BIOAg Project Progress Report

Report Type:
Progress

Title:
Provision of forage protein reservoirs to enhance utilization of low-quality forages by beef cattle.

Principal Investigator(s) and Cooperator(s):
PI: Donald Llewellyn, Ph.D., Associate Professor and Livestock Extension Specialist; Director, Lincoln County Extension, WSU Extension

Co-PI: Steve Fransen, Ph.D., Forage Crops Specialist Emeritus, WSU Extension/WSU Department of Crop and Soil Sciences, will provide expertise in forage establishment, production, and quality

Co-PI: Shannon Neibergs, Ph.D., WSU Extension Economist will provide expertise in all aspects of the project that focuses on economics.

Cooperators: WSU Department of Animal Sciences, Pullman, WA, WSU Vetter Farm, Stevens County, WA, and Gary Rohwer, Bar Diamond, Inc., Parma, ID (forage analysis laboratory; GPS cattle movement monitoring, steers fitted with rumen cannulas).

Abstract:
Forages are well suited for livestock production, wildlife habitat, and provide benefits for soil conservation. As forages mature, protein declines and fiber increases. In ruminant nutrition, forages with less than 7% crude protein are considered low quality. Since protein is the first-limiting nutrient with low quality forages, grazing mature forage grasses typically requires provision of supplemental protein. Our proof-of-concept project focuses on providing protein reservoirs designated to produce protein-rich forages (dryland alfalfa and sainfoin) for beef cattle with possible ancillary benefits in biodiversity. Protein reservoirs in association with pastures and rangelands represent a viable option to meet the nutrient requirements of livestock and is a self-fed means of reducing labor and cost of purchased supplements. Once established, forage quality, digestibility, yield, and cost will be quantified throughout the grazing season; cattle movement and use of base forage and protein reservoirs will be monitored through GPS tracking.

Project Description:
Our project revolves around the providing of high-quality forages to cattle during seasonal declines in forage quality. This is accomplished by the provision of forage legumes in areas adjacent to the main grazing areas and limiting access to the legumes by various fencing technologies such that cattle can meet their protein requirements while also enhancing the utilization of base forages. Cattle access to forage protein reservoirs will be restricted by fencing and monitored by GPS tracking. Forage quantity and quality of the base forages and legumes will be monitored throughout the grazing season. In addition, we expect benefits to wildlife.

Outputs

Overview of Work Completed and in Progress:

We are currently engaged in the forage establishment phase of this project (details of base forage mixes follow soil descriptions). Preparations have been underway for several months and establishment of perennial forages will take place in spring 2025 (BIOAg funding was not available early enough in 2024 and early spring seeding date is critical for proper forage germination and establishment). Two sites have been selected (see the acreage maps below):

- The WSU Vetter Farm map (left) shows areas 3 and 4, which comprise 39.7 acres that are in the process of being renovated into a new perennial grass blend. Area 5 is 9.6 acres and is comprised of primarily meadow foxtail (wet area) and will remain as such to be included in the grazing component of this project. In addition, a strip of legumes (dryland alfalfa and sainfoin) along the riparian area near the WSU Vetter Farm headquarters will serve as the protein reservoirs used as a protein supplement for cows when the perennial grasses decline in quality in the late summer. The protein reservoirs will also serve as an attractant for wildlife (animals and birds).
- The map of the WSU Department of Animal Sciences acreage (right) shows the area for pasture being renovated. This acreage has a total of 60 acres and will include protein reservoir strips along the west and north borders near the WSU Dairy. Grazing and monitoring will be conducted in the same manner as at the WSU Vetter Farm.

WSU Department of Animal Sciences soils

The first line from the USDA-NRCS soil survey for the Palouse series is “The Palouse series consists of deep, well drained soils formed in loess on hills.” This states the series is wind derived, highly permeable and easily damaged through water and/or wind erosion. The key to managing this series is to maintain a perennial cover of grasses, legumes, forbes or other like plants. The following in-depth soil taxonomy terms, their meaning and management use for both the Palouse and Clayton series is provided.

Table 1. Soil taxonomic defined and use for Palouse Fine-silty, mixed, superactive, mesic, Pachic Ultic Haploxerolls with Mollisol order with mollic suborder and argillic horizon.

