with timely forage and pasture information*

Brush Busters Individual Plant Treatment Herbicide Control Options

- *RWFM-PU-055: How to Master Cedar*
- *RWFM-PU-063: How to Avoid Lumps When Treating Cut Stumps*
- *RWFM-PU-076: How to Take the Green out of Greenbriar*
- *RWFM-PU-123: How to Control Honey Locust*
- *RWFM-PU-112: How to Beat Huisache*
- *RWFM-PU-064: How to Control Macartney Rose*
- *RWFM-PU-099: How to Beat Mesquite*
- *RWFM-PU-376: How to Brush Off Minor Species*
- *RWFM-PU-100: How to Control Prickly Pear and Other Cacti*
- *RWFM-PU-062: How to Take Out Tallow Trees*
- *RWFM-PU-375: How to Tame Texas Persimmon*
- *RWFM-PU-106: How to Take the Luck Out of Controlling Yucca*
- *RWFM-PU-067: Brush Busters Mixing Guide*

Brush Busters Cost Calculator for Individual Plant Treatment Projects

- *Brush Busters Cost Calculator App for Apple*
- *Brush Busters Cost Calculator App for Android*

Weed Busters Plant Treatment Herbicide Control Options

- *RWFM-PU-072: How to Control Common (Annual) Broomweed*
- *RWFM-PU-073: How to Get Drummond's and Common Goldenweed*
- *RWFM-PU-074: How to Neutralize Silverleaf Nightshade*
- *RWFM-PU-077: How to Pound Threadleaf Groundsel*
- *RWFM-PU-078: How to Sweep Out Perennial Broomweed*
- *RWFM-PU-081: How to Take the Sting Out of Texas Bullnettle*
- *RWFM-PU-082: How to Take the Kick Out of Western Horsenettle*

THE NEXT STEPS

Now that you have become familiar with basic herbicide terms, herbicide characteristics, and some of the resources available to you, what are the next steps?

Determine how often you may be applying herbicides that are restricted use or state limited use. It may be worth getting a pesticide applicator license if you find them necessary on a regular basis. More information can be located on the TDA's website under *"Outdoor Pesticide Licenses."*

Give yourself enough time to go through all the steps necessary to obtain a license. Remember to maintain it by obtaining the required continuing education units (CEUs) and keeping records of applications made. Record-keeping forms can be found on the *AgriLife Agricultural and Environmental Safety Unit's website*.

Otherwise, you may consider using non-restricted herbicides or hiring a commercial applicator when necessary.

TAKE-HOME MESSAGE

This article is a primer on rangeland and pasture herbicide basics. Using herbicides according to the label is important for maintaining their availability in the market and keeping applicators and our environment healthy.

SCSC-PU-149
February 2023

SUGGESTIONS FOR WEED CONTROL IN PASTURES AND FORAGES

Vanessa Corriher-Olson, Ph.D.[1], Scott Nolte, Ph.D.[2], and Zachary Howard[3]

The suggestions contained herein are based primarily on herbicide labels and research by the Texas A&M AgriLife Research and Extension Service. The use of product names is not intended as an endorsement of the product or of a specific manufacturer—nor is there any implication that other formulations containing the same active chemical are not equally as effective. Product names are included solely to aid readers in locating and identifying the herbicides suggested.

The following information is for educational purposes only. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by AgriLife Extension is implied.

This publication is not a substitute for the herbicide product labels. It is intended to serve only as a guide for controlling weeds in pasture and forages. Labeled rates and restrictions change constantly, therefore, consult the product label before use.

[1]Professor and Extension Forage Specialist
[2]Associate Professor and State Extension Weed Specialist
[3]Extension Program Specialist, Weed Science

Weeds can be controlled in croplands through cultural, mechanical, and chemical means. Judicious use of these individual methods (or a combination of them) manages weeds effectively without causing economic loss or harming the environment. Deciding which practice to use will depend on the weed(s) being controlled and the infestation level. Also, the crop being planted will immensely determine when to use mechanical measures.

CONSIDERATIONS FOR CULTURAL AND MECHANICAL WEED CONTROL INCLUDE:

1. Remove light or spotty infestations of weeds by hand-hoeing or spot cultivation to prevent spreading weed seed(s), rhizomes, or roots. Exercise caution when plowing perennial weeds—careful to prevent the transport and spread of plant parts to other areas of the field.
2. Use weed-free planting seed to protect against weed infestations in the row and the introduction of new weed species.
3. Thoroughly clean harvesting equipment before moving from one field to the next or require it of the custom harvesters before they are entering fields.
4. Use mechanical tillage to remove initial weed flushes prior to planting, thereby reducing or eliminating the potential for continued infestation.
5. Consider the economics of using mechanical cultivation alone for weed control in the crop, especially where annual weed infestations are light.
6. Practice rotation to crops that physically out-compete certain weeds, resulting in their gradual decline.

The following tables summarize key information about herbicides commonly used on pastures in Texas. Each table presents information relevant to specific forage types and management scenarios. Ensure that the table is selected that best represents personal needs and information desired.

Within each table, the first column contains lists of weeds controlled by a particular herbicide. The second column is the product (herbicide common name) used to control the weeds listed in the first column. The third column describes current available information on application rate for broadcast application. Always refer to the herbicide label before use. This is followed by the recommended time of application based on forage growth stage or time of year. The "Remarks" column contains pertinent information, including haying and/or grazing restrictions, toxicity issues, max application rates, and other information.

Table 1. Bermudagrass Pastures – Newly Sprigged.

Weeds controlled	Product (herbicide common name company)	Application rate per acre (broadcast)	Times to apply	Remarks
Annual grasses and annual broadleaf weeds.	**Weedmaster®** (2,4-D + dicamba) Nufarm **Outlaw®** Helena	1 to 2 qts.	Pre-emergence 7 to 10 days after planting.	For use after planting vegetative stolons of hybrid bermudagrass. Reduced control may be expected if weeds are allowed to reach 1 inch tall before application or if germination occurs 10 days after application. Consult the Weedmaster® supplemental label for further information.
Annual broadleaf weeds.	**Direx® 4L** (Diuron) ADAMA	0.8 to 2.4 qts.	After planting and before emergence of bermudagrass or weeds.	**Do not pasture or mow for hay until 70 days after treatment.**

Table 2. Dormant Bermudagrass Pastures.

Weeds controlled	Product (herbicide common name company)	Application rate per acre (broadcast)	Times to apply	Remarks
Annual broadleaf and grass weeds including little barley.	**Gramoxone® SL 3.0** (*Paraquat dichloride*) Syngenta	0.7 to 1.3 pts.	Post-emergence during dormancy.	**Do not pasture or mow for hay until 40 days after treatment.** Gramoxone® SL 3.0 is a restricted use herbicide and is poisonous. Use of surfactant will improve the performance of this herbicide.
Annual grasses and weeds in bermudagrass.	**Glyphosate** (glyphosate) Several manufacturers	1 to 4 pts. (4 lb./gal. product)	Active weed growth before bermudagrass growth (dormant bermudagrass).	Only one application per year, per field. **Application must be at least 60 days before grazing or harvest.** Use only on fields that have an established stand of bermudagrass where some temporary injury or discoloration can be tolerated. Do not use where cool-season legumes are a major part of the forage component.
Sandburs in dormant bermudagrass.	**Prowl H_2O®** (Pendimethalin) BASF	1.1 to 4.2 qts.	Pre-emergent	**Do not pasture or mow for hay until 40 days after treatment.** Do not exceed 3.2 quarts of Prowl H_2O per acre, per year. Some stunting and chlorosis (pale discoloration of leaves) of bermudagrass may occur with post-emergence applications.
Sandburs, annual ryegrass, and crabgrass in dormant bermudagrass.	**Rezilon®** (indaziflam) Envu	3 to 5 oz.	Pre-emergent	**DO NOT exceed 6 oz./acre of Rezilon in a 12-month period.** When applied at a rate greater than 3 oz./acre, hay may not be harvested until 40 days after application. No grazing restrictions; 22-month minimum plant back interval for cereal crops; 22-month minimum plant back interval for root crops; 22-month minimum plant back interval for soybean.

Table 3. Pasture Sod Suppression and Renovation.				
Weeds controlled	Product (herbicide common name company)	Application rate per acre (broadcast)	Times to apply	Remarks
Sod suppression	**Gramoxone® SL 3.0** (*Paraquat dichloride*) Syngenta	0.7 to 1.3 pts.	Post-emergence in late summer or early fall to sod not > 3 inches tall. Apply before or at time of seeding winter annuals.	**Do not graze in treated areas until 60 days after treatment or until winter annuals seedlings are 9 inches tall.** Gramoxone® SL 3.0 is a restricted use herbicide and is poisonous. Using a surfactant will improve the performance of this herbicide.
Broadleaf weeds	**Glyphosate** (glyphosate) Several manufacturers	0.5 to 5 qts. (4 lb./gal. product)	Apply before planting forage grasses and legumes.	Use for pasture, hay crop renovation, and labeled weeds. **Note: Remove domestic livestock before application and wait 8 weeks after application before grazing or harvesting.**
Broadleaf weeds	**Glyphosate** (glyphosate) Several manufacturers	Spot treatment. 1 to 2 percent solution (1 to 2 qts. per 25 gals. of water)	Apply during active growth. For perennials, apply during seedhead formation.	Labeled for forage grasses and legumes, including bahiagrass, bermudagrass, bluegrass, fescue, ryegrass, alfalfa, and clover. No more than 1/10 of any 1 acre should be treated at any time.

Table 4. Permanent Grass Pastures and Established Grass Crops.				
Weeds controlled	Product (herbicide common name company)	Application rate per acre (broadcast)	Times to apply	Remarks
Annual and perennial grasses such as field sandbur, large crabgrass, green foxtail, barnyardgrass, broadleaf signalgrass, Texas panicum, johnsongrass, vaseygrass, nutsedge spp, and numerous broadleaf weeds. Suppression of bahiagrass, dallisgrass, and smutgrass.	**Plateau®** (imazapic) BASF	2 to 12 oz. (Refer to label for weed specifics)	Post-emergence after 100 percent bermudagrass green-up.	Bermudagrass growth suppression after treatment should be expected. The severity and longevity of this suppression will be minimized if bermudagrass is actively growing at the time of application and good growing conditions prevail following application. Consult label regarding varietal sensitivity. Application uniformity and accuracy are essential.
Annual broadleaf weeds. For Texas bullnettle, spray in the early bloom stage. See label for specific perennial weeds.	**2,4-D® amine or low volatile ester** (2,4-D) Several manufacturers	1 pt. to 1 qt. (4 lb./gal. product)	Post-emergence when weeds are actively growing.	Do not apply to newly seeded grasses until the grass is well-established or after heading begins. Do not apply when grass is in boot-to-milk stage if grass seed production is desired. **Do not graze dairy animals on treated areas within 7 days after treatment.** Using a surfactant will improve the performance of this herbicide. **Note: White and arrowleaf clovers have tolerated 0.5 lb./A of 2,4-D® applied in February or March in East Texas. Either Weedmaster® or Grazon P+D® will typically give better control of perennial weeds than 2,4-D® alone.**
Annual broadleaf weeds. For Texas bullnettle, spray in early bloom stage. See label for specific perennial weeds.	**Weedmaster®** (2,4-D + dicamba) Nufarm **Outlaw®** Helena	1 pt. to 1 qt. Can tank mix 0.25 to 0.5 pt. of Banvel® with 0.75 to 1.5 pts. 2,4-D amine or low volatile ester (4 lbs./gal. form)	Post-emergence when weeds are actively growing.	As above. **Do not graze meat animals in treated areas within 30 days of slaughter. Treated grasses may be harvested for hay, but do not harvest within 37 days of treatment. Banvel®** alone is labeled for use in grass pastures. Consult label for specific recommendations. Using a surfactant will improve the performance of this herbicide. **Note: For Banvel® alone in a rope wick, 1:3 water mixture is labeled.**
Annual broadleaf weeds and selected perennial weeds (refer to label).	**GrazonNext HL®** (aminopyralid + 2,4-D) Corteva	1.2 to 2.1 pts.	Post-emergence when weeds are actively growing.	Use higher rates for perennial weeds. Do not plant forage legumes until a soil bioassay has been conducted to determine if aminopyralid residues remaining in the soil will adversely affect the legume establishment. Do not harvest forage for hay within 7 days of GrazonNext HL® application.

