This summer I had the opportunity to work as a student research intern at OSU's Union Station with Goujie Wang. I worked in a team with two other students where we collaborated on our individual projects that we were placed on, to collect our data efficiently and correctly; the main work for the summer came from Michael Waite's project working with Alfalfa as it needed to be harvested 4 times during the internship period. Typically, my project would take up most of our time during the summer but because this was my project's last year, we would use it as a reset year for the plots so the next project will not be influenced by the previous forage species.

The project that I was assigned to was; Long-term Forage Production of Perennials Effects on Soil Health under Limited and Competing Water Resources in Eastern Oregon. The purposes of this project were to; evaluate perennial forage species yields and stability, asses stand longevity of different perennial forage species, and to quantify soil health improvements with different forage species over six years under the limited and competing water resources. In order to do this, a total of 20 perennial forage species were planted in four replications for a total of 320 plots for the project. The forage species fell into one of four categories;

Perennial Cool Season Grasses with Low Yield: Crested Wheatgrass, Bluebunch Wheatgrass, Intermediate Wheatgrass, Idaho Fescue, and Great Basin Wildrye.

Perennial Cool Season Grasses with High Yield: Orchardgrass, Meadow brome, Tall Fescue, Perennial Ryegrass, and Timothy.

Perennial Legumes: Purple Blossom Alfalfa, Yellow Blossom Alfalfa, Birdsfoot Trefoil, Sainfoin, and Cicer Milkvetch.

Perennial Warm Season Grasses: Big Bluestem, Indiangrass, and three switchgrass varieties (Dacotah, Sunburst, and Cave-in-Rock).

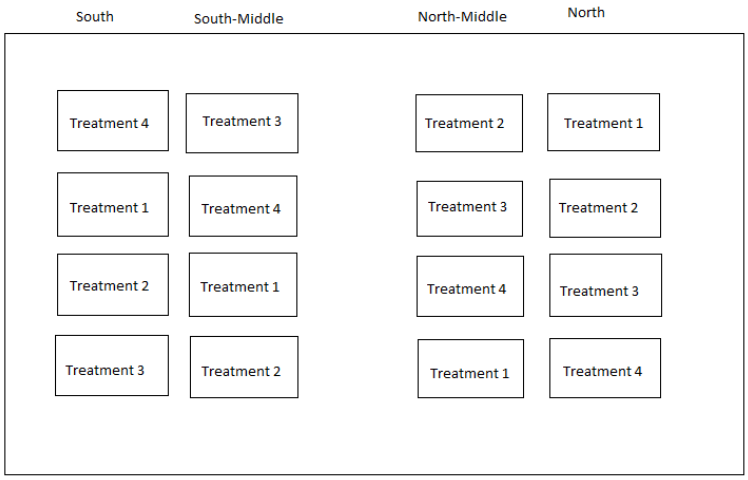

Figure 1. Layout of Water Treatments for Perennials project

The four replications used represented different irrigation treatments: 1) whole season irrigation from May 1 to September 15; 2) Late season water shortage irrigation from May 1 to August 1; 3) Middle and late season water shortage from May 1 to June 15; 4) No irrigation at all. The irrigation treatment layout can be seen above in figure 1. The point of the different irrigation plots is that they will represent different water allowances in Eastern Oregon as some farmers and ranchers do not have the same water rights as others and may be limited in how long they have water usage availability. The irrigation was done every Thursday and Friday until the 3rd treatment (cutoff of June 15) was done, we then only had to water every Friday as the pump could handle our pressure load then. We collected data from each irrigation treatment every Friday after irrigation, we put rain gauges in every plot except in the plots that were not irrigated (we did put on in the treatment 4 plot in the North row). The duration of our irrigation every week was dependent on the Evapotranspiration (ET) for the past seven days (previous week's Friday through the Thursday immediately before irrigation day). To figure out the ET for the week, we used the Bureau of Reclamation's Agrimet site that gave us data from the nearest weather station in Imbler that provided us with Evapotranspiration levels for Alfalfa: The Alfalfa data was used as it was still an active project his year and we were still harvesting it throughout our time while the Perennials were not being harvested this year.

