



Virginia Forage and Grassland Council, Inc. Conservation Innovation Grant (CIG) Ronnie Nuckols Case Study Summary

Using Annual Forages and Improved Grazing Management to Build Soil Health and Improve System Performance

Farm Demonstration Cooperator

Mr. Ronnie Nuckols
Owner-operator

Farm Facts:

30 miles west of Richmond, VA north
of Route 6 in Goochland County

Typical rolling piedmont landscape
consisting mostly of highly weath-
ered, well-drained, upland soils with
good forage production potential

Fenced, non-forested pastureland
totals approximately 115 acres

Enterprise:

Commercial cow/calf production sys-
tem, primarily Angus cross cattle

Stocked with 70 cow-calf pairs, 3
bulls and 18 yearling replacement
heifers

Managed with both fall and spring
calving herds

Grant Recipient:

This farm demonstration was partially
funded through a USDA-NRCS Conserva-
tion Innovation Grant

Key Project Partners:

USDA-NRCS
Monacan Soil and Water Conservation District
Virginia Cooperative Extension
Virginia Tech

Case Study Release Date:

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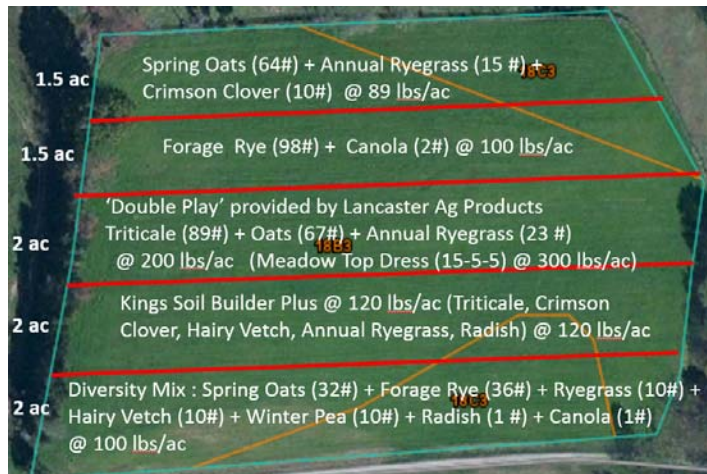


When Ronnie Nuckols took over full management of this farm in 2009, after retiring from his construction business, it had been continuously grazed for many years resulting in low productivity pastures, heavy weed pressure and excessive hay feeding. After learning more about how improved grazing management could increase the function and productivity of his pastures, he made a plan and began implementing changes.

Using management tips and technical information gained from his peers, Extension and conservation service professionals, Ronnie worked with the Monacan Soil and Water Conservation District to exclude streams and install the needed infrastructure to facilitate a basic rotational grazing system. Over a few years pasture condition improved, weed pressure declined and pasture productivity increased. During this time Ronnie visited other farmers who were using annual forage species and more intensive management techniques to boost pasture productivity and improve soil health. He wanted to implement these strategies on his farm, but he had several questions to be answered. So he teamed up with the Virginia Forage and Grassland Council and developed a demonstration project to evaluate using annual forage mixtures for the following purposes:

1. To provide a fresh, high quality forage, to extend the grazing season into late fall and early spring for yearling heifers.
2. To mix forage species from different functional groups to possibly increase performance through diversity.
3. To build soil health by keeping the soil covered, minimizing soil disturbance, maximizing living roots and energizing the soil with diversity.
4. To compare how the different forage species mixes meet the stated production goals while providing a positive economic return on investment.

Demonstration Site Map, Layout and Planting Plan



Demonstration Establishment

The demonstration was planted on September 2, 2014, after the second harvest of Teff for hay, and a successful herbicide burndown of all remaining vegetation. To minimize soil disturbance, the five winter annual forage mixtures shown above were no-till planted at approximately ½- ¾ inches deep. Based on soil test results a complete fertilizer was applied supplying 50-20-70-10(S) at a cost of \$65 per acre on 4 of the demonstration plots. The 'Double Play' treatment received 200 lbs. per acre of 'Meadow Top Dress' (15-5-5-2.5-1-13) at a cost of \$89 per acre, an organic fertilizer provided by Lancaster Agricultural Products. All fertilizer was broadcast after planting.



With the goals of building soil health while producing a high quality, productive forage for grazing, Ronnie sought the advice from industry, conservation and extension specialists before deciding on these 5 different mixes.