Soil Taxonomic term – USDA-NRCS	What does this mean?	How do we use this?
Palouse	Region found in eastern WA, western ID and northeastern OR	Our location of the WSU beef cattle pastures near Pullman.
Fine-silty	Soil particle size by weight; must be <15% of the soil particles are fine sand ranging in size 0.002 – 0.006 mm diameter.	These particles are < 12% clay and retain more water than sand but less than clay. But this soil releases water easier than from clay soils. This soil also has more cation exchange sites than sand but less than clay soils.
Mixed	Clay mineralogy is < 50% for any one of the six major classes of clays.	Since no one clay dominates, we would need to dig deeper to find which clays are present. Each clay will have different properties for nutrient release
Superactive	The first soil horizon is Ap, which is the topsoil (A, where many nutrients are found for plant growth) that has been plowed or disturbed (mixed) layer (other type of ag activity) that is not only active but extremely active.	A horizon in soils is where the greatest activity of plant growth occurs; however, with better forage species and variety selection desirable species will explore and use nutrients and water from B and lower horizons. An Ap horizon has been normally mixed through plowing or disturbance at some time. But this is not completely necessary for specific sites where slopes are steep and erosion hazard is high.
Mesic	Mean annual soil temperature at 50 cm ranges between 8 and 15 °C. These are relatively cool soils.	This soil temperature is ideal for growing perennial forage legumes and grasses. In this region, soil moisture will be limited during the growing season but cooler temperatures and SOM extend forage growth.
Pachic	One of the horizons is > 50 cm thick.	Both Bw1 and Bw2 soil horizons are each about 20 inches or 50 cm thick. The letter 'w' means weathered or weak in color or structure. The number means this is a thicker layer.
Ultic	These soils are weathered.	These soils contain the clays, are leached out and will impose acidic conditions after they are blown into the Palouse.
Haplo	Minimal number of soil horizons. This soil only has A and B (subsoil, retrains many nutrients that have leached down from the A horizon and typically where clay accumulates) horizons.	Soils that are less developed (mature) have fewer horizons and no hardpan. No C horizon since these are all windblown soil materials
Xer	Free draining or summer dry soil.	This suggests the soil will infiltrate water easily year-round, allowing leaching to occur. Standing water is not expect in winter but will dry during the growing season. Found under a Mediterranean climate, which is common in WA state.
Oll	The soil order is Mollisol or grassland soil.	This is the soil developed under grasslands. It has a thicker A horizon because after grasslands were established there was little either water or wind erosion. This possesses a relatively low nutrient rich B horizon with little subsoil development.

WSU Vetter Farm soils

The first line from the USDA-NRCS soil survey for the Clayton series states, "The Clayton series consists of very deep, well drained soils formed in mixed glaciofluvial deposits mixed with loess and volcanic ash in the upper part." This key statement does an excellent job of describing how this series was formed and implies agronomically what crops can be grown and how to manage them. To summarize, this soil was formed with volcanic ash and washed glacial deposits resulting in a deep, easily drained soil that is droughty in summer but allows water for easily flow through anytime. The soil horizons and depth as follows: Ap1 0 to 5 inches, Ap2 5 to 8 inches, E&Bt1 8 to 29 inches, E&Bt2 29 to 42 inches, E&Bt3 42 to 52 inches, C 52 to 62 inches.

Table 2. Soil taxonomic defined and use for Clayton Course-loamy, isotic, mesic Vitrandic Haploxerept with Inceptisol order with Ochric suborder and Cambic horizon.

Soil Taxonomic term – USDA-NRCS	What does this mean?	How do we use this?
Clayton	Soil series located at the Vetter Farm, Stevens Co.	This series possess many similarities to the Spokane series [Coarse-loamy, isotic, mesic Vitrandic Haploxerolls], but lacks an E horizon and is a Mollisol order like the Palouse series.
Coarse	Soil texture where particles > 2 mm in diameter. Feels gritty and will not make a ribbon in your hand.	Coarse soils are gravel ranging from 2 – 75 mm with 1 to 2 % gravel found from the Ap1 through C horizon at 155 cm in this Clayton series. Means soil is stable for erosion, high water permeability but low water holding capacity.
Loamy	Loamy soils generally have an excellent balance of about 39% sand, 37% silt, and 24% clay plus organic matter. Texture will promote an E horizon or eluviation.	Excellent for growing all agronomic crops. Clay and silt hold soil water about twice as long as sand, which reduces soil compaction. Loamy soils provide better year-round soil water by avoiding summer drought or winter flooding. Easy release of nutrients to plant roots. E horizon or eluviation means 'to wash out' is leached out clay minerals from forest littler originated in Ap1 and Ap2 horizons in Clayton series into the E&Bt1, E&Bt2, and E&Bt3 horizons. Often found in forest originated soils where acid producing forest littler in Ap horizons. The 't' in the B horizon means translocated clay, in that clay from the above horizon has leached into the current horizon.
Isotic	Is a mineralogy clay class different from 'mixed' clay class in pH is measured by NaF because of no carbonates and short crystallines.	Fairly new soil taxonomy class that distinguishes the clay fraction with higher ability to binds Phosphorus (P) in soil, thereby reducing adsorption. This could cause nutrient issues for plant P root requirements when soil pH is moderate to slightly acidic. Note, in Clayton series the entire profile is acidic suggesting easy leaching of base cations throughout.
Mesic	Mean annual soil temperature at 50 cm ranges between 8 and 15 °C. These are relatively cool soils.	This soil temperature is ideal for growing perennial forage legumes and grasses. In Clayton series with Ap1 and Ap2 horizons and higher soil moisture subsoils should experience little summer moisture stress or standing winter water stress on selected crops cooler temperatures and SOM extend forage growth.