Figure 2. North end of perennial plots on May 26th

Figure 4. North end of perennial plots on September 14th

Figure 3. South end of perennial plots on May 26th

Figure 5. South end of perennial plots on September 14th

The above figures 2,3,4, and 5 are visuals of what both the north and south ends of the field that we used for the perennials project. The pictures on the left were taken May 26th shortly after we mowed the whole field. After we'd mowed the field, we planted our seed mix that we used to reset the field from the perennial project. Then we sprayed the field with herbicide so we could reduce the number of weed that would come up this year. The pictures on the right were taken September 14th, these were taken shortly before we sprayed the field once again with herbicide to kill of the plant material and reduce above ground biomass during the winter months. The field is currently ready for fall planting to prep for the next project.

In order to collect data for my project previous year's researchers would; conduct a mean stage count, do a visual evaluation, harvest clippings, then each plot would be harvested. The mean stage count gave us data as to where in the species stage of life that plat was, this was based off looking at 10 random plants within the plot that typically fell in the middle of the plot. Next, clippings were taken from each plot from two of the middle most rows in a two-foot length along the rows, these were placed in a labelled bag that told us the identification information. The clippings were weighed to give us a wet weight, then dried for three to four days and weighed again for a dry weight so we knew how much mass was water weight and how much was true biomass. These samples were then stored to be ground later. When the samples needed to be ground, the process was done by putting the samples into the dryer for a day then put through a Wiley mill and the ground samples were put into a labelled plastic bag with the same information that was on their designated paper bags initially. The samples were then sorted and stored for testing later. Based on previous data from harvesting, select samples would be sent out to be tested at a lab for forage/nutrient quality. Due to the high costs of forage testing, not all samples will be sent out.

Interestingly, I found an article that related well to my summer project with soil water health and perennials under drought conditions. This article found perennials were more productive and had a deeper root system, there was an obvious relationship between water uptake and root distribution that allowed the perennials to use more water from deeper in the soil profile (Ferchaud, 2015).

In addition to the field work that was done throughout the season, I also worked on entering and compiling data for my Perennial's project from past years. I worked with the data to understand what our harvests, clippings, and other data meant in terms of what the goal of my project was. I was unable to evaluate the combined data as it was not compiled, reviewed, and assessed by my BES mentor, Goujie Wang, until after the deadline for my paper, but while inputting the data I was able to understand more about the purpose of my project.

As we move into the fall, we shift our focus from data management and harvesting, to planting, grass mixtures, spraying, fertilizing, and winterizing our plots and various equipment. Due to a late frost this year we will be completing final harvests in October, this includes the mean stage counts, visual evaluations, clippings, grinding, and field harvest. During fall term I will continue working on grinding as we did in the late summer, to finish up projects from previous years that still needed processing. In addition to these tasks, I will also be looking into some soil moisture meters to use in the plots so we can

better gauge soil water content and adjust watering schedules during the spring and summer based off of that data instead so we can be more accurate. These moisture meters will be semi-permanent and will be placed in the soil after the field has been planted for the next project and will be deep enough so as to not interfere with harvesting and such. They will be able to read the soil moisture content at multiple soil depths multiple times a day, they will be logged on the meters and be collected once a week; this will allow us to be more accurate when watering for future projects and not have to rely on data from Imbler or to always water just based off the alfalfa evapotranspiration.

Because we work together as a team on the different projects each of us were assigned too, we worked on each project throughout the summer as tasks came up for them. As stated before, the main project we worked on this year was the alfalfa stand project, other projects we worked on were the West SARE project, and the Oregon Trail Seeds Winter Triticale Project. Originally, we were going to be working another alfalfa project, working to grow clippings of chosen alfalfa plants within Michael's alfalfa stand project. We prepped transplant pots and watered them multiple times a day at the greenhouse located on Eastern Oregon University's campus. However, this project was not successful for this year so we did not proceed with it.

Another project that we worked on at the end of the summer internship was the West SARE project, the purpose of this project was to determine the ability of overseeded crop to flourish in grazing pastures that are primarily perennial and annual grasses. The trial areas included three locations, one dryland pasture, one area that was previously planted with alfalfa, and one that was purely grass pasture. Within each location was three different treatments; treatment 1 - no overseeding, treatment 2 - two plant types, and treatment 3 - six plant types.