- **# 1 Diversity Mix @ 100 lbs. per acre:** Spring Oats (32#), Forage Rye (36#), Annual Ryegrass (10#), Hairy Vetch (10#), Winter Pea (10#), Radish 1#), Rapeseed (1#)
- **#2 Kings 'Soil Builder Plus' @ 120 lbs. per acre:** Triticale (77#), Annual Ryegrass (12#), Crimson Clover (14#), Hairy Vetch (12#), Daikon Radish (2#)
- **#3 'Double Play' @ 200 lbs. per acre:** Triticale (89#), Oats (67#), A. Ryegrass (23#),
- **#4 Simple Mix with Brassica @ 100 lbs. per acre:** Forage Rye (98#), Rapeseed (2#)
- **#5 3-Way with Legume @ 89 lbs. per acre:** Spring Oats (64#), A. Ryegrass (15#), Crimson Clover (10#)

The forage mixtures range from a simple 2 species mix to a highly diverse 7 species mix. Likewise seeding rates varied from 89 lbs. per acre up to 200 lbs. per acre depending on the mixture. The forage mixtures represent different plant functional groups (grasses, legumes and forbs) including some species that will produce well in fall but winter kill.

"While transitioning this hay field to grazing I want to build soil health, however; the forage mix has to yield well and provide grazing days for my cattle," Ronnie Nuckols.

Two of these seed mixtures were recommended by seed companies and the others were custom blended for various conservation and production purposes. Ronnie was curious to see how the forage mixtures, at these seeding rates, would perform both in the fall and the following spring after winter grazing.

- How would these mixtures yield?
- Would the cattle graze them readily?
- Would they provide ground cover and other perceived benefits to build soil health?

Fall Growth and Species Mixture Performance

By mid-November the forages had grown tremendously ranging in estimated yield between 1,450 to 2,400 lbs. dry matter per acre. A forage field day was hosted in early November 2014 where 40 people attended to see, touch and learn about the various forage species planted in mixtures in the demonstration.

In plot #1 the Diversity Mix included spring oats, forage rye, annual ryegrass, hairy vetch, winter pea, radish and rapeseed (shown on right). This results in a very diverse mix of plant structure, leaf and root shape and includes at least two species from each of the plant functional groups (grasses, legumes and forbs). Average plant height across this strip was 17.6 inches with an estimated yield of 2,000 lbs. dry matter per acre. Both the spring oats and radish have maximum growth potential in the fall, but if not grazed, they would die in late winter during hard freeze conditions.



Plot # 1, Diversity Mix

Plot #2, 'Soil Builder Plus', provided by Kings Agriseeds, included triticale, annual ryegrass, crimson clover, hairy vetch and daikon radish. This represents another diverse forage mix with plants from each basic functional group. The radish, crimson clover and triticale seemed to dominate the stand during fall growth with an average plant height of 16.6 inches and an estimated yield of 1600 lbs. dry matter per acre by mid-November. This mixture was designed to penetrate and aerate the soil with the root tuber of the daikon radish and fix N with the high legume content. As mentioned earlier, the daikon radish would likely winter kill in February if not grazed before then.



Plot # 2, 'Soil Builder Plus'

Plot #3, the 'Double Play' mix was provided by Lancaster Ag. Products and planted at the high rate of 200 lbs. per acre to maximize production of high quality forage. This mix included triticale, spring oats and annual ryegrass and was fertilized with 300 lbs. per acre of their Meadow Top Dress (15-5-5), provided by Lancaster Ag. Products. This plot provided less diversity of species, however it produced a high quality, thick forage mass with an average height of 16.6 inches and an estimated yield of 1,900 lbs. dry matter per acre. In this demonstration the forage was grazed, however; it could have easily been harvested and stored or sold as feed to a local dairy.



Plot # 3, 'Double Play'

Plot #4, a Simple Mix with Brassica included forage rye and rapeseed planted at 100 lbs. per acre. This mix was the least expensive to plant, but it also had less diversity (1 grass and 1 forb) and the lowest fall yield, estimated at 1,450 lbs. dry matter per acre. When planning seed mixtures and establishment rates, cost is definitely important but as they say, “you often get what you pay for.” Depending on the priority of goals, one must invest wisely by selecting the right species and planting rates for the desired use.