continued on next page

Table 4. Permanent Grass Pastures and Established Grass Crops.				
Weeds controlled	Product (herbicide common name company)	Application rate per acre (broadcast)	Times to apply	Remarks
Annual broadleaf weeds and selected perennial weeds. For Texas bullnettle, spray in early bloom stage. See label for specific perennial weeds.	**Grazon P + D®** (picloram + 2,4-D) Corteva	1 to 4 pts. Can tank mix 0.25 to 0.75 pt. Tordon 22K® with 1 to 3 pts. 2,4-D® amine or low volatile ester (4 lbs./gal. form)	As above.	New legume seedlings may not be successful if planted within 1 year after applying herbicide. **Do not transfer livestock onto broadleaf crop areas without first allowing 7 days of grazing on untreated grass pasture.** Tordon 22K® (Picloram) alone is labeled for grass pastures. Consult label for specific recommendations. Using a surfactant will improve the performance of this herbicide.
Johnsongrass, smutgrass, vaseygrass, silverleaf nightshade, milkweed, hemp dogbane, ragweed, and sunflower.	**Glyphosate** (glyphosate) Several manufacturers	Wick or other applicators 1:2, 1 gal. in 2 gals. of water	During active weed growth. For perennials apply at seedhead formation.	**Remove domestic livestock after application and wait 14 days after application before grazing and harvesting.** No more than 1/10 of any acre should be treated at a time. Further applications may be made in the same area at 30-day intervals.
Annual broadleaf weeds, some perennial broadleaf weeds, and bahiagrass.	**Cimarron Plus®** (metsulfuron + chlorsulfuron) Envu	0.125 to 1.25 oz.	Apply when weeds are actively growing.	No grazing restriction. Has residual soil activity so it may affect the following crops: ryegrass, alfalfa, and clover. Rate for Pensacola bahiagrass control is 0.375 oz./A. Using a surfactant will improve the performance of this herbicide.
Smutgrass and other weeds in bermudagrass and bahiagrass.	**Velpar® L** (hexazinone) Nova Source	2.75 to 4.5 pts.	Warm and moist soil conditions (weeds actively growing).	Only one application per year. Oak trees are extremely sensitive to Velpar® L. **Do not feed treated forage or hay within 38 days of application.** Using a surfactant will improve the performance of this herbicide. Some forage grass injury may occur.
Annual broadleaf weeds, annual ryegrass, and annual bromegrass.	**Amber®** (triasulfuron) Syngenta	0.28 to 0.56 oz.	Post-emergence applications to pastures when weeds are in an early stage of active growth.	No grazing restrictions. Has residual soil activity so it may affect following crops: ryegrass, bromegrass, alfalfa, and clover; extremely sensitive to Amber®. Amber® can be tank-mixed with 2,4-D®, Banvel®, Grazon P + D®, Weedmaster®, and Weedone® LV6 according to label. Using a surfactant will improve the performance of this herbicide.
Annual and perennial broadleaf weeds, sandburs, johnsongrass, crabgrass (large), and bahiagrass.	**Pastora®** (*Metsulfuron methyl*; *nicosulfuron*) Envu	1 to 1.5 oz.	Post-emergence when weeds are actively growing. For sandbur control, apply when sandbur is less than 1.5 inches tall. Sandbur greater than 1.5 inches tall may be suppressed resulting in a reduction in sandbur seed heads.	Do not apply more than 2.5 oz. of Pastora® per acre, per year. No grazing or hay harvest restrictions.
Annual broadleaf weeds.	**Sharpen®** (saflufenacil) BASF	1 oz.	Post-emergence when weeds are actively growing.	No grazing or hay harvesting restrictions.
Annual and perennial broadleaf weeds.	**PasturAll® HL** (Aminopyralid + 2,4-D) Corteva	1 to 4.5 pts.	Post-emergence when weeds are actively growing.	**Do not harvest forage for hay within 7 days of application.** Do not make more than 2 applications per year. Do not apply within 30 days of previous application.
Annual and perennial broadleaf weeds.	**Pasturegard® HL** (triclopyr + fluroxypyr) Corteva	1.5 to 4 pts.	Post-emergence when weeds are actively growing.	**Do not harvest hay within 14 days after application.**
Annual and perennial broadleaf weeds and bahiagrass.	**Chaparral®** (*Metsulfuron methyl* + *aminopyralid*) Corteva	1.0 to 3.3 oz.	Post-emergence when weeds are actively growing.	No grazing or hay harvesting restrictions.
Annual and perennial broadleaf weeds.	**Duracor®** (aminopyralid + florpyrauxifen-benzyl) Corteva	12 to 20 oz.	Post-emergence when weeds are actively growing.	No grazing or hay harvesting restrictions.

Table 5. Sorghum-sudan Hybrids (forage types).				
Weeds controlled	Product (herbicide common name company)	Application rate per acre (broadcast)	Times to apply	Remarks
Annual weeds and grasses.	**AAtrex® 4L** **AAtrex Nine-O®** (atrazine) Syngenta	3.2 to 4 pts. 1.7 to 2.6 lbs.	Pre-emergence: Apply during or shortly after planting. Post-emergence: Apply 2.4 pts./A (4L) or 1.3 lbs./A (Nine-O) when sorghum is 6 to 12 inches tall. Do not apply post-emergence in liquid fertilizer solution.	**Apply only on Texas Gulf Coast and Blackland areas.** In case of planting failure, sorghum or corn may be replanted. Do not make a second application. If originally applied in a brand and sorghum or corn is replanted in untreated row middles, this product may be applied in a band to the second planting. Use low rates where organic matter is 1 to 1.5 percent and high rates on soil with more than 1.5 percent organic matter. Use only on medium and fine-textured soil. **Note: Do not graze or feed forage from treated areas for 21 days after application. 2,4-D® can be used post-emergence for broadleaf weed control in sorghum sudan and millets.**
Annual broadleaf weeds.	**Weedmaster®** (2,4-D + dicamba) Nufarm	1 pt. to 1 qt.	Post-emergence when weeds are actively growing.	**Do not graze meat animals in treated areas within 30 days of slaughter. Do not graze lactating dairy animals in treated areas within 7 days of treatment.** Do not harvest for hay within 37 days of treatment. Using a surfactant will improve the performance of this herbicide.

Table 6. Alfalfa and Clover – New Plantings.				
Weeds controlled	Product (herbicide common name company)	Application rate per acre (broadcast)	Times to apply	Remarks
Annual grasses and some annual broadleaf weeds.	**Balan® DF** (benefin) Loveland products	2 lbs. on coarse and medium soils, 2.5 lbs. on fine soils	Preplant (incorporate before seeding alfalfa).	Incorporation equipment should be a tandem disc, PTO-driven tillers, cultivators, or hoes. Use only on alfalfa, birdsfoot trefoil and clover (alsike, ladino, and red). **Note: Balan® DF is also labeled as a preplant treatment before planting alsike and ladino clovers.**
Annual grasses and some annual broadleaf weeds.	**Eptam® 7E** (EPTC) Gowan	2.25 to 4.5 pts.	Preplant (incorporate immediately following the application).	Temporary crop stunting and sealing of the first leaves will occur if conditions for germination and growth are not optimum. Adequate rainfall or irrigation will relieve crop symptoms. Do not use on white Dutch clover. **Do not apply within 14 days of harvesting or grazing alfalfa.**

Table 7. Dormant, Semi-dormant, or actively growing Alfalfa and some Clovers (refer to product label).				
Weeds controlled	Product (herbicide common name company)	Application rate per acre (broadcast)	Times to apply	Remarks
Annual broadleaf weeds and annual grasses.	**Sinbar® 80W** (terbacil) NovaSource	0.5 to 1.5 lbs.	Before or after emergence of weeds, but before they are 2 inches tall or across.	Treat only semi-dormant or dormant stands established for 1 year or more. **Dormant alfalfa:** Make a single application in the fall after plants become dormant or in the spring before new growth begin. **Semi-dormant or non-dormant varieties:** Apply in fall or winter after last cutting or in spring before new growth starts. **Note: Do not use on seedling alfalfa or alfalfa-grass mixtures. Do not apply to established stands after new growth starts in the spring. Do not apply on snow-covered or frozen ground as crop injury may result.**
Annual broadleaf weed.	**2,4-DB®** Several manufacturers	1 to 3 qts. Use 1 to 2 qts. if weeds are less than 1-inch high, 2 to 3 qts. if weeds are 1 to 3 inches high.	Post-emergence when clovers have 2 to 4 trifoliate leaves.	Labeled for seedling and established alfalfa, seedling birdsfoot trefoils, seedling alsike clover, seedling ladino clover, and seedling red clover. Using a surfactant will improve the performance of this herbicide. **Note: Do not graze or feed seedling clovers within 60 days after application. Do not feed hay from treated crops to livestock within 30 days after application. Do not use on established clovers grown for seed.**
Grasses and certain broadleaf weeds.	**Kerb® 50W** (pronamide; 0.5 to 0.75 lbs.) Corteva	1 to 1.5 lbs.	Pre-emergence to weeds during fall or winter months in established legumes or in new plantings in trifoliate leaf stage.	Effective with dependable rainfall or overhead irrigation. With low rainfall or furrow irrigation, increase rate 0.5 lb. of product per acre. **Note: Do not graze or harvest for forage or dehydration within 25 days after application.**
Annual grasses and broadleaf weeds.	**Treflan TR-10®** Granules (trifluralin) Corteva	20 lbs.	Pre-emergence to weeds after January 1.	Application must be followed by 1/2-inch of sprinkler irrigation or rainfall, or flood irrigation, within 3 days. If this has not occurred, then shallow cultivation must be performed to activate and uniformly distribute the herbicide, taking care not to cause severe injury to the alfalfa.
Annual grasses and broadleaf weeds.	**Pursuit DG®** (imazathapyr) BASF	1.08 to 2.16 oz.	Post-emergence to seedling alfalfa (Second trifoliate or larger) or established alfalfa.	Established alfalfa applications must be made when alfalfa is dormant, semi-dormant (less than 3 inches of regrowth) or between cuttings. Weeds should be 1 to 3 inches tall at application and a surfactant or crop oil concentrate and a liquid fertilizer solution should be added to the spray mixture. Application rate will depend on weed species and size. Do not apply more than 2.16 oz. per year.
Annual broadleaf weeds and certain annual grasses.	**Karmex® DF** (diruon) ADAMA	1.5 to 2 lbs. Do not exceed 3 lbs. per acre, per year.	Pre-emergence in March or early April, but before spring growth begins on the alfalfa.	**Treat dormant stands of alfalfa established for 1 year or more.** Do not apply to seedling alfalfa or to alfalfa-grass mixtures; do not apply to alfalfa under stress from disease, insect damage, shallow root penetration, or alkali spots; do not apply to flooded fields or to snow-covered or frozen ground (as crop injury may result). **Note: Do not graze or feed forage or hay to livestock within 30 days following application.**
Annual grasses and broadleaf weeds.	**Velpar L®** (hexazinone) NovaSource **Velpar DF CU®** (hexazinone) NovaSource	1 to 3.0 qts. on soils with less than 1 percent organic matter. Consult label for rates on specific soil textures. 0.33 to 2 lbs. (Consult label as above.)	Pre-emergence or early post-emergence to the weeds in the fall or winter after alfalfa becomes dormant or in the spring before new growth begins.	**Treat dormant stands of alfalfa established for 1 year or for one growing season.** Do not apply to actively growing alfalfa or to stubble between cuttings. Do not apply to snow-covered, frozen ground. **Note: Do not graze or feed forage or hay to livestock within 30 days following application.**