Soil Taxonomic term – USDA-NRCS	What does this mean?	How do we use this?
Vitrandic	A soil feature. Means ashy fragments and glassy materials are found in the Ap horizons. Plus, more than 35% of this horizon is composed of gravelly and organic particles.	This series is prone to summer droughty conditions because clays and cations are leaching down, lowering pH but should have higher SOM.
Haplo	Minimal number and development of soil horizons.	Terms suggests the soil is less well developed (mature) many have fewer horizons and no hardpan. This soil has about plow depth Ap but the deep E&Bt horizons that are in the developing phase and lighter color than Ap because of nutrient leaching, lower SOM and greater compaction. (subsoil, retrains many nutrients that have leached down from the A horizon and typically where clay accumulates) horizons. The C horizon or parent material horizon is below E&Bt3, about 130 cm deep, and where plant roots are found in the Clayton series. This soil has less subsoil development.
Xer	Free draining or summer dry soil.	This suggests the soil will infiltrate water easily year-round, allowing leaching to occur. Standing water is not expect in winter but will dry during the growing season. Found under a Mediterranean climate, which is common in WA state.
Ept	The soil order Inceptisol or beginning soil.	Very young soil where B horizon is developing and color differences between horizons are starting to show. This order is often found in or near mountains, which is the case for Clayton series.

Soil samples will be collected at both the WSU Beef Unit and Vetter Farm, farm units 3 and 4, in the near future. Complete analyses will be conducted on each set of samples. Our desire is to collect a stratified sample from 0-6, 6-12, 12-24, and 24-36 inches. The study will be planting, through no-till, perennial cool-season grasses (both bunch and rhizomatous), alfalfa and sainfoin, that will each be inoculated with the proper rhizobia for nitrogen fixation. We expect, from the series description, extra care must be exercised with the Clayton series to ensure P and zinc (Zn) (which is also needed for forage root development) needs are met. This will better ensure forage plant establishment and deeper rooting for perenniality of each selected crop. The species and varieties selected are all deep rooted. Both the Palouse and Clayton series provide an opportunity for root exploration of the deeper horizons for root development. This will mitigate some of the effects of lower soil water holding capacity, which can impact stand establishment success in the first year and a moderate dormancy summer period after establishment. Thus, nutrient remediation and no-till planting will occur in spring as soon as soil conditions allow. With annual soil sampling and repeated nutrient applications, forage yields and pasture carrying capacity will be high, as well as animal response and health. This combination of recognizing soil properties, forage crop selection and planned grazing treatments will provide the best possible treatment results of this project research.

WSU Pullman seed mix

RAINIER SEEDS

PO Box 1064
Davenport, WA 99122
Toll free 1(800) 828-8873
Phone 1(509) 725-1235
Fax 1(509) 725-7015
www.rainierseeds.com

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QUOTE

Quote Date: **Sep 16, 2024**
Quote Expires: **Oct 16, 2024**

Prepared for:
Washington State University
Extension
303 6th St
PO Box 399
Davenport, WA 99122
p 509-492-8380

Mix Name:

WSU Custom #2 Forage Mix

Prepared by:	Ordered by:	FOB:
Jessica Hoard	Don	Davenport, WA

Rate	Component
25.0 %	Intermediate Wheatgrass
25.0 %	Pubescent Wheatgrass
30.0 %	Festulolium
20.0 %	Russian Wildrye

100.0 % **Unit Cost:** **$4.208 / lb**

WSU Vetter Farm seed mix

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Jessica Hoard		Davenport, WA

Rate	Component
50.0 %	Festulolium
25.0 %	Intermediate Wheatgrass
25.0 %	Pubescent Wheatgrass

100.0 % **Unit Cost:** **$2.68 / lb**

Methods, Results, and Discussion (discussion for final reports only):
N/A

Publications, Handouts, Other Text & Web Products:
Will be available after forage and cattle data are being collected.

Outreach & Education Activities:
These activities will commence when data is collected.

Impacts
We are currently in the establishment phase of our research and therefore too early to collect impact data.

Additional funding applied for/secured:
Currently we have secured research/program funding associated with a WSU Extension/Lincoln County Memorandum of Agreement (MOA) that will fund a complementary component of this project dealing with biodiversity and enhancement of wildlife. In addition, a grant application entitled, *From Silvopasture to Wetlands: A Demonstration of Virtual Fencing in NE Washington's Varied Lands for Sustainable Grazing*, has been submitted to the Western SARE Research & Education grant program to assist in the funding of the cattle containment and movement monitoring described in this BIOAg grant research.

Graduate students funded:
N/A

Recommendations for future research:
It is our hope that Western SARE virtual fencing funding is approved so that we can embed our protein reservoir trial within the virtual fencing study. In doing so, we will be able to show real-world research applications as well as the nutritional aspects of the BIOAg study.