Plot # 4, Simple Mix with Brassica



Plot # 5, 3-Way Mix with Legume

Plot #5 was a 3-Way Mix with Legume including spring oats, annual ryegrass and crimson clover planted at 89 lbs. per acre. Spring oats planted in late summer have tremendous growth potential during the fall of the year with adequate soil moisture and fertility. In this case the oats grew like crazy and quickly dominated the mix, out competing the crimson clover and ryegrass. From a fall production standpoint this mixture led the pack with an average height of 21.5 inches and an estimated average yield of 2,400 lbs. dry matter per acre. This mix had a relatively low level of diversity, but made up for it in production and quality of forage.

Based on these photos and descriptions, it is easy to distinguish the differences between mixtures. Composite forage grab samples were collected in late October and sent to the lab for quality analysis. Forage height was measured within each demo strip and averaged, then an average sample was cut, dried and weighed to estimate forage yield within each treatment. All treatments tested very high in percent crude protein and total digestible nutrients with both yield and quality summarized in the table on the right. Each forage mixture used in this demonstration had strengths or weaknesses depending on the intended purpose. The data collected and summarized in this case study is from a non-replicated, grazing demonstration and is to be used for general awareness and comparison. It is not considered research.

#	Treatment Species Mix	Est. Yield (lbs. DM/ac)	Quality (CP %)	Quality (TDN%)
1	Diversity Mix	2000	25.9	73.6
2	'Soil Builder Plus'	1600	25.1	70.3
3	'Double Play'	1900	27.2	75.1
4	Forage Rye and Rapeseed	1450	25.7	73.8
5	Spr. Oats, Ryegrass, Crimson Clover	2400	33	75.1

Mr. Nuckols turned 22 yearling heifers (850 lb. average) into the diversity treatment and began strip-grazing them across the demonstration field. He used portable electric poly-wire and step-in pigtail posts to move the cattle daily. When given the choice of all 5 mixtures the heifers went to the predominantly grass treatments first. The more diverse mixtures included a high percentage of brassicas such as the daikon radish and rapeseed. These had a different look and texture than the cattle were used to grazing, but within a few days they quickly became accustomed to these species and cleaned them up as well.

This group of heifers grazed on the 9-acre demonstration plot through December 10th for a total of 37 days. They were provided free choice hay to balance out the high protein values in the fresh forage. This translates into 814 heifer grazing days on this fall demonstration.



The vigorous growth of these forage mixtures resulted in virtually 100 percent canopy cover on all the plots prior to grazing. One benefit of planting a mix of species together is to capitalize on different leaf shapes and plant structures to fill voids and capture sunlight while covering and protecting the soil surface. Strip-grazing these heifers resulted in a high grazing efficiency and removal of most of the standing forage. Even after strip-grazing these diverse mixtures in the demonstration, field measurements confirmed 96% ground cover going into winter. The ground cover consisted of 68% live leafy canopy and 28% plant residue leaving less than 5% bare ground. All livestock were removed from this field after December 10, 2014. Ronnie was very pleased with the fall production and utilization of these treatments. The next big question was "How will they perform in the spring to further extend the grazing season and boost economic return?"



The seasonably cold winter stretched into a cool, wet spring. The forage rye had good green color in late February while all the other species in the demonstration did not green up until after mid-March. On March 19th, 50 lbs. N per acre was surface applied on 4 treatments. On the 'Double Play' treatment, 200 lbs. per acre 'Meadow Top Dress' was broadcast as a spring organic fertilization. Forage species selection plays an important role in timing the green up and growth in the spring as shown in the photo on the right from March 23, 2015. No spring fertilizer nitrogen was applied on the last 100 feet of the demonstration at the far end of the field. This was planned in order to compare growth and performance of the different forage mixtures with and without spring N.

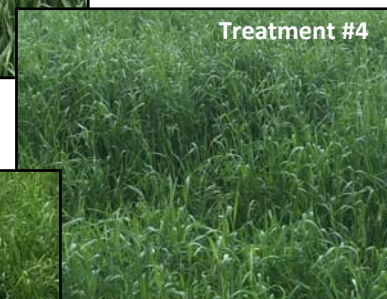
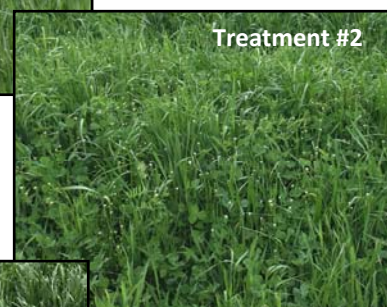


"Looking across the field I was unsure how well these annuals were going to grow back since my heifers grazed them down in December. We are 19 days away from a forage field day and based on what I see now, I just don't know what to expect for regrowth," Ronnie stated on April 2nd.