continued on next page

Table 7. Dormant, Semi-dormant, or actively growing Alfalfa and some Clovers (refer to product label).				
Weeds controlled	Product (herbicide common name company)	Application rate per acre (broadcast)	Times to apply	Remarks
Annual broadleaf weeds and grasses.	**Metribuzin® 75** (metribuzin) Loveland	0.5 to 1.33 lb./acre	Apply when weeds are less than 2 inches tall or before weed foliage is 2 inches in diameter. Do not apply metribuzin during the first growing season after seeding.	**Treat only dormant, established alfalfa.** Injury may occur if metribuzin is applied earlier than 12 months after seeding. Apply metribuzin after growth ceases in the fall or before growth begins in the spring. **Note: Do not graze or harvest within 28 days after application.**
Annual grasses and some annual broadleaf weeds.	**Eptam® 7E** (EPTC) Gowan	2.25 to 3.5 pts.	Meter into the irrigation water applied to established stands prior to weed emergence.	Use the lower-rate on very coarse soils. Limit use to one application per cutting. Do not use on white Dutch clover. **Do not apply within 14 days of harvesting or grazing alfalfa.**
Annual broadleaf weeds.	**2,4-DB®** Several manufacturers	1 to 3 qts.	When weeds are less than 3 inches high. Weeds in the rosette stage should be treated when rosettes are less than 3 inches across.	Treat alfalfa when plants have 2 to 4 trifoliate leaves. For irrigated crops, apply herbicide as soon as possible after irrigation. Delay next irrigation for at least 7 to 10 days after spraying to avoid washing the chemical into the root zone. 2,4-DB® is a restricted use herbicide. Use of surfactant will improve the performance of this herbicide. **Note: Do not graze treated crop or feed hay from treated crop to livestock within 60 days after application.**
Annual and perennial grasses.	**Poast Plus®** (sethoxydim) BASF	1.5 to 2.25 pts.	When grass weeds are actively growing and 4 to 25 inches tall. Consult label for specific weed recommendations.	Poast Plus® is absorbed through the leaves and translocated to roots and buds. Active growth is required. **Minimum time from application to harvest is 14 days for hay or 7 days for grazing or green chop.** Always add 1 pt./A of DASH® or 1 qt./A of crop oil concentrate to enhance herbicide performance. Consult label use rate and application timing specifications for different parts of Texas.

Table 8. Winter Pastures for Grazing only (wheat, oats, rye, barley, ryegrass, and mixtures thereof).				
Weeds controlled	Product (herbicide common name company)	Application rate per acre (broadcast)	Times to apply	Remarks
Annual broadleaf weeds (Refer to label for specific weeds controlled).	**Patriot®** (*Metsulfuron methyl*) Nufarm	0.1 oz.	Post-emergence after two-leaf stage but before boot stage of wheat or barley.	If ryegrass is present, slight to severe injury may occur. Metsulfuron may be combined with other herbicides for expanded broadleaf weed control. Metsulfuron has no grazing restriction in labeled crops. Use of surfactant will improve the performance of this herbicide.
Annual broadleaf weeds (Refer to label for specific weeds controlled).	**Amber®** (triasulfuron) Syngenta	0.28 to 0.56 oz.	Post-emergence on wheat up to pre-boot stage or barley from two-leaf to pre-boot stage.	Amber® is labeled only for use in wheat and barley only. Applications to ryegrass or other winter forages may result in severe damage. Amber® may be combined with other herbicides for expanded weed control. Refer to the Amber® label for additional precautions and recommendations. Amber® has no grazing restriction on labeled crops. Use of surfactant will improve the performance of this herbicide.
Annual broadleaf weeds and some biennial and perennial broadleaf weeds (Refer to label for specific weeds controlled).	**MCPA®** Several manufacturers	0.5 to 1.5 pts.	Post-emergence after grain is in 3 to 4-leaf stage, or fully tillered for the 1.5 pt. rate.	Use higher rates for biennial and perennial weeds. **Do not graze or harvest for livestock feed for 7 days.** Refer to the specific MCPA® product label for additional restrictions and precautions. Use of surfactant will improve the performance of this herbicide.
Annual broadleaf weeds and some biennial and perennial broadleaf weeds (Refer to label for specific weeds controlled).	**2,4-D®** Several manufacturers	0.5 to 1.5 pts.	Post-emergence after grain is fully tillered.	Most 2,4-D® products are labeled for use in wheat, barley and rye. Application timings other than those recommended on the individual 2,4-D® product label may result in small grain injury. Use the higher rate range for biennial and perennial weeds Consult individual product label for additional precautions and use restrictions. Use of surfactant will improve the performance of this herbicide.

The following table contains all products previously listed in this publication and any grazing, haying, or slaughter restrictions. This table is only intended to be used as a guideline for these restrictions. Always refer to the most current label for up-to-date recommendations.

Table 9. Grazing/hay Restrictions for Pasture Herbicides in Days.[1]

Herbicide	Lactating dairy		Non-lactating		Meat animals		Slaughter
	Graze	Hay	Graze	Hay	Graze	Hay	
Amber®	0	30	0	30	0	30	NL[2]
Banvel® 0.5 qt./A 0.5 to 1 qt./A 1 to 2 qts./A	 7 21 40	 37 51 70	 0 0 0	 37 37 37	 0 0 0	 37 37 37	 30 30 30
Cimarron PLUS®	0	0	0	0	0	0	NL
Diurex® 4L	70	70	70	70	70	70	NL
Duracor®	0	14	0	14	0	14	NL
GrazonNext HL®	0	7	0	7	0	7	NL
Grazon P+D®	7	30	0	30	0	30	3
PasturAll HL®	0	7	0	7	0	7	NL
Pasturegard HL®	0	14	0	14	0	14	3
Plateau®	NL	7	NL	7	NL	7	NL
Prowl H_2O®	0	0	0	0	0	0	NL
Reclaim®	0	0	0	0	0	0	0
Remedy® < 2 qts./A 2 to 6 qts./A	 14 NS[3]	 NS NS	 0 14	 7 14–NS[4]	 0 14	 7 14–NS[4]	 3 3
Rezilon®	0	0–40[4]	0	0–40[4]	0	0–40[4]	NL
Roundup Ultra® Spot (0.1/A) Renovation 1	 14 56	 14 56	 14 56	 14 56	 14 56	 14 56	 NL NL
Sharpen®	0	0	0	0	0	0	0
Tordon® 22K	14	0 (<1 qt.)	0	0 (<1 qt.)	0	0 (<1 qt.)	3
Velpar L®	0	38	0	38	0	38	NL
Weedmaster®	7	7	0	7	0	7	30
2,4-D® amine	7	30	7	30	7	30	3
2,4-D® ester	7	30	7	30	7	30	3

[1]This table is only intended to be used as a guideline for these restrictions. Always refer to the most current label for up-to-date recommendations.
[2]NL = No restrictions listed on label.
[3]NS = Next season.
[4]Refer to label for specific time interval based upon use rate.

BOOM SPRAYER CALIBRATION

1. Determine nozzle spacing.
2. Refer to the table below for length of calibration course.
3. Mark off the calibration course on the actual area to be sprayed.
4. Record the time required to drive the calibration course at the desired field gear and RPM to be used while spraying.
5. Park tractor, maintain RPM used to drive course, turn on the sprayer, and set it at proper pressure for desired nozzle tips.
6. Catch water from one nozzle for the time equal to that required to drive the calibration course.
7. Ounces of water caught = gallons per acre.
8. Divide gallons per acre into the number of gallons in spray tank to determine how many acres will be sprayed. Add the appropriate amount of herbicide for the number of acres to be sprayed.

Chart for Nozzle Spacing and Length of Calibration Course				
Nozzle spacing (inches)	18	20	30	40
Length of calibration course* (linear feet)	227	204	136	102

*To determine the calibration course for a nozzle spacing not listed, divide the spacing expressed in feet into 340 (340 sq. ft. = 1/128). Example: Calibration distance for 19-inch nozzle spacing = 340 ÷ 19/12 = 215 ft.

BOOMLESS SPRAYER CALIBRATION

1. Determine swath width.
2. Refer to the table below for the length of the calibration course.
3. Mark off the calibration course.
4. Record the time required to drive the calibration course at the desired field gear and RPM.
5. Park the tractor, maintain RPM used to drive course, and turn on the sprayer.
6. Catch water for the time equal to that required to drive the calibration course.
7. Pints of water caught = gallons per acre.
8. Divide gallons per acre into the number of gallons in spray tank to determine how many acres will be sprayed. Add the appropriate amount of herbicide for the number of acres to be sprayed.

Chart for Nozzle Spacing and Length of Calibration Course						
Effective Swath Width (feet)	25	30	35	40	45	50
Length of calibration course* (linear feet)	218	182	156	136	121	109

*To determine the calibration course for a swath width not listed, divide the swath width expressed in feet into 5,460 (5,460 sq. ft. = 1/8 of an acre). Example: Calibration distance for 32-ft. swath width = 5,460 ÷ 32 = 171 ft.

Management Strategies for Sustainable Pastures and Beef Production

Monte Rouquette, Jr., PAS
TAMUS Regents Fellow & Professor
Texas A&M AgriLife Research
Texas A&M AgriLife Research and Extension Center, Overton

For those of us who may ask, "I wonder what they meant when they said...?" we can always rely on the "authority" of Webster's Dictionary with definitions for current terminology in Agriculture and Corporate Business, including the following:

- **Management** - "Judicious use of means to accomplish an end; skillful treatment; to control and direct; executive skill."
- **Strategies** - "The large-scale planning and directing of operations in adjustment to combat area (climatic diversity)."
- **Sustainability** - "The ability to maintain or cause to continue in existence or a certain state, or in force or intensity."
- **Maintain** – "To continue or persevere in or with; to carry on; to hold or keep in any condition especially in a state of efficiency."

With respect to sustainability of forages and pastures for cattle production, management strategies provide guidance and set expectations and objectives for the overall property enterprises which focus on pastures and cattle production goals. From the perspective to "maintain," promote, or enhance sustainable pastures, managers should implement stocking strategies based on relevant, comparative data from Research and/or Extension publications. In addition, managers use on-site, visual assessments and mental integration of cause-and-effect impact on pasture-animal performance. Thus, management strategies include an array of input-output decisions with potential objectives to "match" forage-animal requirements for production and economic rewards (Rouquette, 2015).

Some of the input information that owners and managers may seek includes some of the following questions: 1) What forages are present on my property, and which forages are best adapted to my vegetation-climatic area? 2) What is the soil fertility status of my pastures, and how much, if any, fertilizer is required for my desired level of forage production? 3) What is the best stocking rate for my operation, and what visual or measured "indicator" shows an optimum stocking rate strategy for sustainable cattle production? 4) Should I produce or purchase hay, and how do I know if a supplemental protein or energy feed may be needed? 5) What breedtype of cattle are best adapted to my vegetation zone, and what season(s) should they calve? and 6) How can I plan a forage-cattle operation system that includes a sustainable ecosystem which encourages wildlife food and habitat? (Rouquette & Aiken, 2020).

Stocking strategies should be characterized within a specific vegetation zone and combined with the Art and Management of efficient forage utilization and sustainability for the desired or optimum pasture-animal production. Figure 1 is a schematic that shows Inputs, driven primarily by climate, soil, and forage, and Outputs, driven primarily by production per unit land area. In-

between the Inputs and Outputs are the management Decisions, which include stocking strategies, of which stocking rate has the primary influence (Rouquette, 2015).

