**Multistate Research Activity Accomplishments Report**

**Project/Activity Number:** WERA1014

**Project/Activity Title:** Intensive Management of Irrigated Forages for Sustainable Livestock Production in the Western U.S.

**Period Covered:** September 1, 2021-August 31, 2022

**Date of This Report:** October 31, 2022

**Annual Meeting Date(s):** August 31, 2022 – September 1, 2022

**Participants:** Ates, Serkan – Oregon State Univ.; Hannaway, David – Oregon State Univ.; Brewer, Linda – Oregon State Univ.; Norberg, Steve – Washington State Univ.; Hall, Jerry – Grassland Oregon; Ballerstedt, Peter – Barengrug USA; Cappallezzi, Shannon – DLF-Pickseed; Wirth, Don – Saddlebutte Ag, Inc.; Gillson, Cher – Ioka Turf & Forage Seed; Adeniji, Amanda – Emerald Green Seeds; Maxwell, Tom – Lincoln Univ (New Zealand); Bohle, Mylen – Oregon State Univ.; Jones, Gordon – Oregon State Univ.;Halbleib, Mike – Oregon State Univ.;Nelson, Berit – Oregon State Univ.; Owens, Vance – Oregon State Univ.;McGregor, Ian – Oregon State Univ.; Cruickshank, Jenifer – Oregon State Univ.;Silvernail, Ian – Oregon State Univ.; Smith, Evie – Oregon State Univ.; Brummer, Joe – Colorado State Univ.

**Brief summary of minutes of annual meeting:** Discussed that the annual report for WERA 1014 is due by October 31 and should be integrated by objective rather than by state. The current project is expiring next year and those in attendance decided to prepare and submit a project renewal by January 15, 2023. The following updates were presented: Vance Owens (USDA-NIFA Program Leader), Joe Brummer (Colorado report), Steve Norberg (Washington report), Woody Lane (grower groups), Peter Ballerstedt (healthy diets), Tom Maxwell (New Zealand), Beret Nelsen (survey), Gordon Jones (pleasure horse problems on dryland pastures), Shelby Filley (international forage trial – herbal leys), Ian McGregor (overseeding annual forages into perennial existing perennial pasture), Shayan Ghajar (review of the first 13 months at OSUES), and Serkan Ates (agrivoltaics).

**Accomplishments:** The work of the WERA 1014 *Intensive Management of Irrigated Forages for Sustainable Livestock Production in the Western U.S.* investigates and disseminates information on producer response to drought and consequent financial stress. Current areas of research and outreach emphasize alternative forages, grass and legume mixtures, the place of annual and perennial forages in a time of increasing drought stress and irrigation cutbacks, and animal preference for and performance on novel or alternative forage species. Progress over the past year toward completion of project objectives includes the following:

**Objective 1: Conduct an annual review of current research and extension programming in the western region specific to cultivated, irrigated forage systems or as integrated components of rangeland forage-livestock systems, and compile/update a list to be shared among all participants.** Participants presented the current research and Extension activities from their state at the annual meeting. These presentations keep all participants informed of regional activities related to production and use of irrigated forages, encourage sharing of ideas and resources, and avoid duplication of efforts. Examples of the project-related activities, outputs, and outcomes are as follows:

* Evaluation of novel forage species, legumes and other forbs, to diversify forage production and extend the grazing season for dairy and sheep grazing systems. Previous work in New Zealand, Syria and Jordon has provided significant exposure to other species not used in the arid West of the USA.
* Evaluation of forage species for increased water use efficiency and seasonal forage production to develop systems that balance agricultural production needs for irrigation water with ecological needs for ecosystems services including wildlife and fish habitat.
* On-farm Oregon Pasture/Forage Needs Assessment (Sept 2021 – June 2023). The objective of this on-going mixed-methods needs assessment is to assess the current practices, preferred information sources, and research and extension needs of Oregon pasture and forage producers. The secondary objective is to trial best practices in agricultural needs assessments and provide a model for the conduct of needs assessments for other crops, in other regions, and in the future. The project is funded ($14K) by OSU Ag. Extension Program Leader.
* Oregon State University Extension and Research faculty working together through collaboration with WERA 1014 members, participants in the NCCC31 group and the OSU Forage and Livestock Systems Extension Working Group seek to increase collaboration on planning and execution of high priority projects of sustainable forage-livestock systems. As part of the USDA-NIFA funded Sustainable Agricultural Systems project, the [MatchForage](https://forages.oregonstate.edu/matchforage) website is developing comprehensive content of forage and livestock topics and segments devoted to the interrelationships among soil, water, plant, animal, and human health and the economic and social implications of sustainable agricultural systems. Fact sheets for dozens of important forages are under development. This content will be combined in a species selection system to help extension field faculty and specialists, farmers and ranchers, and agricultural agency personnel select species appropriate to local conditions. These resources will also be used in teaching applications for species selection and management.