The cool, wet weather resulted in slow growth coming out of winter but how quickly things change when the growth begins! By the second full week of April all the treatments were growing vigorously. Composite forage samples were taken from each treatment, with and without spring N, on April 13th, then mailed directly to the lab for quality analysis. Detailed measurements were collected on April 16-17, documenting ground cover and species composition. Five clippings were harvested from each treatment, then dried and weighed to estimate average spring forage dry matter yields. A summary of the spring forage yield and quality by treatment is shown in the table below.



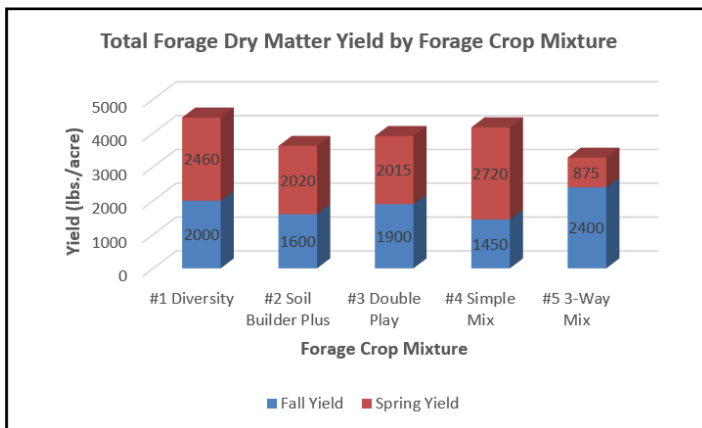
#	Treatment Species Mix (April 16, 2015)	Est. Yield (lbs. DM/ac)	Quality (CP %)	Quality (TDN%)
1	Diversity Mix	2460	24	71
2	'Soil Builder Plus'	2020	23	73
3	'Double Play'	2015	25	74
4	Forage Rye and Rapeseed	2720	21	69
5	Annual Ryegrass Crimson Clover (Spring Oat residue)	875	19	70



By the April 16th spring yield measurement date, four of the five treatments had produced very well and all of the mixtures were high in nutritional value as a feed source. Treatment 4 was the earliest maturing because it was primarily forage rye which greened up earlier and matured quicker than any of the other species in this demonstration. The rye was already in the early head growth stage resulting in more forage dry matter per acre. From a forage utilization standpoint, the cattle should have already been on this plot grazing. Next was the diversity mix which had a high component of rye, annual ryegrass and hairy vetch. The 'Soil Builder Plus' and 'Double Play' had relatively the same yield and quality. Treatment #5, which only had annual ryegrass and crimson clover this spring, was very thin and slow growing at this time. This is attributed to the high, spring oat seeding rate (64 lbs.) in this mixture which dominated the stand in the fall and truly suppressed the rest of the mixture.



The growth potential of these annual species in simple or complex mixtures is tremendous. The graph below represents both fall and spring growth in each of the forage crop mixtures. These are much more than just cover crops when used in a situation like this. With the proper competition control and fertilization these mixtures can produce a high volume, high quality feed. Some of the initial seeding rates were considered high, but when planning for two separate production and harvests periods this increases the return on investment.

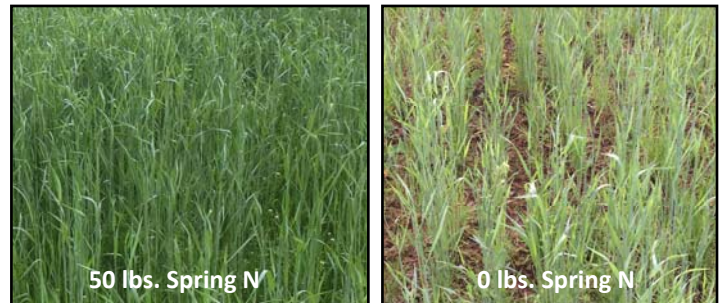


When comparing the performance of these forage crop mixtures planted in late summer, treatments 1, 3, and 5 seemed to have the highest fall growth potential given fertilizer and good rainfall conditions. Treatments 1 and 4 had a higher spring yield by mid April primarily because of the forage rye which was the earliest maturing species in the mixes. Treatments 2, 3, and 5 had continued growth in May after the first grazing due to the annual ryegrass which persisted until June however this additional growth was not measured.