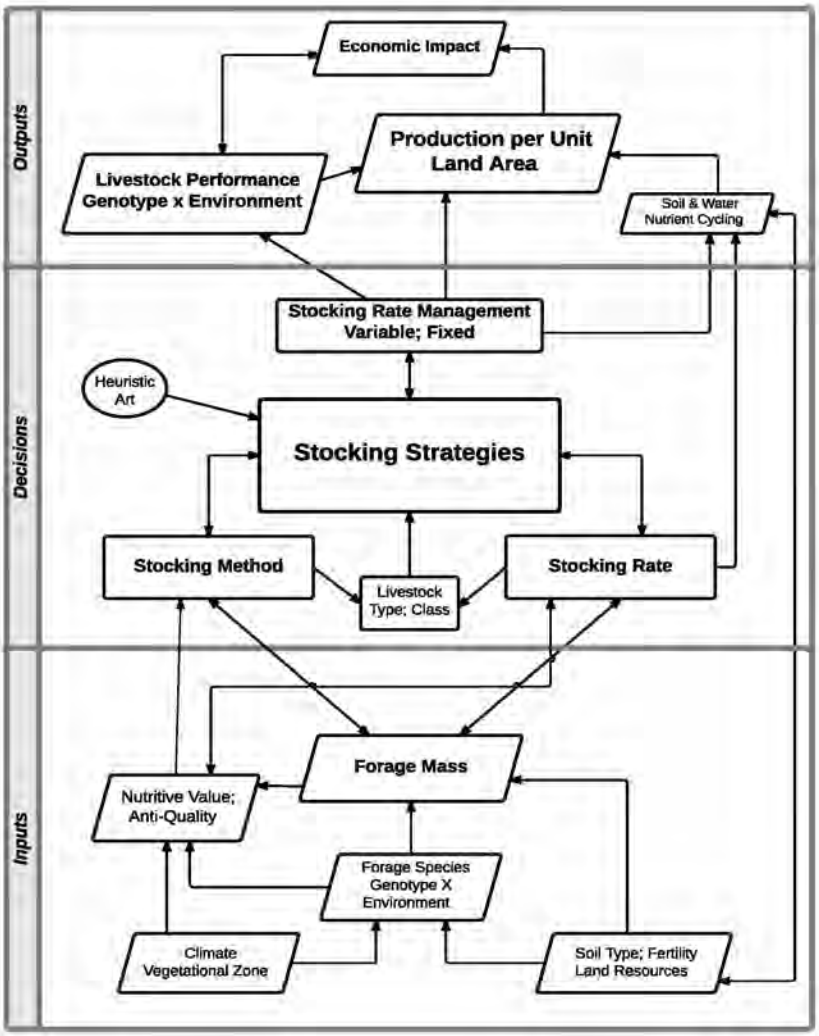


Figure 1. Inputs and outputs of pasture-animal systems as directed by stocking strategy decisions. (Adapted from F.M. Rouquette, Jr., 2015 Crop Sci. 55:2513-2530.)

Sustainability of pastures and cow-calf production in the US has received increased attention during the past few years. The increasing land values and ownership scenarios, redirected agricultural production objectives, and financial requirements for new (novice) ownership affect land use, livestock enterprises, and sustainability of the beef industry (Rouquette, 2017). Like many business enterprises, agriculture has similar concerns of sustainability with livestock products and production. The US Roundtable for Sustainable Beef (USRSB) is a multi-stakeholder initiative that was developed to support sustainability of the US beef value chain (USRSB, 2016). The USRSB has worked in collaboration with the Global Roundtable for Sustainable Beef (GRSB, 2016) to meet goals for beef value. Consequently, the GRSB has defined "sustainable beef" as a socially responsible, environmentally sound, and economical product. And, this product prioritizes natural resources, efficiency and innovation, people and the community, animal health and welfare, and food. Socially responsible is a synonym for

"Management." The primary definition of sustainable beef is dependent and controlled by management strategies and practices for environmental stability and economic returns. Some of the primary components of sustainable beef are illustrated in Figure 2. Site-specific vegetation zones, pasture ecosystems, management, and stocking strategies are the main components that influence sustainability of pastures and livestock production. The overall intensity of the operation is management specific. Thus, beef production and the beef value chain are controlled by biological-economic risks and stewardship-legacy objectives (Rouquette, 2017).

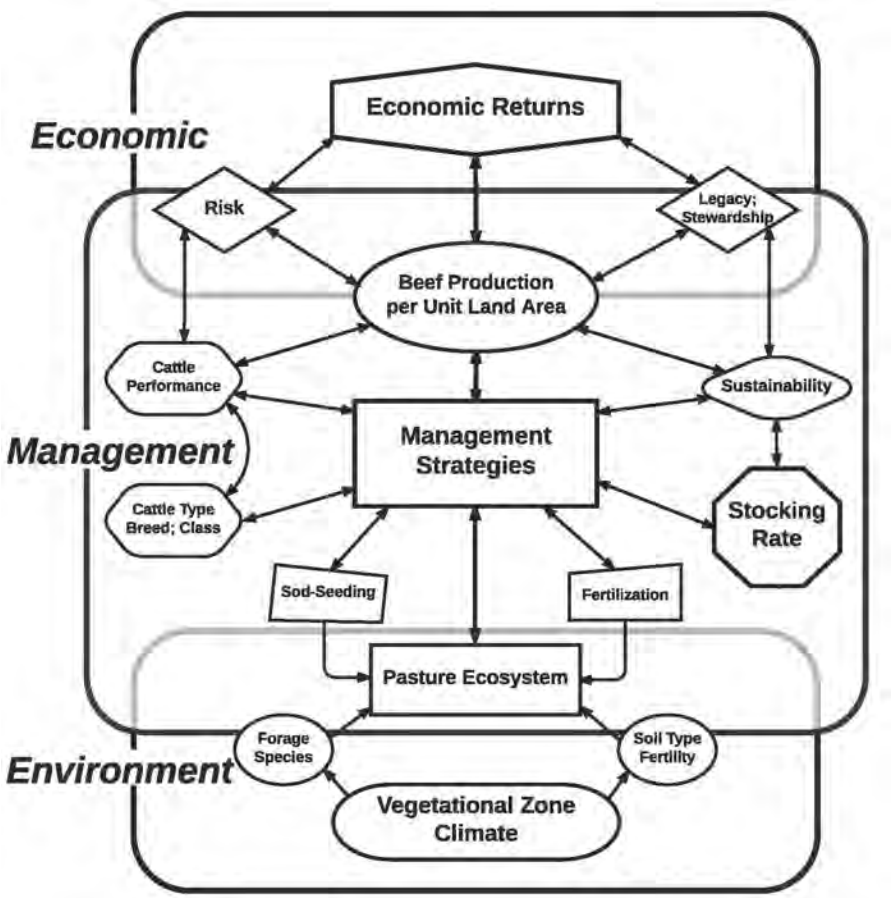


Figure 2. Sustainability of cow-calf production controlled by environment, management, and economic considerations. (Adapted from F.M. Rouquette, Jr., 2015 Crop Sci. 55:2513-2530.)

Production per animal and per unit land dictates the economic effect of the system, and is influenced primarily by stocking rate and secondarily by stocking method. Many stocking strategies have been proposed and incorporated to implement forage-animal production systems with outcomes that seek to optimize animal gains without the destruction of the forage resource. In other words, strategies that will "maintain" and "sustain" the plant-animal ecosystem are desired. In some of the early grazing research studies from the 1950s, management and stocking strategies for optimum forage utilization and animal performance introduced the concept of Flexible Grazing Management which was led by Dr. Roy E. Blaser (Blaser et al., 1962). Some of the management strategies evaluated from 1956 to 1982 by Blaser and coworkers included: a)

fattening steers on pastures; b) first and last rotational grazers; c) top and bottom grazers; and d) creep or forward-creep grazing.

Stockers and Warm-Season Perennial Grasses

Numerous grazing experimentation using weaned, stocker calves on warm-season perennial grass pastures were targeted at forage utilization and animal performance to document sustainable management principles. Figure 3 illustrates the general forage production of warm-season grasses during the active growing period. Some stocking strategies used to enhance stocker gains from pastures included the following:

- **Animal Breedtype, Age, and Weight.** Young (< 6 mo), lightweight (< 450 lb), non-Brahman crossbred stockers grazing in the Gulf-Coast and southeastern US region have much lower ADG than older, heavier calves. Optimum to maximum ADG for steers stocked on bermudagrass, for example, may be achieved with long-yearlings weighing >650 lb, with a body condition score of ≤4, and having Brahman influence (Oliver, 1972, 1978; Rouquette et al., 2005).
- **Forage Variety or Cultivar.** The ADG of stockers is directly related to nutritive value (TDN, Crude Protein) and available forage mass. Among warm-season perennial grasses, 'Tifton 85' bermudagrass has produced greater stocker gains than other grasses (Hill et al., 1993). Tifton 85 bermudagrass has some of the highest digestibility and the best potential for optimum or maximum ADG from bermudagrass pastures.
- **Stocking Rate.** Adequate forage mass availability that allows stockers to selectively graze high percent leaf components results in optimum to maximum ADG. Results from grazing research have shown that optimum stocker gain is related to the amount of forage available for consumption. Expressing stocking rate as Forage Allowance (lb DM forage : lb Body Weight) shows that forage allowance > 1.0 : 1.5 is necessary for optimum ADG and gain per acre.
- **Stocking Method.** Continuous stocking and numerous "types" of rotational stocking approaches have been used to enhance stocker gains. The subject of continuous vs. rotational stocking has led to an active debate between scientists and among stakeholders. One of the primary strategies that results in reduced to no ADG from a rotational stocking venture is that of forcing stockers to have a high percent utilization of forage in the resident paddock. This "forced consumption" results in intake of low nutritive value stem portions before moving to another paddock. Regardless of any data that may provide an alternative or equal advantage for continuous vs. rotational stocking, the method of choice selected by a manager or stakeholder does not have to be scientifically assessed to be the "best method." Rather, the stocking method used must provide a "comfort zone" that has reduced risk and the perception of being the "best method" for the stakeholder's objectives (Bransby 1988, 1991).

  Alternative stocking strategies using a first-last rotational method (Blaser, et al., 1986), and which may incorporate a two-herd (Rouquette et al., 1992) or a three-herd system (Rouquette et al., 1994) on bermudagrass pastures significantly enhanced ADG of the first herd. In this scheme, the first grazers consumed only the top third of the forage available which had much higher nutritive value than the lower two-thirds remaining for the next herd.
- **Supplementation.** Numerous supplementation grazing experiments have been evaluated by scientists as a method of enhancing ADG compared to pasture-only stockers.

Depending upon the objectives, the foci of these experiments ranged from: 1) using levels and nutrient concentration of supplement to increase stocking rate and gain per acre; to 2) substituting supplements for reduced forage available in pasture; to 3) using supplements to increase ADG for a niche market; to 4) achieving the most cost-effective method of supplementation. In general, daily supplementation of 0.2% to 0.3% of animal Body Weight has shown the best biological efficiencies of supplement to extra gain ratio. The cost of the additional gain is most always the primary objective of a supplementation program for stockers.

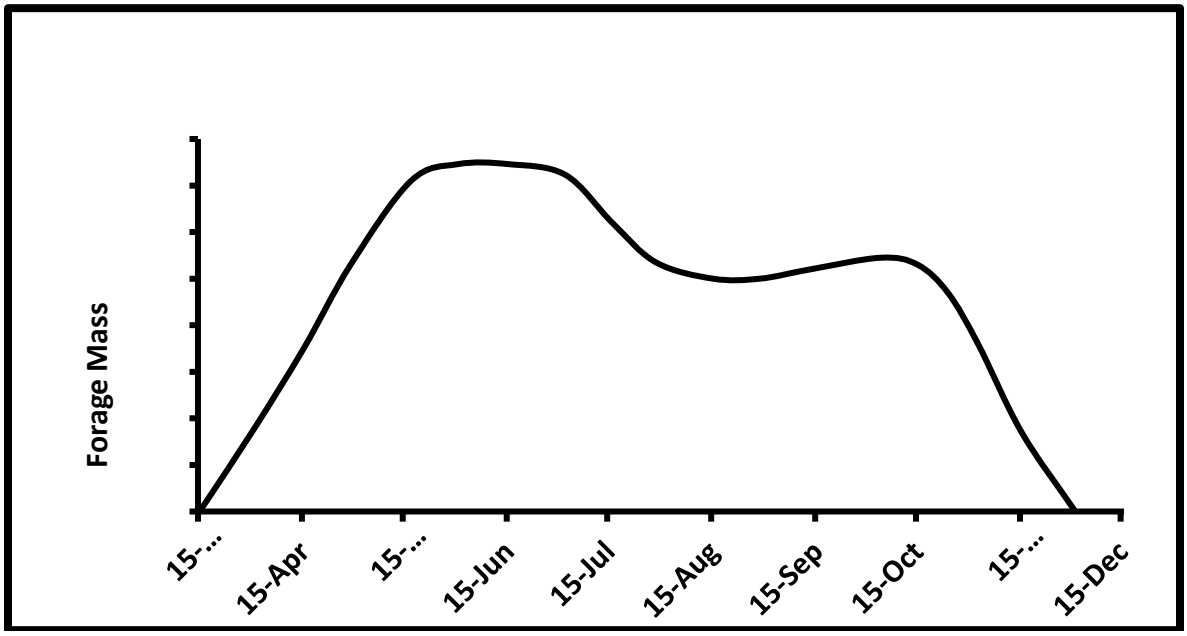


Figure 3. Illustration of forage dry matter mass variations of warm-season perennial grass during growth season.

