

**Western Sustainable Agriculture Research & Education**  
**Award number 2020-38640-31523**  
**Project number SW21-927**  
**<https://western.sare.org>, 406-994-4785**

**Title: Dry Matter Intake and Feed Efficiency of Four Dairy Breeds in a Pasture-Based Heifer Development Program**

**Abstract:**

In 2019, there were over 3.6 million dairy cows in the western U.S. [1], making dairy a dominant sector of the region's agriculture. Organic milk production is becoming more prevalent, with organic products increasing from 1.92% to 4.38%, of all milk products sold, between 2006 and 2013 [2]. Organic milk companies promote their product based upon the health and environmental benefits of pasture-raised milk [3] and require at least 120 grazing days per year for both lactating cows and replacement heifers [4]. However, milk production is 32% lower in dairies using 75-100% of pasture-based forage compared to those using 25% or less pasture forage [5]. Insufficient dry matter intake (DMI) of pasture by dairy cows is a major factor limiting milk production [6], and it has been observed that some dairy breeds are more efficient grazers than others [7-9]. Therefore, improved feed efficiency - the relative ability of a cow to convert feed into growth or milk, is increasingly important in pasture-based dairy systems [10, 11].

This proposal expands our previous Western SARE projects that evaluated how grass-legume pastures with different energy, protein, and condensed tannin (CT) levels affected beef steer and Jersey heifer growth performance (SW10-088 and SW17-046). Those studies found that forage characteristics only explained 50% of the variation in DMI and average daily gain (ADG) [12, 13]. Furthermore, producers on our research team asked about the influence of dairy breed on performance within their pasture-based systems. Thus, we propose to investigate the effects of dairy breed, pasture type, and breed-by-pasture type interactions on DMI, feed efficiency, and environmental and economic sustainability of heifers raised in pasture-based systems. A multi-disciplinary team will conduct this research at the Utah State University Lewiston Pasture Research Facility where replicated pastures of grass monoculture (MONO) or grass-birdsfoot trefoil (MIXED) are established. Four breeds of dairy heifers (Holstein, Jersey, Holstein/Jersey crossbreds, and 3-way Holstein/Montbeliarde/Viking Red crossbreds [i.e., ProCROSS]) will be compared as they rotationally graze pasture treatments (MONO vs MIXED) throughout the summer. Producer cooperators will provide dairy heifers and participate in DMI and forage evaluation of pastures on their dairies.

Outreach is a major component of the proposal with contributions from university extension and eOrganic. This program will integrate traditional outreach with electronic media and be

guided by input from producer cooperators and similar stakeholders. The primary targeted audiences will be dairy producers, Extension educators, NRCS personnel, and other professionals who advise farmers/ranchers. Emphasis will be on providing opportunities to train these individuals in the local area, statewide, and across the western region.

These objectives are in direct response to stakeholder feedback and are expected to identify differences in feed efficiency. It is anticipated that some breeds will respond to both high quality (MIXED) and lesser quality (MONO) pastures, whereas some breeds will respond only to high-quality pastures. At the end of the research, we expect to provide producers with solid scientific AND economic data on pasture-based dairy heifer development for a variety of pasture-types and dairy breeds.

## **Project Objectives:**

### **RESEARCH OBJECTIVES**

Our long-term goal is to enhance the sustainability of pasture-based dairy. The central hypothesis of the current proposal is that genetic background (“breed”) will have a significant influence on the physiological responses of dairy heifers grazing grass/birdsfoot trefoil (MIXED) or grass-only (MONO) pastures, and these differences will be reflected in measures of environmental and economic sustainability. Specific research objectives are:

1: Determine the influence of dairy breed on DMI and feed efficiency in heifers grazing either grass-monoculture or grass/birdsfoot trefoil mixed pastures. We hypothesize that DMI and feed efficiency will differ across breeds but will be greater in MIXED pastures compared to MONO pastures for all breeds. We also anticipate that some breeds will have greater feed efficiency relative to other breeds on lesser quality pastures.

2: Evaluate the influence of dairy breed on nutrient leaching when grazing either grass-monoculture or grass/birdsfoot trefoil mixed pastures. We hypothesize that animals grazing the pastures with the CT-containing birdsfoot trefoil (MIXED) will have improved nitrogen (N) utilization as measured by reduced N in groundwater leachate compared to those grazing grass monocultures, and that greater feed efficiency will be associated with greater N-utilization efficiency.

3: Ascertain the influence of dairy breed on the economic sustainability of pasture-based heifer development. We hypothesize that heifer breed/pasture type combinations with relatively greater feed efficiency will have greater annual net financial impact and reduced payback period.