When producing annuals for supplementing a grazing system a common priority is to increase the length of the grazing season. In this sense, production yield matters. The more forage dry matter lbs./acre produced often results in more grazing days. If the cattle can start grazing even 2 weeks earlier in the spring using annuals, while providing the perennial pastures time to grow and accumulate standing biomass, it effectively extends the grazing season while taking the pressure off the perennial pasture at initial spring greenup.

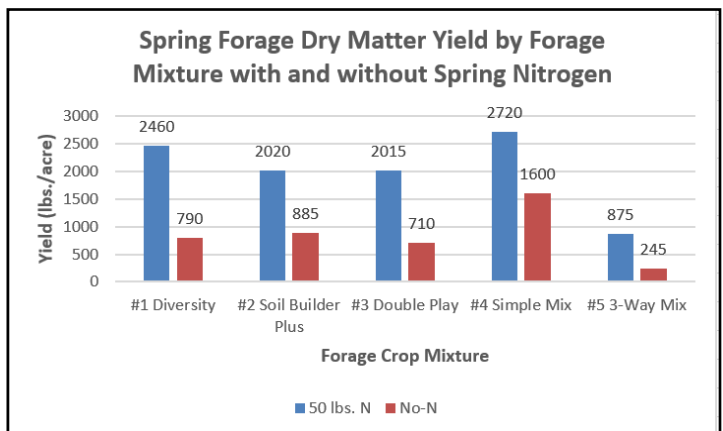
Some producers question whether a spring nitrogen fertilizer application is needed, or can they save that money and let the annuals extract the nutrients from the soil and use annual legumes in the mix to add nitrogen to the system.

For this specific reason, the spring nitrogen fertilizer treatment was not applied to the last 100 ft. of the mixed annuals at the east end of the demonstration field. As the plants began to grow again in early April the differences were obvious across all forage treatments. By mid-April you could easily see the contrast in green leaf color and thickness of the stands when comparing where the spring N was and was not applied.



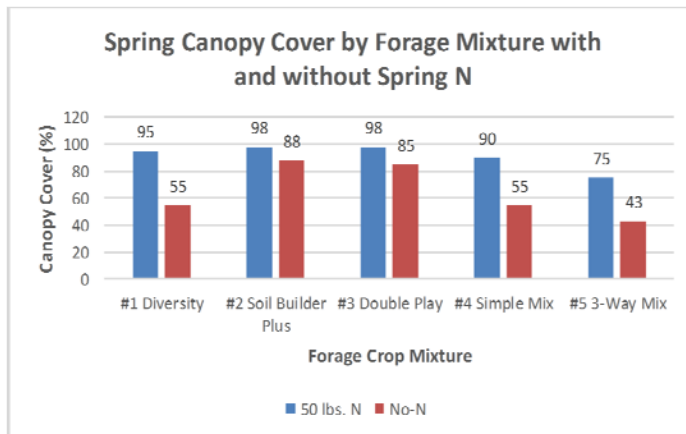
To quantify the impact of spring N application shown in the contrasting photos above, detailed canopy cover measurements were taken, then forage samples were harvested, dried and weighed for an accurate comparison.

The graph below illustrates the average differences in spring forage dry matter yield for each of the annual forage mixtures with and without spring N.



Spring forage yield was drastically higher across all treatments when 50 lbs. spring N was applied compared to no spring N application. The yield increase was nearly 2 to 3 times as high with N depending on the species mixture.

When spring N was not applied, canopy cover declined across forage mixtures and dropped significantly in mixtures without legumes. Canopy measurements from each treatment were summarized in the graph below.



The decrease in canopy cover can be significant, since plant canopy cover is the first line of defense protecting the soil surface from direct rainfall impact and erosion, as well as excessive heating and moisture evaporation from the sun. The photo below shows how thin the stand is without spring N, resulting in more bare ground, less vigorous plants and more room for weeds, all of which reduces production on these acres.



In contrast to this, look at the following picture on the same forage mixture where 50 lbs. spring N was applied.



Based on the observations and measurements taken during this demonstration, a lot can be learned and used by other producers across the state.

Following these measurements and the spring field day, Ronnie's fall calving herd was turned into the test field to graze on April 22, 2015. The herd consisted of 43 mature cows and 40 calves averaging 450 lbs. The total herd was estimated to be approximately 70,000 lbs. of livestock or 70 animal units (AU). This herd strip grazed this test field across forage mixtures for 22 solid days. This 9 acre field provided 3 full weeks of grazing or 1,540 animal unit grazing days. In reality the cattle should have gone into the field a week earlier but grazing was delayed until the outreach event was hosted. Having this high volume, high quality annual forage the first 3 weeks of spring green-up, provided uninterrupted growth for the perennial pasture acreage on the farm while this herd was grazing the annuals.