**Objective 2:** **Based on the above review, identify emerging issues and opportunities related to cultivated, irrigated forages and forage-livestock systems in the western region, prioritize those issues, and work cooperatively to develop regional funding proposals to support research and outreach activities.** As an outcome of Objective 1, gaps in the knowledge base are continuously identified and used to direct future research and Extension priorities. WERA 1014 members have a long history of working together in collaborative efforts across the region to develop and submit regional grant proposals, conduct research, and develop joint Extension programming. Examples of collaborative projects:

* Evaluation of ecosystems benefits of pastures and role of forages for pollinators
* Monitoring of GHG emissions from phytochemically diversified pastures
* Exploring the potential of spent hemp biomass as potential livestock and poultry feed
* Development of pasture systems for agrivoltaics.

**Objective 3:** **Identify regionally based colleagues and stakeholders working with cultivated, irrigated forages and forage-livestock systems to include in the project, and mentor early-career colleagues.** The Annual Meeting provided mentoring for early- and mid-career colleagues. Energetic and productive discussion about experimental design, statistical analysis, and data interpretation followed most of the presentations, with a free exchange of ideas, and offers of further collaborations.

Over the years, participants in this group have included industry representatives and field personnel from the Natural Resources Conservation Service in the annual meeting. The perspective of these individuals guides research and Extension activities conducted by this group. We will continue to develop these relationships and include these individuals to our annual meeting. At the 2022 Annual Meeting, nine seed company representatives and eight forage producers were invited and planned to attend. Sudden and extreme weather circumstances prevented many from participating. However, one seed company hosted an evening barbeque on a local research farm. Many interested faculty, industry representatives, and producers who had been unable to attend the weekday meetings attended this evening event. This casual event provided opportunities for networking among the WERA 1014 participants with industry, producer and faculty groups not formally part of the project.

Discussion and brainstorming during the 2022 WERA Annual Meeting of forage species and management options to improve the establishment and persistence in the xeric environment of the Rogue Valley in Oregon. Valuable information and ideas were shared to address issues of dryland perennial stand failure associated with climate change-induced drought. Future research ideas generated include use of novel-endophyte tall fescue, adjusted planting time to mitigate annual grass competition, and experimentation with wheatgrasses for dryland pasture.

**Impacts:** The overarching project goal is to achieve environmentally and economically sustainable forage and grassland management. These efforts promise grower benefits including reduced costs, improved productivity, and greater enterprise sustainability. Although project members acknowledge relatively low adoption of intensive management of irrigated forages, this and similar work conducted world-wide demonstrate the following benefits to growers from adoption of these practices: 1) reduced production costs, 2) increased animal output per acre, 3) land use efficiency, 4) reduced fertility inputs, 5) increased carbon sequestration, 6) reduced runoff and wind erosion, and 7) improved quality of life for farmers and ranchers.