Stockers and Cow-Calf on Winter Annual Forages

Active grazing can be extended into the fall, winter, and early spring using cool-season annual grasses or grass-clover management options (Mullenix & Rouquette, 2018). Small grains that are adapted to the Southern US include cereal rye, wheat, oats, and triticale. Rye has shown the best tolerance to low pH (acidic) soils. These small grains when combined with annual ryegrass have a bimodal forage DM accumulation trait (Figure 4). With a stocker operation, stocking strategies present challenges that are primarily related to fertilization with N and climatic diversity. With the major forage production occurring in the late-winter to early spring months, stocking rates have to be flexible to allow for proper utilization. Stocking strategies and stocking rates that are appropriate at initiation of grazing in November to December may be too high in December to January, and these initial stocking rates maybe too low in February to April (Rouquette, 2015). Thus, the stocking strategy for stocker cattle in which optimum to near-maximum gain per animal (ADG) and gain per acre are achieved must incorporate a flexiblstocking rate that may be two times greater in the spring than in the fall (Rouquette et al., 2013).

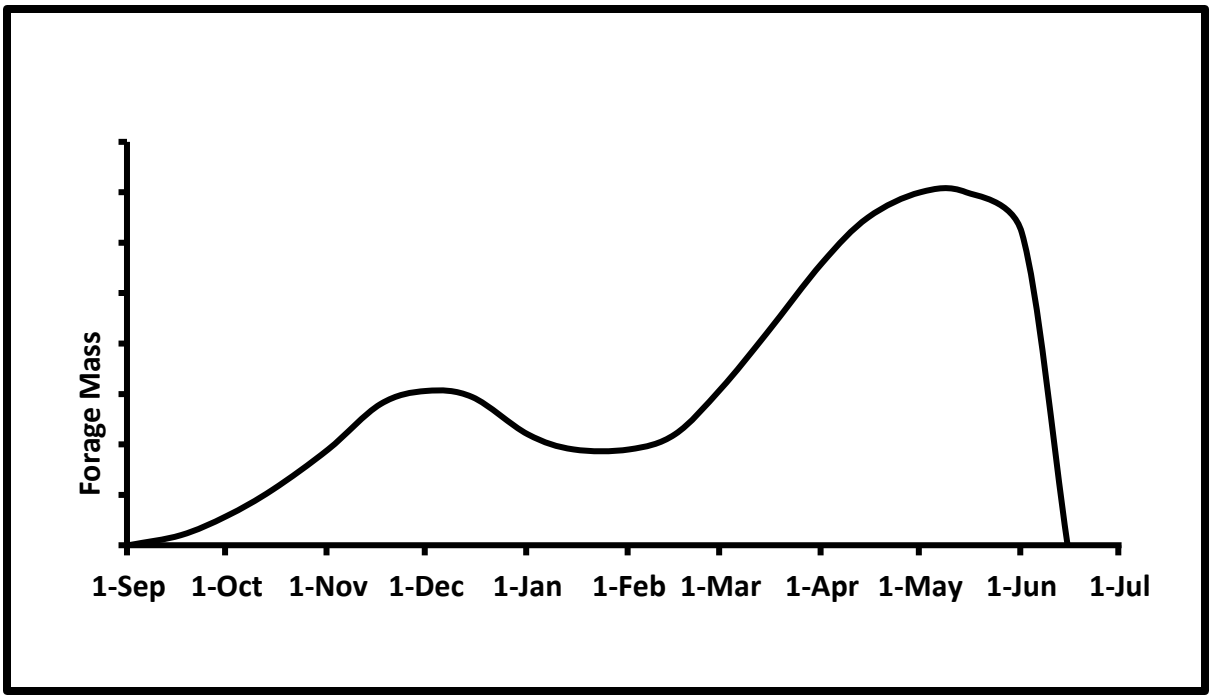


Figure 4. Bimodal forage mass and growth attributes of small grain and annual ryegrass pastures.

Perhaps one of the most recommended stocking strategies for small grain + ryegrass pastures is that of using cows and calves to assist with desired grazing pressure or forage availability. A commonly used stocking strategy to match forage production with utilization has been that of using limit-grazing of cows and calves or stockers (Altom, 1978). Some of these limit grazing strategies may involve grazing 2 to 3 days per week, 2 to 3 hours per day, or other combinations that allow managers to have a daily or weekly appraisal of forage produced and utilized.
For cows and calves, annual ryegrass and/or clovers have long been used to extend the grazing season on warm-season perennial grass pastures. The magnitude of stocking rate effects on cow-calf performance during a 29-year period has shown the relationship of forage mass and performance (Rouquette, 2017), and the impact on stand maintenance (Rouquette et al., 2011).

Cow-Calf

With respect to cows and calves, there are several management options that may be used for sustainable pasture and beef production. In the southeastern states from Interstate 20 to the Gulf of Mexico, warm-season perennial grasses are the basic forages for pastures. Figure 3 shows the general forage growth of these grasses during the year, from time of emergence from winter dormancy in the spring to time of active growth after the first killing frost in the fall. Cow-calf systems are therefore managed over a 365-day period with the basic pasture grass becoming dormant during the winter. Thus, to provide a constant source of forage for daily consumption, an array of strategies may be implemented that includes winter-annual forages and/or hay with stockpiled warm-season, perennial grasses with or without supplementation (Figure 5) (Rouquette, 2020).

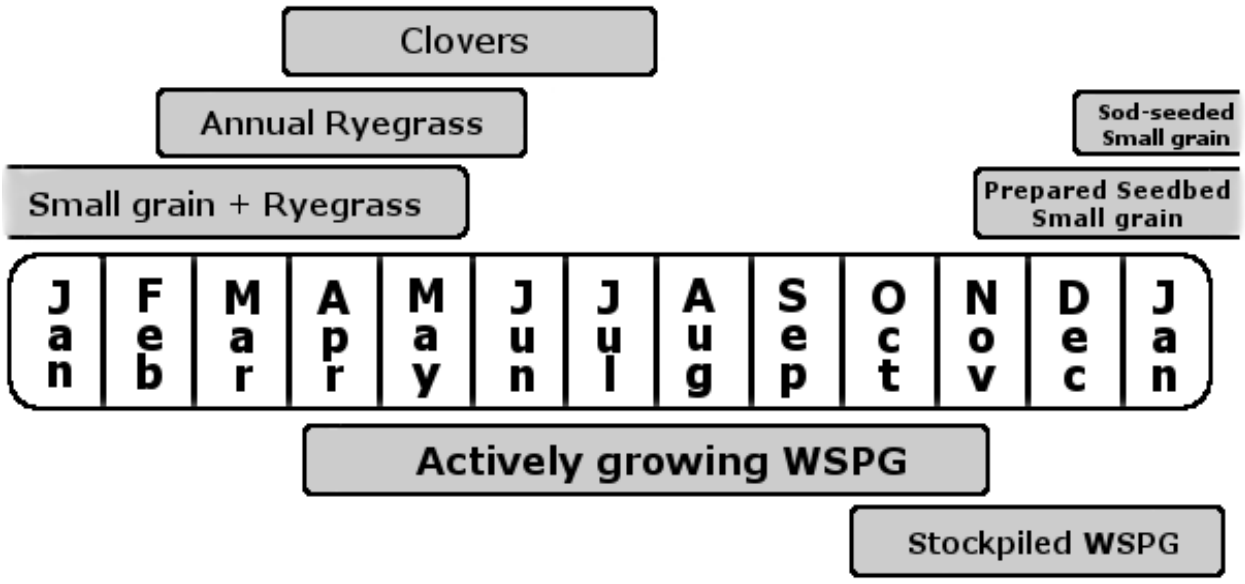
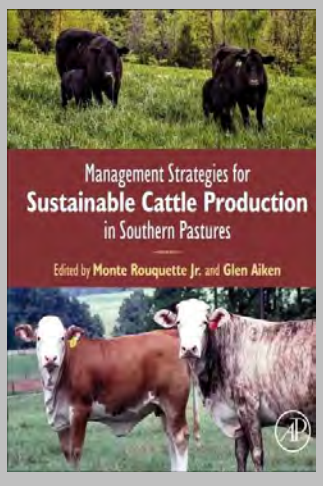


Figure 5. Forage combinations with warm-season perennial grasses (WSPG) for 365-day grazing in Hardiness Zone 8.

Time of calving is a management decision with considerations given for pastures within a specific vegetation zone. The choice and selection of a calving season offers challenges for management to match forage production traits and subsequent nutritive value of pastures with the opportunities for rebreeding the cow herd. Management objectives for calving season include desired weaning percent, weaning weight, and percent rebreeding. One of the most important considerations for rebreeding the cow herd is that of body condition score (BCS) of the cow at time of calving (Rouquette et al., 2018). Although there are always some differing circumstances, cows should have a BCS of 5 or greater at time of calving for successful rebreeding in the designated season. To decide on the best calving season for a specific property, some of the following objectives and decisions should be considered and explored by management (Figure 6). The most appropriate strategies to attain acceptable BCS and reliable, sustained 12-month calving intervals are related to the forage and pasture conditions during the dry cow period from time of weaning to the next calf. Thus, much if not all of the success of a 12-month calving system is due to the management of dry cows and pastures during the 3 to 4 months pre-calving.

- A warm-season perennial grass pasture that allows for overseeding with cool-season annual forages such as small grain, ryegrass, and clover.
- The calving season that offers the best opportunity to wean heavy-weight calves.
- The calving season that offers appropriate forage-pastures for dry cows to meet nutritional requirements for weight gain and with reduced costs for supplementation and labor.
- The calving season that offers the best opportunities for merchandizing/selling calves and cull cows.
- Pasture availability for retained ownership from time of weaning for an additional 100 to 200 days of grazing.



Management Strategies for Sustainable Cattle Production in Southern Pastures

Edited by: **Monte Rouquette, Jr.**, Regents Fellow and Professor of Forage Physiology, Texas A&M AgriLife Research Center – Overton, TX, and **Glen Aiken**, Center Director, UF-IFAS North Florida Research and Education Center – Quincy, FL

"Provides strategies to optimize cattle welfare and to help improve the sustainability of pastures and profitable cattle production."

KEY FEATURES

- Documents the effects of cattle grazing on greenhouse gas emissions and carbon footprints.
- Discusses strategies to enhance soil fertility, soil health, and nutrient cycling in pastures.
- Provides information on the use of stocking rates, stocking strategies and grazing systems to optimize biological and economic implications of cow-calf production and weaned calves and stockers.
- Presents strategies for cattle supplementation and watering systems to minimize negative impacts on water and soil health.
- Describes pasture systems, production-harvesting, and consumer preferences for pasture-finished beef.
- Includes methods for weed control to maintain pasture condition and ecosystem stability.
- Describes management strategies to integrate cattle operations with wildlife sustainability.
- Chapters authored by 26 nationally and internationally recognized scientists from land grant universities and USDA/ARS centers in the southeastern US.
- A practical resource for scientists, students, and stakeholders on management strategies for pastures.

TABLE of CONTENTS

Available at: Amazon.com, BarnesAndNoble.com, and Elsevier.com
search for *Management Strategies for Sustainable Cattle*
(use promo code FOOD319 at Elsevier.com for a special discount and free shipping)

Figure 6. Management Strategies for Sustainable Cattle Production in Southern Pastures

Forage and pasture options for the more humid regions that include bermudagrass and cool-season annual forages, and which fit calving seasons for Fall (Table 1), Winter (Table 2), and Spring (Table 3), are provided as examples of management strategies (Rouquette et al., 2020). The long-term, 29-year relationship of lactating cow and suckling calf weight gain with stocking rate, expressed as Forage Allowance, on bermudagrass pastures overseeded with ryegrass or clover, is shown in Figure 7 (Rouquette, 2017).