## **EDUCATION OBJECTIVES**

As part of our long-term goal to enhance the sustainability of pasture-based dairy, we will implement an innovative and impactful multi-faceted extension/outreach program on the production and environmental benefits of pasture-based dairy heifer development. Pasture-based milk production is a fast-growing segment of agriculture in the Intermountain West and this project will bridge the gap in urgently needed information regarding breed and pasture-type differences. We have devised a solid research plan that will generate a wealth of highly novel data across a very broad and multidisciplinary research spectrum. The results from this study will be of value to the scientific and pasture-based dairy farming communities in general, but our research/outreach effort is designed to translate this information to make a real difference to individual dairy farmers and their families throughout the Intermountain West. Specific education objectives are:

1: Implement an innovative and impactful multi-faceted extension/outreach program for producers and professionals in the local area, statewide, and across the western region on the production, environmental, and economic benefits of grass/legume grazing for pasture-based dairy production systems.

2: Create and pilot the Intermountain Regional Dairy Grazing School.

3: Produce and publish scholarly and educational products.

## **WSARE SW21-927 2021 Annual Report**

### **RESEARCH RESULTS AND DISCUSSION:**

\*\*\* click on 'Research' on web form to access this section

**Number of farmers who participated in research** (Enter "0" if there were none): 3.

**Results and discussion** (Present and describe the research data, and interpret the findings as related to the hypothesis(es). Include unexpected or unanticipated results and their implications. Data tables and graphics may be inserted in the box with text.)

#### **Objective 1: Determine the influence of dairy breed on DMI and feed efficiency**

- Heifers were weighed (BW), body condition scored (BCS), and blood and rumen fluid samples drawn at the initiation of grazing, and at the end of every 35 day grazing cycle during 2021. Blood and rumen fluid assays are ongoing. These data were combined with data from 2020. The heifer performance data from 2020 were analyzed and reported as part of the requirements for

a Utah State University M.S. thesis (Sawyer Fannesbeck). The main results of the thesis are summarized as follows:

- We saw that BFT significantly increased ADG for all breeds. Heifers which grazed the MIX treatments averaged 0.48 kg of gain/day, whereas heifers on MONO pastures averaged 0.28 kg/day. Overall changes in BCS were significantly affected by both the differences in pasture treatment and breed of the animals (Figure 1).
- The different treatments did not cause any significant differences in fecal egg count (FEC) or total rumen volatile fatty acids (VFA) concentrations.
- Overall, we found that Jerseys were able to gain a higher percentage of their mature body weight and maintain their body condition better, while grazing, than heifers of other breeds (Figure 2).
- We also determined that grazing BFT can have noticeable positive effects on ADG, BCS, and change in percent mature BW.
- Grazing intake and herbage measurements were collected during the 2021 grazing season and used to determine dry matter intake (DMI) and feed efficiency. These data were combined with data from 2020. The herbage data were analyzed and will be reported as part of the requirements for a Utah State University M.S. thesis (Michael Greenland). To date, the main results of the thesis are summarized as follows:
  - We used herbage disappearance to determine DMI. Both feed conversion efficiency (FCE) and residual feed intake (RFI) were derived using heifer weight and DMI. All measures were normalized to 40% metabolic mature body weight of the corresponding dairy breed to account for difference in size and growth of the heifers.
  - We observed greater DMI on grass-BFT mixtures. Among breeds, Holstein had the greatest DMI, then the two crossbreds, and Jersey had the least (Table 1).
  - Feed efficiency was most favorable for Jersey, less efficient for both crossbreds, and Holsteins showed variable results depending upon efficiency measure (Table 1, Figure 3).
  - Grazing adaptation defined as change in DMI during successive 24+ h increments over the 3.5 d grazing period was also considered, and DMI declined throughout the grazing period for all breeds similarly on both pasture-types. In addition, no breed × pasture-type interactions were found for DMI, FCE, or RFI suggesting that no breed had an advantage on higher quality (grass-BFT mixture or early grazing period) or lower quality (grass monoculture or late grazing period) forage.
  - Multivariate analyses will be conducted (in 2022) to identify forage quality parameters associated with DMI and feed efficiency.
- On-farm trials –

- The three collaborating producers received rising plate meters (RPM) and training about how to use the RPM to determine pre- and post-grazing herbage mass, and estimate subsequent intake.

**Objective 2: Evaluate the influence of dairy breed on nutrient leaching**

- In 2021, field data were collected, and sample analyses are ongoing. Field data collected included the following:
  - 1) plant samples were collected before and after each grazing event and dried for later analysis;
  - 2) soil samples were collected in the fall at the beginning of the study for a baseline reading, and in the spring, prior to grazing, and in the fall after the growing season using a Giddings® soil extraction instrument to a depth of 1.524 meters. Soil samples were also collected in the spring of the third year to monitor nutrient movement;
  - 3) soil water (leachate) nitrogen was monitored by lysimeters and leachate collected every two weeks during the growing seasons, and as close as possible to every two weeks during the winter months; and
  - 4) urine and feces were collected from heifers at weigh-ins.
- Samples will be analyzed for nitrate, ammonia, urea, and total nitrogen and carbon.