Examples of specific impacts are as follows:

* Alfalfa variety trials are common across WERA 1014 participants. In Washington, an economic analysis of adopting the top three varieties compared to using the average variety in the trial showed an increase of $95 acre-1 year-1, resulting in a measured impact of 3.8 million dollars a year-1 and a seven-year impact of $19.5 million.
* A hay quality project funded by NIFA at Washington State Univ. is using markers to decrease the time required for release of a variety from an average of seven years to five years. The shorter timeframe increases profits for each release for those companies. Also, use of the markers can increase the nutrient value of new alfalfa hay varieties by $30 ton-1. The potential financial benefit just from forage quality increase in alfalfa sold to dairies is $477 million year-1 in the US.
* Research on phosphorus at WSU has produced updated recommendations that can increase alfalfa yields 0.5-ton acre-1 year-1, worth $86 acre-1 year-1 with the potential impact of $17.6 million year-1 in Washington state.
* In Utah, agronomists and growers have reported widespread adoption of new N fertilizer guidelines that no additional N fertilizer is needed for first year corn grown after alfalfa. If half of Utah’s 84,000 acres of corn is grown in the first year after alfalfa, and if the typical grower has traditionally applied 150-200 lbs N/acre for first-year corn, not applying N fertilizer would result in $3.2 to $4.2 million (at $0.50/lb N) in cost savings to Utah corn growers, annually.

**Publications:**

***Refereed publications:***

Anderson, J.D., Ochoa, C.G., Sahin M. and Ates, S. (2022) The effects of self-regenerating annual clovers on plant species composition and heifer performance in an irrigated pasture in western Oregon, USA. *Grassland Science* doi: 10.1111/grs.12378

Clark, J.D., M.A. Yost, T.C. Griggs, G.E. Cardon, C.V. Ransom, and J.E. Creech. 2021. Nitrogen fertilization and glyphosate-resistant alfalfa termination method effects on first-year silage corn. Agronomy Journal. 113:1712-1723. <https://doi.org/10.1002/agj2.20583>

Clark, J.D., M.A. Yost, G.E. Cardon, C.V. Ransom, and J.E. Creech. 2021. Tillage method and glyphosate-resistant alfalfa termination timing affect soil properties and subsequent corn yield. Agronomy Journal. 113:321-334. <https://doi.org/10.1002/agj2.20478>

Feng He, Zongyong Tong, David B. Hannaway, Xianglin Li. 2021. Erratic precipitation and clipping frequency reshape the community structure and species stability of Leymus chinensis steppe. Ecological Indicators 133 108432. <https://doi.org/10.1016/j.ecolind.2021.108432>

Goosey, H.B., W. Carr, M. King, C. Jones. 2022. Nitrate Toxicity of Montana Forages. Montana State University Extension Service MontGuide. MT200205AG. <https://store.msuextension.org/publications/AgandNaturalResources/MT200205AG.pdf>

Goosey, H.B., A. Williams, M. Van Emon, and R. Malisani. 2022. Collecting a Forage or Feed Sample for Analysis. Montana State University Extension Service MontGuide. MT201610AG. <https://store.msuextension.org/publications/AgandNaturalResources/MT201610AG.pdf>

Gultekin, Yunus, Shelby J. Filley, Mary A. Smallman, David B. Hannaway, Serkan Ates. 2021. Pasture production, persistence of legumes and lamb growth in summer-dry hill pastures. Grass and Forage Science 76 (1): 159-172. <https://doi.org/10.1111/gfs.12497>

Hadfield, J., B.L. Waldron, S.C. Isom, R. Feuz, R. Larsen, J.E. Creech, M.F. Rose, J. Long, M.D. Peel, R.L. Miller, K.A. Rood, A. Young, R. Stott, A. Sweat, and K. Thornton. 2021. The effects of organic grass and grass-birdsfoot trefoil pastures on Jersey heifer development: Heifer growth, performance, and economic impact. Journal of Dairy Science. 104:10863-10878. https://doi.org/10.3168/jds.2020-19524.

Hall, Jean A., Gerd Bobe, Shelby J. Filley, Gene J. Pirelli, Mylen G. Bohle, Guojie Wang, T. Zane Davis, Gary L. Bañuelos (2022). Effects of amount and chemical form of selenium amendments on forage selenium concentrations and species profiles. Biological Trace Element Research. Submitted.