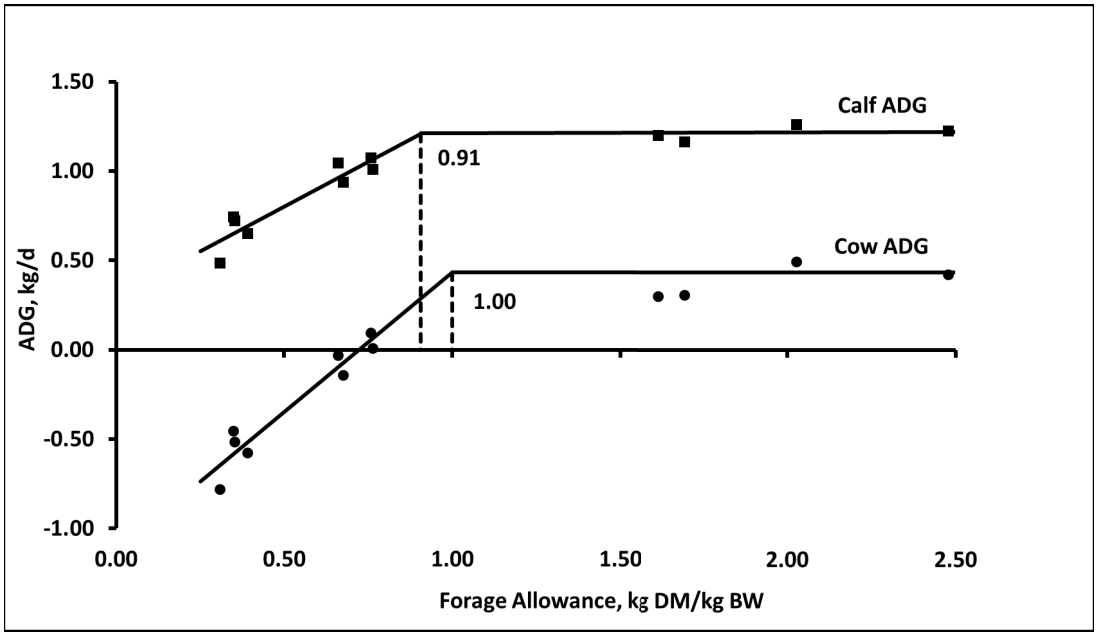


Figure 7. Relationship of cow and suckling calf ADG with forage allowance using a 29-yr stocking rate data set.

Table 1. Forage and pasture options for fall-calving cows.

MONTH	ANIMAL ACTIVITY	FORAGES AND PASTURES
AUG	Dry Cow	Warm season perennial grass (WSPG) pasture[1]
SEP	Calve	WSPG pasture
OCT	Calve; Suckling Calf	WSPG pasture
NOV	Calve; Suckling Calf	Stockpiled forage; WSPG pasture; Hay and/or supplement
DEC	Cow-calf; Suckling Calf **Dec1**: Initiate Breeding	Stockpiled forage; Hay and/or supplement; Limit-graze small grain[2] + annual ryegrass (option)
JAN	Cow-calf; Suckling Calf; Breeding Continues	Limit-graze small grain + annual ryegrass (option); Hay and/or supplement
FEB	Cow-calf; Suckling Calf **Feb15**: Terminate Breeding	Full-time graze small grain + annual ryegrass (option); Ryegrass and/or clover
MAR	Cow-calf; Suckling Calf	Full-time graze small grain + annual ryegrass (option); Ryegrass and/or clover
APR	Cow-calf; Suckling Calf	Ryegrass and/or clover; WSPG
MAY	Cow-calf; Suckling Calf	Ryegrass and/or clover; WSPG
JUN	**Jun15**: Initiate Weaning Cow-calf; Dry Cow	WSPG
JUL	**Jul 15**: Finalize Weaning Dry Cow	WSPG

[1]Bermudagrass, Bahiagrass; native grasses
[2]Rye, oats, wheat

Table 2. Forage and pasture options for winter-calving cows.

MONTH	ANIMAL ACTIVITY	FORAGES AND PASTURES
DEC	Dry cow	Warm season perennial grass (WSPG)[1]; Stockpiled forage; Hay and/or supplement;
JAN	Calve	Hay and/or supplement
FEB	Calve; Suckling Calf	Ryegrass and/or clover
MAR	Calve; Suckling Calf	Ryegrass and/or clover
APR	Cow-calf; Suckling Calf Apr15: Initiate Breeding	Ryegrass and/or clover
MAY	Cow-calf; Suckling Calf; Breeding Continues	Ryegrass and/or clover; WSPG
JUN	Cow-calf; Suckling Calf; Breeding Continues	WSPG
JUL	Cow-calf; Suckling Calf Jul1: Terminate Breeding	WSPG
AUG	Cow-calf; Suckling Calf	WSPG
SEP	Cow-calf; Suckling Calf Late-Sep: Initiate Weaning	WSPG
OCT	Late-Oct: Finalize Weaning Dry Cow	WSPG; Stockpiled forage
NOV	Dry Cow	WSPG; Stockpiled forage; Hay and/or supplement

[1]Bermudagrass, Bahiagrass; native grasses

Table 3. Forage and pasture options for spring-calving cows.

MONTH	ANIMAL ACTIVITY	FORAGES AND PASTURES
FEB	Dry Cow	Hay and/or supplement
MAR	Calve; Suckling Calf	Ryegrass and/or clover
APR	Calve; Suckling Calf	Ryegrass and/or clover
MAY	Calve; Cow-calf; Suckling Calf	Ryegrass and/or clover; Warm season perennial grass (WSPG)[1]
JUN	**Jun1**: Initiate breeding Cow-calf; Suckling Calf	WSPG
JUL	Cow-calf; Suckling Calf; Breeding Continues	WSPG
AUG	**Aug15**: Terminate breeding Cow-calf; Suckling Calf	WSPG
SEP	Cow-calf; Suckling Calf	WSPG
OCT	**Oct15**: Initiate weaning	WSPG
NOV	**Nov15**: Finalize weaning Dry Cow	WSPG; Stockpiled forage; Hay and/or supplement
DEC	Dry Cow	WSPG; Stockpiled forage; Hay and/or supplement
JAN	Dry Cow	Hay and/or supplement

[1]Bermudagrass, Bahiagrass; native grasses

Prolonged, high stocking rates and resultant low herbage mass (HM) under continuous stocking can cause substantial stand loss of both Coastal and common bermudagrass pastures. However, with the aggressive and persistent nature of invasive bermudagrass ecotypes, bermudagrass species continued to provide nearly complete ground cover under N-fertilization regimens. Tables 4-7 show the impact of long-term stocking rates and N fertilization on stand maintenance of bermudagrass. In the absence of N fertilization for 20 years, bahiagrass was a significant invasive species on low HM pastures. Under high HM, the originally planted Coastal and common bermudagrass made up 70 to 75% of the bermudagrass present after 38 years of grazing management. The genetic similarity dendograns and cluster analyses provided profound identification differences among bermudagrass ecotypes. Further genetic analysis would be needed to determine whether these differences were due to contamination from common bermudagrass types in adjacent areas of from intercrossing of Coastal bermudagrass with common bermudagrass pollen. Under grazing strategies for animal performance and production per unit land area, stocking rates of 1 cow-calf pair per ac (1250 to 1300 lb BW/ac) were sufficiently low enough to allow for adequate HM to promote bermudagrass stand maintenance. Low HM created by stocking rates of 2 to 3 cow-calf pair/ac (3150 to 4700 lb BW/ac) did not eradicate bermudagrass ecotypes and other sod-forming grasses; however, these stocking rates substantially eliminated the originally planted Coastal and common bermudagrass (Rouquette, et al., 2011).

Table 4. Long-term stocking and fertility regimen effects on percent stand of forages in Coastal bermudagrass pastures (Rouquette, et al., 2011).

	Bermudagrass	Bahiagrass	Other‡
	----------%----------		
Fertility Regimen			
N plus ryegrass	99.8 a†	0 b	0.24 a
No N plus clover	80.6 b	19.3 a	0.14 a

† Letters in a column grouping, followed by a different letter, differ at $p < 0.01$.
‡ Crabgrass and miscellaneous weeds.

Table 5. Long-term stocking and fertility regimen effects on percent stand of forages in common bermudagrass pastures (Rouquette, et al., 2011).

	Bermudagrass	Bahiagrass	Other‡
	----------%----------		
Herbage Mass			
Low	87 a†	0 b	13 a
Medium	68 b	30 a	3 c
High	64 b	30 a	6 b
Fertility Regimen			
N plus ryegrass	97 a†	1 b	2 b
No N plus clover	49 b	39 a	12 a

† Letters in a column grouping, followed by a different letter, differ at $p < 0.01$.
‡ Crabgrass and miscellaneous weeds.

Table 6. Invasive bermudagrass ecotypes and bahiagrass in Coastal bermudagrass pastures under long-term stocking intensities and fertility regimens (Rouquette, et al., 2011).

Fertility regimen†	Herbage mass	Coastal bermudagrass	Invasive bermudagrass ecotypes	Bahiagrass
		----------%----------		
N plus RYG	Low	14 b‡	86 a	0
N plus RYG	Medium	71 a	30 b	0
N + RYG	High	75 a	25 b	0
No N plus CLV	Low	21 b	73 a	7 b
No N plus CLV	Medium	24 b	45 b	31 a
No N plus CLV	High	78 a	22 c	0 b

†RYG, ryegrass; CLV, clover.
‡Means within a column and treatment not followed by the same letter differ at $p < 0.01$.

Table 7. Invasive bermudagrass ecotypes and bahiagrass in common bermudagrass pastures under long-term stocking intensities and fertility regimens (Rouquette, et al., 2011).

Fertility regimen†	Herbage mass	Common bermudagrass	Invasive bermudagrass ecotypes	Bahiagrass
		----------%----------		
N plus RYG	Low	57 b‡	43 a	0 a
N plus RYG	Medium	60 a	41 a	0 a
N + RYG	High	66 a	34 a	0 a
No N plus CLV	Low	27 b	27 a	46 a
No N plus CLV	Medium	24 b	18 a	59 a
No N plus CLV	High	72 a	28 a	0 b

†RYG, ryegrass; CLV, clover.
‡Means within a column and treatment not followed by the same letter differ at $p < 0.01$.

Considerations for Management Strategies

The most reliable and predictable factor for indexing sustainability of cow-calf production is that of persistence and stand maintenance of forages in pastures of a vegetation zone. Stocking rate, intensity of defoliation regimens, and soil nutrient upkeep are the primary management strategies that control the desired level of pasture and cow-calf production. Management controls the degree of intensity of the cow-calf or stocker operations which are based on level of economic risk and desired environmental and stewardship options. These management strategies should be based on integrating relationships of pasture ecosystems and stand maintenance, environmental awareness, economic implications, and legacy-heritability objectives of property for strategic, sustainable forage-livestock production (Rouquette, 2017).

Management and stocking strategies are uniquely integrated with grazing pressure, stocking rates, deferment of pastures, and harvested forage. Stocking strategies should consider forage growth and nutritive value inputs and allow modifications on defoliation to match animal nutrient requirements in order to produce the desired level of production. The objectives of stocking strategies are targeted at matching stocking rates and stocking methods with climatic conditions for a specific ecoregion with the purpose of exploring optimum biological and economic impacts for a sustainable system (Rouquette, 2015). Stocking strategies should include economic goals and objectives in addition to risk awareness for sustainable pasture-animal production systems.

Successful managers should always have a multi-level "decision-indicator" that includes current, weekly, monthly, and seasonal expectations of forage growth and accumulation which are influenced by climatic conditions. Perhaps the "best strategy" is to "know" and "expect" the potential surplus or deficits in forage accumulation for the near future. Management should implement the "best approach" for optimum utilization via grazing, changes in stocking rate, altering the stocking method, and/or mechanical harvesting. Implementing management strategies requires a similar "mindset" as one preparing for a competitive event: The competitors for management are climatic diversities and appropriate timing to match soil-forage attributes with animal requirements for sustainable livestock production and an economically viable product (Rouquette & Aiken, 2019).