All this sounds good but what does it really mean? How does it pencil out financially? How does a producer look at all this information objectively to know if it was worth the expense to make it a normal part of the forage and livestock system on this farm?



#	Treatment Species Mix	Burn Down	Seed Cost	Drill Rental and Labor	Fertilizer and Nitrogen	Est. Yield (lbs. DM/ ac)	Total Cost Per Acre	Cost Per DM Ton
1	Diversity Mix	24	89	15	102	4460	230	103
2	'Soil Builder Plus'	24	136	15	102	3620	277	153
3	'Double Play'	24	150	15	178	3915	367	187
4	Forage Rye and Rapeseed	24	58	15	102	4170	199	95
5	Spr. Oats, Ryegrass, Crimson Clover	24	77	15	102	3275	218	133

To answer these questions it really boils down to the producer's goals, the type and class of livestock being grazed, the desire to graze versus feed, and the cost comparison of each.

The chart above outlines the costs associated with establishing and producing these forage mixtures per acre and per ton of forage dry matter. Remember these are high quality forages that are more than meeting the nutritional needs of the livestock in a grazing situation. If you compare the cost of these fresh forages to the cost of making, storing and feeding high quality hay then that may be \$120 per ton. But remember most farmers are looking at these annual forages as more than just a comparative feed source, they are also using them to extend the grazing season and improve soil health or the soils overall capacity to function. If someone simply wants the cheapest feed source then they can find it in commodity feeds and marginal to low quality hay. With high stocking rates this results in an intense feeding operation and leads to degradation of the soil, plant and adjacent water resources from the feeding location which directly contradicts the goals of most graziers.

This grazing demonstration on annual forages successfully showed that they can be used to provide a fresh and nutritious forage that extends the grazing season into the late fall and early spring. Specific species mixes can be used to build soil health by keeping the soil covered, minimizing soil disturbance, maximizing living root growth and energizing the system with diversity.

The economic viability will come down to the individual's marketable product and current market prices. Seeding rates and species mixes can be modified to decrease the cost of establishment without giving up significant yield and quality while still achieving the soil health benefits.

Annual forages have a place in grazing systems and they are commonly used today in the following ways:

- Grazing dairies.
- To provide a consistent supply of high-quality forage for finishing livestock on grass pasture.
- As smother crops in a spray-smother-spray situation where one forage type has to be completely killed before transitioning to a different perennial.
- Cover crop grazing in crop rotation cycles.



Lessons Learned and Take Home Points for Using Annual Forages and Improved Grazing Management to Build Soil Health and Improve System Performance

- These annual forage mixes have tremendous potential to produce high-volume, high-quality feed for grazing when established using pre-planting competition control and fertilized after planting.
- Forage species selection and the timing of planting is critically important to ensure the production window matches when the forage is needed for grazing.
- Selecting the right species for your mix can provide both late fall and early spring grazing to maximize your return on investment from a single planting.
- Diverse species mixtures, including grass, legume and forb species, provide complimentary plant and root structures and leaf shapes, maximizing growth from fall through spring.
- Cattle quickly adapt to grazing these different forage types and varying textures with high forage utilization rates of > 75% using strip grazing.
- Post grazing residue can leave >95% ground cover protecting the soil going into the winter months.
- Spring nitrogen applications on these winter annual mixes can provide between 2 and 3 times the biomass production compared to no spring nitrogen.
- No spring nitrogen application significantly decreased biomass yield and reduced canopy cover across all treatments, resulting in more bare soil exposed to potential erosion and weed pressure.
- These mixed forage annuals resulted in high quality forage exceeding the crude protein and total digestible nutrient requirements of the grazing livestock.
- Having winter annuals for grazing in late October—November allows additional time for stockpiling fescue in fall for winter grazing.
- Using these annuals to begin grazing cattle even 2 weeks early in the spring, allows more time for perennial pasture to grow and takes the pressure off the pasture at spring green up.

Contact your local conservation office for more information about how annual forages might fit in your production system. They can help you assess your current pasture condition, stocking rate and based on your goals, help select the right species to develop a mix that should provide nutritious abundant forage in your target window and help build soil health at the same time. For more information about this project you can contact JB Daniel at j.b.daniel@va.usda.gov

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