Harrison, J.H., S. Norberg, K. Fullerton, L. Morgon, E. Whitefield. 2021. Comparison of Struvite to Mono-ammonium Phosphate for Alfalfa Production at Commercial Alfalfa Farms: A Case Study ISSN 2158-9429 Journal of NACAA Volume 14: Issue 2 – December 2021. <https://www.nacaa.com/file.ashx?id=8b9e96af-4a3d-4cf7-ac5c-4d569e00dad6>

Louhaichi, M., Hassan, S., Gamoun, M., Safi, N., Abdallah, M. A., & Ates, S. (2022). Evaluation of rainwater harvesting and shrub establishment methods for sustainable watershed management in northern Afghanistan. *Journal of Mountain Science*, 1-14.

Mackey, E., J. H. Harrison, H. Tao, S. Norberg, A. Adams‑Progar, E. Whitefeld. 2021. Effect of Application Season on Release of Available Phosphorus from Soil Receiving Mono‑ammonium Phosphate or Struvite. Water Air Soil Pollution (2021) 232:467 [https://link.springer.com/article/10.1007%2Fs11270-021-05396-6](https://link.springer.com/article/10.1007/s11270-021-05396-6)

Parker, N. B., Bionaz, M., Ford, H. R., Irawan, A., Trevisi, E., & Ates, S. (2022). Assessment of spent hemp biomass as a potential ingredient in ruminant diet: Nutritional quality and effect on performance, meat and carcass quality, and hematological parameters in finishing lambs. *Journal of Animal Science*. skac263, doi.org/10.1093/jas/skac263

Peter J. Ballerstedt, David B. Hannaway, T. D. Noakes. 2021. Why We Need a Ruminant Revolution: Combating Malnutrition and Metabolic Illnesses to Enable Sustainable Development. XXIV International Grassland Congress / XI International Rangeland Congress. <https://uknowledge.uky.edu/igc/24/3/19>

Pound, C.A., M.A. Yost, J. E. Creech, G.E. Cardon, J. Gale, K. Heaton, S. Price, M. Pace, T. Wilde, and B. Kitchen. 2021. Nitrogen fertilizer needs of first-year small grain forages following alfalfa. Agronomy Journal. 113:2006-2017. <https://doi.org/10.1002/agj2.20561>

Rose, M.F., B.L. Waldron, S.C. Isom, M.D. Peel, K.J. Thornton, R.L. Miller, K.A. Rood, J.A. Hadfield, J. Long, B. Henderson, and J.E. Creech. 2021. The effects of organic grass and grass-birdsfoot trefoil pastures on Jersey heifer development: Herbage characteristics affecting intake.Journal of Dairy Science. 104:10879-10895. https://doi.org/10.3168/jds.2020-19563.

Seeno, E., Naumann, H., and Ates, S. (2022). Production and chemical composition of pasture forbs with high bioactive compounds in a low input production system in the Pacific Northwest. *Animal Feed Science and Technology*, 289, 115324.

Wang, G., Bobe, G., Filley, S. J., Pirelli, G. J., Bohle, M. G., Davis, T. Z., Bañuelos, G. L., & Hall, J. A. (2021). Effects of springtime sodium selenate foliar application and NPKS fertilization on selenium concentrations and selenium species in forages across Oregon. Animal Feed Science and Technology, 276(114944), 15. https://doi.org/https:/doi.org/10.1016/j.anifeedsci.2021.114944

Wang, M., R. Gao, M. Franco, D.B. Hannaway, W. Ke, Z. Ding, Z. Yu, X. Guo. 2021. Effect of Mixing Alfalfa with Whole-Plant Corn in Different Proportions on Fermentation Characteristics and Bacterial Community of Silage. Agriculture 11: 174-185. <https://doi.org/10.3390/agriculture11020174>

Yang, Yungui, Yanyan Lin, Lu Zhao, Xuemei Yang, Ting Guo, and David B. Hannaway. 2021. Influence of ensiling additives on silage quality of several oat cultivars. International Journal of Science 8(2): 23-31. <http://www.ijscience.org/download/IJS-8-2-23-31.pdf>