Treatment 1 species types – species types were the species that were already growing there, no new species were seeded.

Treatment 2 species types – Orchardgrass (*dactylics glomerata L*.), and Birdsfoot trefoil (*lotus corniculatus L.).*

Treatment 3 species types – Festulolium (*x festulolium Asch. & Graebn*.), Chicory, Plantain, White clover (*trifolium repens L.),* Orchardgrass (*dactylics glomerata L.),* and Birdsfoot trefoil (*lotus corniculatus L.).*

In addition to the other projects that our team worked on throughout the summer, we also assisted with the "Oregon Trail Seeds Winter Triticale" the purpose of that project was to grow an ideal triticale variety for a greater amount of forage-able biomass. For this project, our breeding plots were one of a few different areas throughout Eastern Oregon that were being used. We did not end up with an opportunity to visit any of the other locations due to covid, but we met with the head of the project and he assisted us with selecting the best rows among our 80; they were made up of a few different varieties. To begin this process, we first clipped the first three feet of each row, dried each and separated the seed heads, leaves, and stems into labelled bags so we could determine the ratio of each for that row. After that, we went through and flagged the rows that we wanted to harvest based upon the projects criteria, next we harvested the whole flagged row and placed it into a bag with the

corresponding row number, let them air dry in our shop and then separated out the seeds to be planted during the next season so the project could be continued. For this project we not only dried, separated, and weighed the triticale located at Union Station, but we also did this for the other locations that were being used.

At the end of this internship opportunity, I can say that I had an amazing opportunity to increase my learnings in forage growing, harvesting, and overall productivity. Because of the tasks that will need to be carried out during fall term, up until November, I will be continuing to work with Guojie Wang for this fall. I think that I have learned a lot of important tools and experience that will help me in my future career. Since I was encouraged to do a lot of research on my own and have discussions with Guojie on articles pertaining to my project in terms of perennials and overall soil health quality including soil water capacity. There were a lot fewer articles on the subject than I thought and even fewer were done in North America, this was interesting because it seems like we should be studying soil health quality and soil water capacity/holding and the relations to different plant species. There have been some studies done for soil water content and annual forage crops under limited water availability in the dairy industry, one of these studies that were done was in Australia and found that forages under DI that over a period of time develop higher values of MEW and SWD. However, they found that yield was much lower than it had been before, this major decline over the three years was believed to be because many C_3 forages have reached their adaptation limitation (Neal, 2012).

This article really made me think about what we can do to increase forage productivity while also working to adapt our forage species to longer, hotter summers followed by colder winters, with spring and summer seasons getting shorter and shorter. I think that research like that out at Union Station is very important to continue working towards these necessities while not putting excess stress on the land itself. One possibility that we should be working with to move these changes forward is more breeding research and work to increase the adaptation of longer living, more resistant, higher yielding forage species.

As I finish this internship, I look back at the research projects that we worked on during the summer and find certain changes and adaptations that can be made. Firstly, we ended up going longer between harvests than originally planned because of weather, I wonder if we had adjusted better to weather interference, we would have been able to harvest on time. Doing things such as; harvesting on weekends when we had cooperative weather, starting earlier in the morning on windy and excessively hot days, splitting up tasks more so multiple people wouldn't all be working on tasks that only required a few people. The last solution may limit learning if the harvests were only done once, but as every project that needed to be harvested had multiple harvests throughout the summer, each student would work on a different task each harvest to allow for more independent learning after being taught the procedure during the first harvest. This solution is brought up here in my reflection because the tasks that needed to be done before harvest often took two to three days when I believe they could have taken one day if we had been more efficient.

References

1. Ferchaud, F., Vitte, G., Bornet, F. et al. Soil water uptake and root distribution of different perennial and annual bioenergy crops. Plant Soil 388, 307–322 (2015). https://doi.org/10.1007/s11104-014-2335-y

2. Neal, J.S., et al. "Differences in Soil Water Content between Perennial and Annual Forages and Crops Grown under Deficit Irrigation and Used by the Dairy Industry." Field Crops Research, vol. 137, 2012, pp. 148–162., https://doi.org/10.1016/j.fcr.2012.07.013.