Literature Cited

1. Altom, W. 1978. Limit-grazing of small grain pastures. Noble Foundation Agricultural Division Bulleting. Noble Foundation, Inc., Ardmore, Okla. pp. 22
2. Blaser, R. E., J. R. Harlan, and R. M. Love. 1962. Grazing management. *In*: G. O. Mott, editor, Pasture and range research techniques. Comstock Publ. Cornell Univ. Press, Ithaca, NY. p. 11-17.
3. Blaser, R. E., R. C. Hammes, Jr., J. P. Fontenot, H. T. Bryant, C. E. Polan, D. D. Wolf, F. S. McClaugherty, R. G. Kline, and J. S. Moore. 1986. Forage-animal management systems. *In*: M.C. Holliman, (ed). V. P. I. Bull 86-7. Virginia Agric. Expt. Sta. Virginia Polytechnic Inst. And State University, Blacksburg, VA. p. 1-90.
4. Bransby, D. I. 1988. Biological implications of rotational and continuous grazing: A case for continuous grazing. Pages 10–13. *In* Proc. Am. Forage Grassl. Conf., Columbia, MO. Am. Forage Grassl. Counc., Georgetown, TX.
5. Bransby, D. I. 1988. Rotational and continuous grazing interactions with stocking rate on warm season perennial pastures. *In*: Proc. Am. Forage and Grassl. Conf., Baton Rouge, LA. 11-14 Apr. 1988. AFGC, Belleville, PA. p. 97-101.
6. Bransby, D. I. 1991. Biological implications of rotational and continuous grazing: A case for continuous grazing. In: Proc. Am. Forage Grassl. Conf. Columbia, MO. 1-4 Apr. 1991. Am. Forage Grassl. Counc. Georgetown, TX. p.10-14.
7. Bransby, D. I. and B. E. Gamble. 1993. Comparison of rye with a rye + ryegrass mixture for grazing. p. 31-33. *In* Proc. Am. Forage and Grassl. Conf. Des Moines, IA. Am. Forage Grassl. Council. Georgetown, TX.
8. GRSB (Global Roundtable for Sustainable Beef). 2016. The global beef value chain manages natural resources responsible and enhances ecosystem health. https://www.grsbeef.org/GRSB-Resources/. Accessed 7-9-2019.
9. Hill, G. M., R. N. Gates, and G. W. Burton. 1993. Forage quality and grazing steer performance from Tifton 85 and Tifton 78 bermudagrass pastures. J. Anim. Sci. 71:3219-3225.
10. Mullenix, M. K. and F. M. Rouquette, Jr. 2018. Invited Review: Cool-season annual grasses or grass-clover management options for extending the fall-winter-early spring grazing for beef cattle. Prof Anim Sci 34:231-239.
11. Oliver, W. M. 972. Coastal bermudagrass pastures for grazing calves and yearlings in Louisiana. Bull. No. 667. La. Agric. Exp. Stn., Baton Rouge.
12. Oliver, W. M. 1978. Management of Coastal bermudagrass being grazed with stocker cattle. North Louisiana Hill Farm Facts No.21. La. Agric. Exp. Stn., Baton Rouge.
13. Rouquette, F. M., Jr., M. J. Florence, and S. J. Gaertner. 1992. Rotational grazing of Coastal bermudagrass using one herd *vs* two herds. TAES-Overton Res. Ctr. Tech. Rept. 92-1:85-86.
14. Rouquette, F. M., Jr., M. J. Florence, G. H. Nimr, and J. L. Kerby. 1994. Three-herd rotational grazing of bermudagrass with cow-calf pairs and weaned steers. TAES-Overton Res. Ctr. Tech. Rept. 94-1:103-104.
15. Rouquette, F.M., Jr. 2005. Enhancing stocker gains from bermudagrass pastures. 59th So. Pasture and Forage Crop Imp. Conf. Utilization Workgroup, Philadelphia, MS. 11-13 May 2005. p. 1-7.

16. Rouquette, F. M., Jr., J. J. Cleere, C.R. long, and R. D. Randel. 2005. Birth to harvest attributes of Brahman and Brahman-influenced steers. *In*: D.G. Morrison, L. Cundiff, and J. Honeycutt, editors. A compilation of research results involving tropically adapted beef cattle breeds. Coop-Series Bull. Tropically Adapted Breeds-Regional Project S-1013. Louisiana Agricl. Exper. Stn., Baton Rouge, LA. p. 40-59.
17. Rouquette, F. M., Jr., W. F. Anderson, K. R. Harris-Shultz, and G. R. Smith. 2011. Stand maintenance and genetic diversity of bermudagrass pastures under different grazing management strategies during a 38-year period. Crop Sci. 51:2886-2894.
18. Rouquette, F. M., Jr., J. Kerby, G. Nimr and K. Norman. 2013. Stocking strategies and stocking rate to enhance forage utilization, gain per animal, and gain per unit land area for ryegrass pastures. Amer. Soc. Anim. Sci. Indianapolis, IN. Abstract. T258.
19. Rouquette, F. M., Jr. 2015. Grazing systems research and impact of stocking strategies on pasture–animal production efficiencies. Crop Sci. 55:2513-2530. doi:10.2135/cropsci2015.01.0062
20. Rouquette, F. M., Jr. 2017. Invited Review: Management strategies for intensive, sustainable cow-calf production systems in the southeastern United States: Bermudagrass pastures overseeded with cool-season annual grasses and legumes. Prof. Anim. Sci. 33:297-309. doi:10.15232/pas.2016-01591.
21. Rouquette, Jr., F. M., J. L. Kerby, and K. D. Norman. 2018. Effects of stocking rate on body condition of F-1 (Brahman x Hereford or Angus) cows at weaning and rebreeding performance. Anim. Sci., Vancouver, CN.
22. Rouquette, F. M., Jr. and G. E. Aiken. 2020. Introduction: Management strategies for sustainable cattle production in southern pastures. Chpt. 1:1-10. Elsevier Publ.
23. Rouquette, Monte, Jr., Vanessa Corriher-Olson, and Gerald R. Smith. 2020. Management strategies for pastures and beef cattle in the Middle-South: The I-20 Corridor. p.123-188. In: Monte Rouquette, Jr. and Glen E. Aiken (Ed). Management strategies for sustainable Cattle Production in Southern Pastures. Elsevier Academic Press. San Diego, CA. USA..
24. USRSB (US Roundtable for Sustainable Beef). 2016. A multi-stakeholder initiative developed to advance, support and communicate continuous improvement in sustainability of the U.S. beef value chain. https://www.usrsb.org/about.aspx. Accessed 7-9-2019.

USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

Natural Resources Conservation Service

101 South Main Street, Temple, Texas, 76501
(254) 742-9800

Contacts:
Kristy Oates, USDA-NRCS State Conservationist
Charles Kneuper, USDA-NRCS State Resource Conservationist
Stacy Riley, USDA-NRCS Assistant State Conservationist for Programs

The United States Department of Agriculture has one agency that is charged with providing technical assistance to private landowners. This agency is called the Natural Resources Conservation Service and has offices that serve every county in Texas. The NRCS can assist people on a voluntary basis to apply engineering practices, agronomic practices, wildlife management and rangeland management to land.

This agency works one-on-one with private landowners in the development of conservation plans. Agency personnel help landowners make decisions concerning goals and objectives of their operation and choose the best practices to apply in a timely manner to meet the needs of the land, while obtaining the goals and objectives of the landowner. These decisions are recorded in a conservation plan, and practices are scheduled on a yearly basis to achieve the goals and objectives. This conservation planning is done in partnership with local soil and water conservation districts, which are political subdivisions of the state of Texas. This process allows the USDA-NRCS, as a federal agency, to work with private landowners.

The USDA-NRCS also works with private individuals and groups to implement conservation on the ground in concert with several Farm Bill programs that provide financial assistance for installing conservation practices. Programs address brush management, wildlife management, grazing management, range and pasture planting, cross fencing, water development for livestock, irrigation systems, erosion control, and programs that are specific for restoration of wetlands and rangelands. The 2018 Farm Bill offers America's agricultural producers and nonindustrial private forest landowners more assistance than ever before to voluntarily conserve natural resources on our Nation's privately owned farm and ranch lands.

Farm Bill financial assistance programs include the Environmental Quality Incentives Program (EQIP), the Conservation Stewardship Program (CSP), the Agricultural Conservation Easement Program (ACEP), and the Regional Conservation Partnership Program (RCPP).

For more information, contact a local NRCS office, USDA Service Center, local conservation district, or visit www.tx.nrcs.usda.gov.

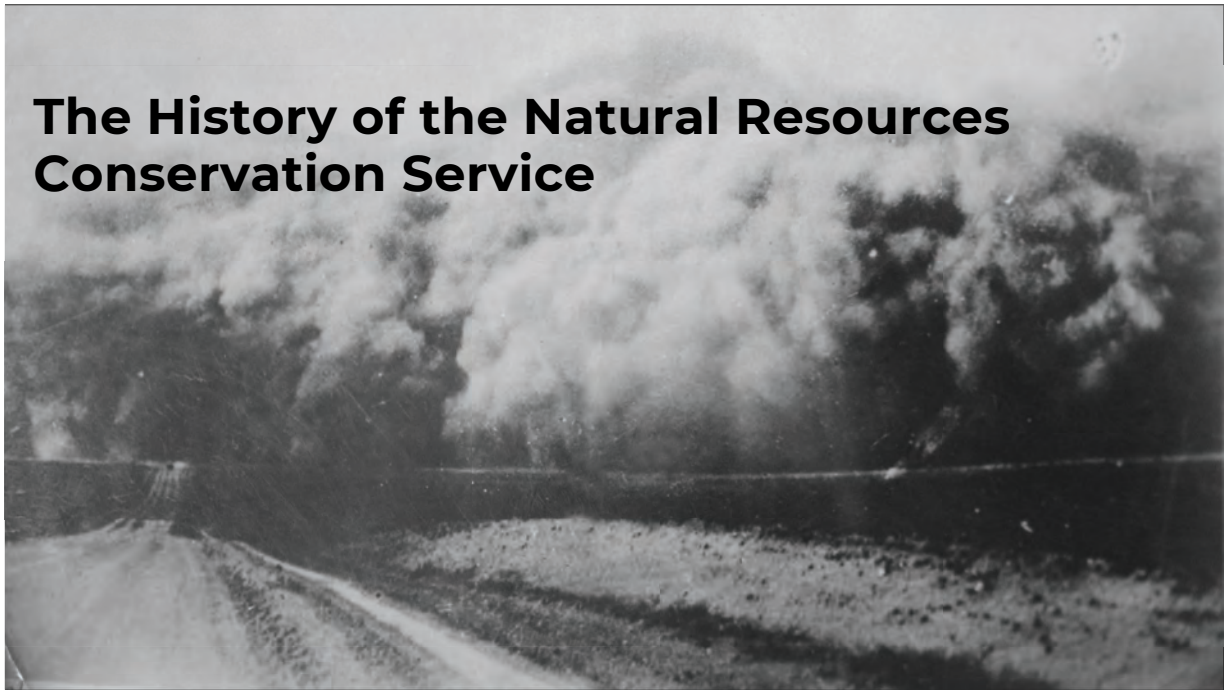
USDA is an equal opportunity provider, employer and lender.

USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

Range Update June 2024

Jason Hohlt, Zone Rangeland Management Specialist
Bryan, Texas

FARM PRODUCTION AND CONSERVATION
FSA | NRCS | RMA | Business Center



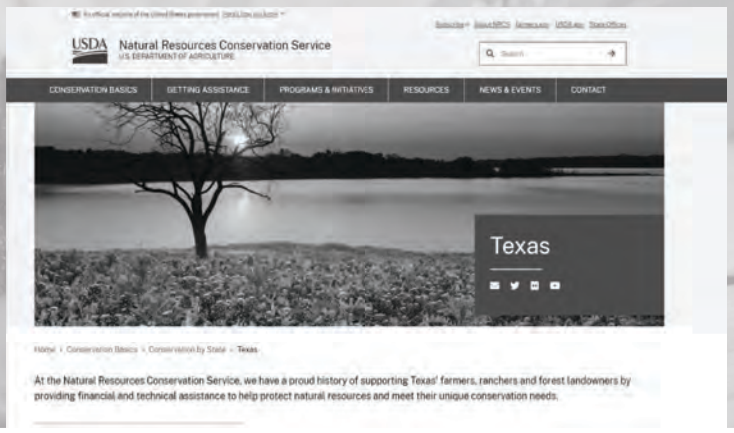
NRCS Vision:

A world of clean and abundant water, healthy soils, resilient landscapes, and thriving agricultural communities through voluntary conservation.

USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

How do you find NRCS?

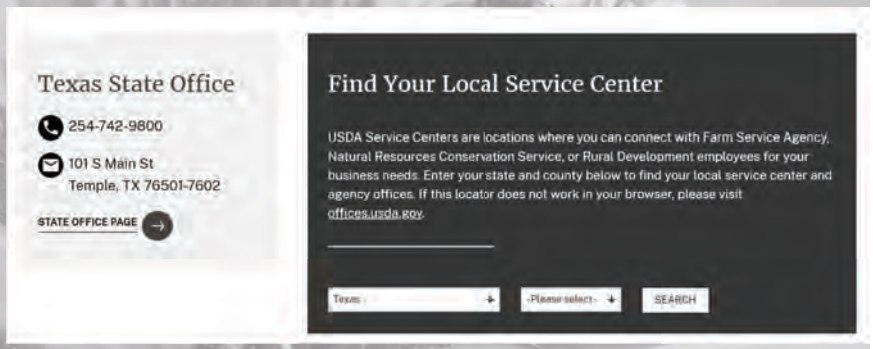
- Search: Texas NRCS



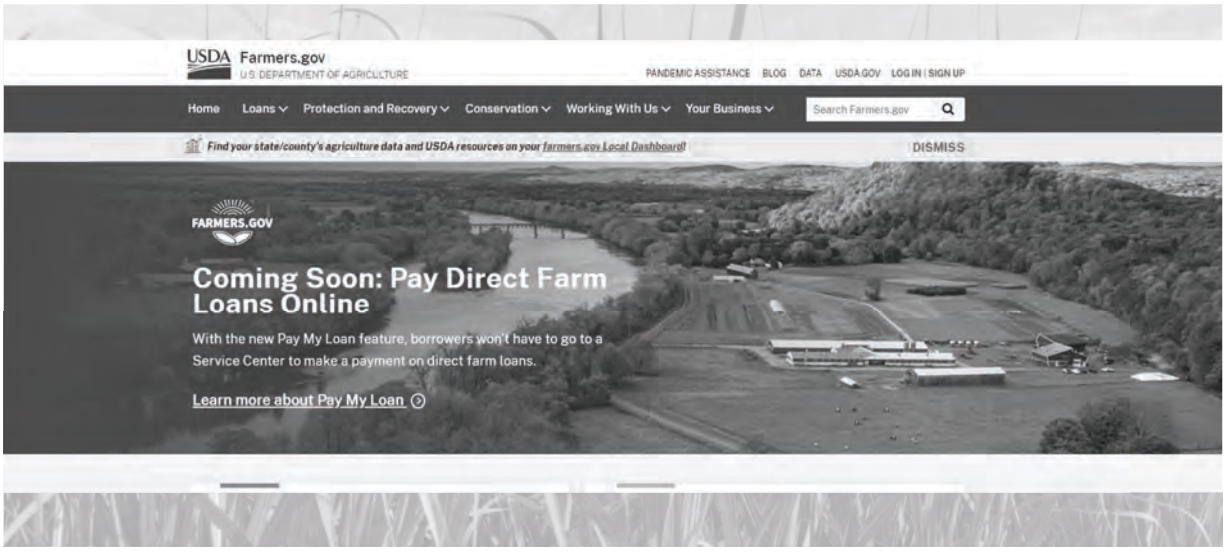
FARM PRODUCTION AND CONSERVATION
FSA | NRCS | RMA | Business Center

How do you find NRCS?

- Search: Texas NRCS



USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE



FARM PRODUCTION AND CONSERVATION FSA | NRCS | RMA | Business Center

USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

What We Do

- Technical Assistance

- Financial Assistance

FARM PRODUCTION AND CONSERVATION

USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

Three Great Technical Assistance Opportunities:

- 1. Get a complete inventory or your property.

Three Great Technical Assistance Opportunities

- 2. Identify Problems and Opportunities

USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

Three Great Technical Assistance Opportunities

- Leverage the experience of others.

FARM PRODUCTION AND CONSERVATION
FSA | NRCS | RMA | Business Center

Financial Assistance

- EQIP – Environmental Quality Incentives Program
- CSP – Conservation Stewardship Program
- ACEP – Agricultural Conservation Easement Program

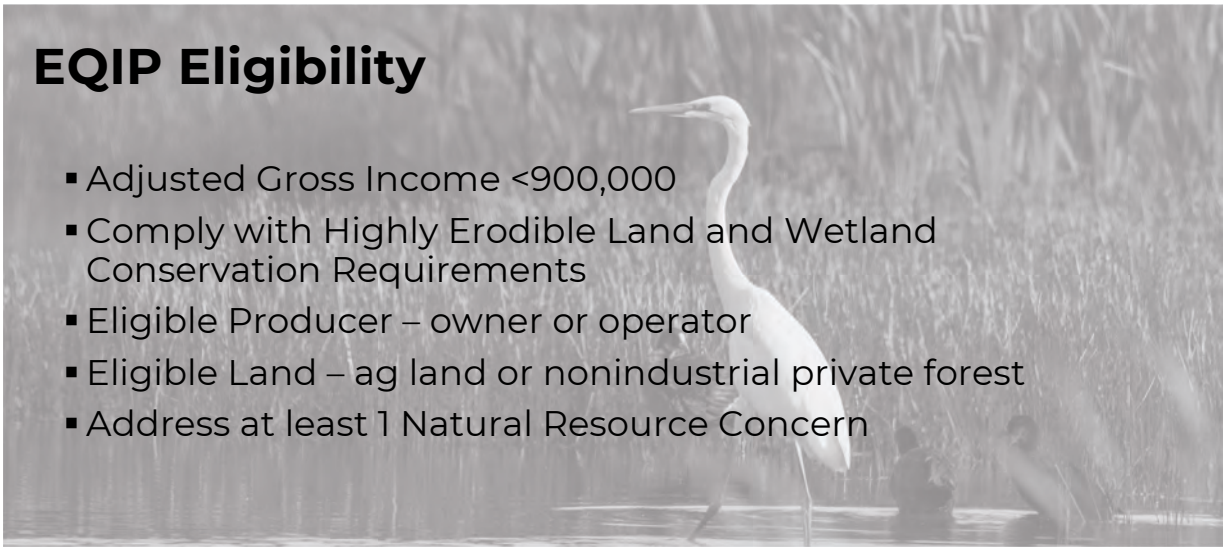
USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

<u>EQIP Purpose:</u> To promote agricultural production, forest management, and environmental quality as compatible goals, and to optimize environmental benefits.

- Common Conservation Practices:
  - Cross Fencing
  - Brush Management
  - Livestock Water
  - Grass Planting

FARM PRODUCTION AND CONSERVATION FSA | NRCS | RMA | Business Center

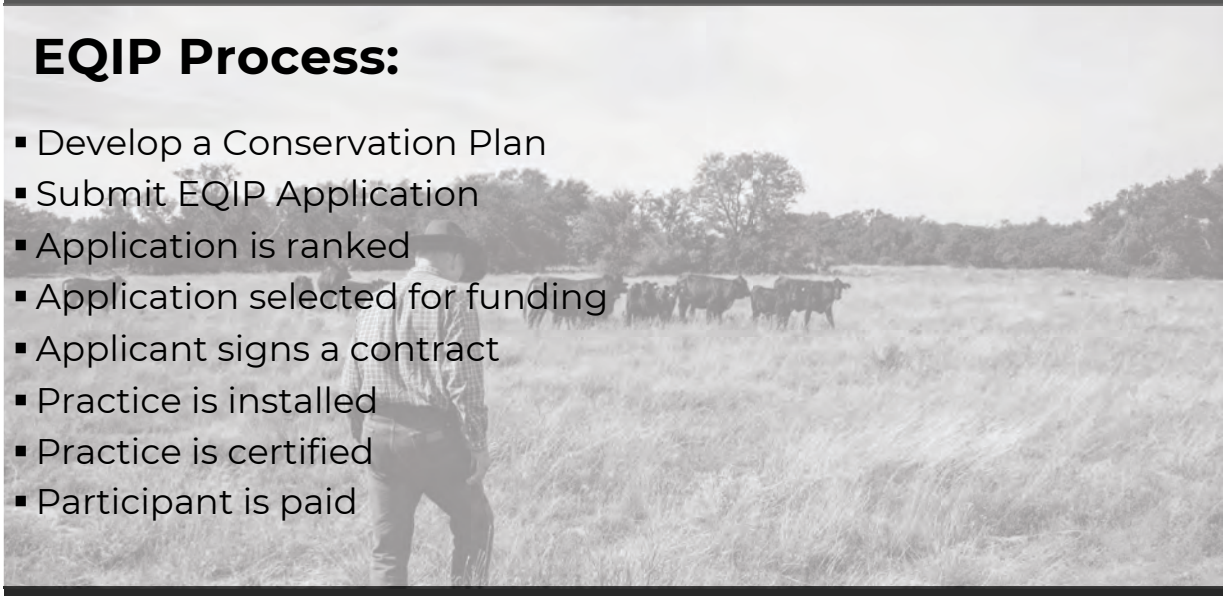
EQIP Eligibility



- Adjusted Gross Income <900,000
- Comply with Highly Erodible Land and Wetland Conservation Requirements
- Eligible Producer – owner or operator
- Eligible Land – ag land or nonindustrial private forest
- Address at least 1 Natural Resource Concern

USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

EQIP Process:



- Develop a Conservation Plan
- Submit EQIP Application
- Application is ranked
- Application selected for funding
- Applicant signs a contract
- Practice is installed
- Practice is certified
- Participant is paid

FARM PRODUCTION AND CONSERVATION
FSA | NRCS | RMA | Business Center

Payment Rates

- Examples for 2024:
  - Brush Mgmt., Chemical Broadcast $33.31/ac
  - Fence, level non-rocky $2.40/ft
  - Native Grass Planting $145.51/ac

Higher Rates for:
Limited Resource Producer
Socially Disadvantaged Groups
Beginning Farmer and Rancher

USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

Purpose of CSP: To encourage producers to address priority resource concerns and improve and conserve the quality and condition of natural resources in a comprehensive manner by:

1. Undertaking additional conservation activities

2. Improving, maintaining, and managing existing activities across the entire agricultural operation…

FARM PRODUCTION AND CONSERVATION
FSA | NRCS | RMA | Business Center

USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

CSP Eligibility:

- Adjusted Gross Income <900,000
- Comply with Highly Erodible Land and Wetland Conservation Requirements
- Eligible Producer – owner or operator that shares in the risk of the ag operation
- Eligible Land – ag land or nonindustrial private forest

USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

CSP Eligibility:

- Meet a minimum stewardship threshold
- Improve at least 1 Natural Resource Concern during the contract by undertaking a new activity.

USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

CSP Activities:

5-year contract

Example Activities:

- Riparian Corridors
- Contingency Planning
- Vegetation / Soil Monitoring
- Wildlife Habitat Improvement

FARM PRODUCTION AND CONSERVATION

FSA | NRCS | RMA | Business Center

USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

Conservation Easement Opportunities:

- Agricultural Land Easement Program
- Wetland Reserve Easement Program

FARM PRODUCTION AND CONSERVATION

FSA | NRCS | RMA | Business Center

Agricultural Land Easement Details

- No minimum ownership time
- Must be working agricultural lands
- Perpetual easements only
- Only eligible conservation entities can apply
- The conservation entity holds the easement

Wetland Reserve Easement Details

- 24 month minimum ownership time
- 30 yr and Permanent Easements
- Must be a wetland in need of restoration
- U.S. Government holds the easement and controls all management activities.
- Landowner retains title, access control, hunting/fishing rights, and minerals.
- Management activities by permission only.

USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

www.nrcs.usda.gov

FARM PRODUCTION AND CONSERVATION FSA | NRCS | RMA | Business Center