**Objective 3: Ascertain the influence of dairy breed on the economic sustainability of pasture-based heifer development.**

- In 2021, nothing to report on economic analysis. These analyses will begin in summer of 2022.

**Research conclusions:**

**This section is not completed until portions of the research are completed or until the final report. Distill the key, important conclusions and recommendations from the research results and discuss how the results are impacting or could impact farming.**

- None for 2021 annual report

## Education & Outreach:

### A. Education & Outreach Activities Summary

**For activities: Enter or update the total numbers of the different types of educational activities conducted or created by the project team, to date.**

1. Consultations (an estimate is acceptable): 2021, 15 / Total, 15
2. Curricula, factsheets or educational tools: 2021, 0 / Total, 0
3. Journal articles
4. On-farm demonstrations
5. Online trainings
6. Published press articles, newsletters: 2021, 0 / Total, 0
7. Tours: 2021, 0 / Total, 0
8. Webinars, talks and presentations: 2021, 2 / Total, 2
9. Workshop / field days: 2021, 1 / Total, 1
10. Other: 2021, 1 (web page) / Total, 1

### Participants for 2021 report

# Farmers and Ranchers: 2021, 64 / Total, 64

# Ag professionals: 2021, 223 / Total, 223

# Academia: 2021, 150 / Total, 150

**Education and outreach description.** Describe the activities indicated above as well as outreach in progress (e.g. newsletter, journal articles, upcoming presentations, etc.).

### Education and Outreach Description for 2021 Annual Report

#### Consultations for 2021 annual report:

- Responded to 15 questions (phone calls, emails, on-site visits) about grass-legume mixtures for pasture, including how to establish and manage grazing.

#### Curricula, factsheets or educational tools for 2021 annual report:

None

#### Published press articles, newsletters for 2021 annual report:

None

### **Tours for 2021 annual report:**

None

### **Webinars, talks and presentations for 2021 annual report:**

Miller, R., B. Waldron, S. C. Isom, K. Thornton-Kurth, K. Rood, E. Creech, M. Peel, J. Hadfield, R. Larson, and M. Rose. 2022. Improving Production and Minimizing Nutrient Loss in Grazing Systems through the Use of Grass-Legume Mixtures. eXtension Waste to Worth: Advancing Sustainability in Animal Agriculture. Waste-to-Worth 2022. Participants: 50 farmers/ranchers, 200 agricultural professionals, 100 academia.

Fonnesbeck, Sawyer. Influence of cattle breed and forage type on organic dairy heifer performance. M.S. thesis defense presentation. Utah State University, Logan. August 11, 2021. Participants: 3 farmers/ranchers, 2 agricultural professionals, 35 academia.

### **Workshop / field days for 2021 annual report:**

Utah State University Lewiston Pasture Research Farm field day. July 28, 2021. Lewiston, Utah. Participants: 41 total. 15 farmers/ranchers, 11 agricultural professionals, 15 academia. The following presentations related to this project were given:

- Dr. Clay Isom. Dairy heifer grazing project overview.
- Michael Greenland, USU graduate student. Dry Matter Intake and Feed Efficiency of Four Dairy Breeds in Pasture-Based Heifer Development.
- Sawyer Fonnesbeck, Idaho State University Extension and former graduate student on project. The Influence of Cattle Breed and Forage Type on Dairy Heifer Performance
- Dr. Rhonda Miller. N-Cycling in Organic Dairy Grazing Systems.

### **Other Educational and Outreach Activities for 2021 annual report**

A web site for the project was established through eOrganic in a previous related Western SARE grant, SW17-046 (found at <https://eorganic.info/node/33809>; verified 4/28/22). The project SW21-927 is an extension and continuation and will be using the same website. Information on the website will be updated to reflect the new project. As publications, presentations and trial results from the projects become available, we will make them available here.

### **Publications for 2021 annual report**

Miller, R., B. Waldron, S. C. Isom, K. Thornton-Kurth, K. Rood, E. Creech, M. Peel, J. Hadfield, R. Larson, and M. Rose. 2022. Improving Production and Minimizing Nutrient Loss in Grazing Systems through the Use of Grass-Legume Mixtures. eXtension Waste to Worth: Advancing Sustainability in Animal Agriculture. Waste-to-Worth 2022 Proceedings. Available at: <https://lplc.org/improving-production-and-minimizing-nutrient-loss-in-grazing-systems-through-the-use-of-grass-legume-mixtures/>.

Miller, R., B. Waldron, C. Isom, K. Thornton-Kurth, K. Rood, E. Creech, M. Peel, M. Rose, and J. Hadfield. 2021. Nutrient Cycling in an Organic Dairy Grazing System. In 2021 American Society of Agronomy Abstracts. Madison, WI: American Society of Agronomy.

Fonnesbeck, Sawyer. Influence of cattle breed and forage type on organic dairy heifer performance.. M.S. thesis, Utah State University, Logan. 2021.