Yost, M.A., C.A. Pound, J.E. Creech, G.E. Cardon, M.G. Pace, B. Kitchen, M. Nelson, and K. Russell. 2021. Nitrogen requirements of first-year small grains after alfalfa. Soil Science Society of America Journal. 85:1698-1709. <https://doi.org/10.1002/saj2.20269>

Zhensong Li, Feng He, Zongyong Tong, Xianglin Li, Qingchuan Yang, David B. Hannaway. 2022. Metabolomic changes in crown of alfalfa (Medicago sativa L.) during de-acclimation. Research Square (Preprint) <https://doi.org/10.21203/rs.3.rs-1515778/v1>

***Extension Publications***

Bouska, C., Filley, S., and Jones, G. (2021-2022). Livestock and Forages Newsletter for Western Oregon. Oregon State University Extension Service. https://extension.oregonstate.edu/newsletter/livestock-forages-e-news

Brummer, Fara, Serkan Ates, David B. Hannaway, 2021. Birdsfoot Trefoil in Irrigated Pastures: Northern Great Basin Pasture Systems Can Benefit From Legume Interseeding. Oregon State Univ. Extension Ser. EM 9319. <https://catalog.extension.oregonstate.edu/em9319>

Dreves, A., N. Kaur, M. Bohle, D. Hannaway, G. Fisher, and S. Rondon. 2020. Insect and Mite Pests of PNW Pastures. <https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/pnw750.pdf>

Fery, Melissa, David Hannaway, David Chaney, Maud Powell, and Garry Stephenson. 2020. Introduction to Pasture & Grazing Management. Oregon State University Extension Service Circular. <https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em9302.pdf>

Filley, S. (2022). Foxtail Control in Pastures and Hayground. Oregon State University Extension Service. https://extension.oregonstate.edu/crop-production/pastures-forages/foxtail-control-pastures-hayground

Fransen, Steve, et.al. “Northwest Inland Pasture Calendar”. WSARE Grant approved in 2019 to be published Fall, 2022.

Jones, G., S. Ghajar, S. Duggan, and M. Fery. Understanding Sugar and Nonstructural Carbohydrates (NSC) in Equine Pasture and Hay. OSU Extension Bulletin – In Review. The idea for this bulletin was conceived through discussion with WERA 1014 colleagues, and an early draft of the document was much improved with comments and suggestions from J. Brummer (CSU), and S. Franzen (WSU).

Goosey, H.B., M.G. Rolston, and G.D. Johnson (Retired). 2022. Effects of Eprinomectin Residues on Face Fly (*Musca autumnalis*) Survival in Dung of Cattle (*Bos tarus*) Vaccinated with Longrange. Arthropod Management Tests. 47(1): 1-2. doi.org/10.1093/amt/tsac071

MacAdam, Jennifer and Mylen Bohle. (August 10, 2022) Altitude Adds Energy Value to Alfalfa Hay. Hay and Forage Grower (online). https://hayandforage.com/article-4061-altitude-adds-energy-value-to-alfalfa-hay.html

Wanner, K.W., C. Christopher Caron, H.B. Goosey, and E.A. Rodbel. 2022. Efficacy of Select Insecticides to Control Pyrethroid Resistant Alfalfa Weevils, 2021, Arthropod Management Tests. 47(1): 1-2. doi.org/10.1093/amt/tsac062

Yost, M., Holt, J., Austin, J., Creech, J. E., Allen, L., McAvoy, D., Winward, D. (2021). Biochar impacts on crop yield and water use. USU Extension. <https://extension.usu.edu/crops/biochar-factsheet>

Yost, M., Austin, J., Miller, R. L., Allen, L., Cardon, G., Larsen, R., Creech, J. E. (2021). Manure application through pressurized irrigation systems. USU Extension. <https://extension.usu.edu/crops/research/manure-application-through-pressurized-irrigation-systems>

Yost, M., Sullivan, T., Kitchen, B. M., Allen, L., Baker, M., Creech, J. E. (2021). Strategies for deficit irrigation of forage crops. USU Extension. <https://extension.usu.edu/crops/research/strategies-for-deficit-irrigation-of-forage-crops>