Oregon State University

Beef Cattle Sciences

Oregon Beef Council Report

2014 Edition

Oregon State University | Extension Service

Oregon State University

Beef Cattle Sciences

Oregon Beef Council Report

Thank you for the interest in the 2014 - Oregon Beef Council Report. This publication contains information about research studies funded by the Oregon Beef Council, and conducted by faculty members from Oregon State University. In this publication, all articles are printed in grayscale. Colored articles are available at the Beef Cattle Sciences website (http://beefcattle.ans.oregonstate.edu), under the "Extension Publications" link. For questions, suggestions, or comments regarding this publication, please contact Reinaldo Cooke (541-573-4083 or reinaldo.cooke@oregonstate.edu).

Table of contents

Oregon State University

BEEF130

Oregon Beef Council Report

Beef Cattle Sciences

Effects of organic or inorganic *Co*, *Cu*, *Mn*, and *Zn* supplementation to late-gestation cows on performance responses of the subsequent calf crop[1]

R. S. Marques,[2] R. F. Cooke,[2] M. C. Rodrigues,[2] B. I. Cappellozza,[2] P. Moriel,[3] and D. W. Bohnert[2]

Synopsis

Supplementing beef cows during late gestation with *Co*, *Cu*, *Zn*, and *Mn* increased cow and calf performance, and such outcomes were further improved when an organic source was offered.

Summary

Eighty-four multiparous Angus × Hereford cows were ranked by BW and BCS, and allocated to 21 drylot pens at the end of their second trimester of gestation (day 0 of the study). Pens were assigned to receive 1 of 3 treatments: 1) supplementation with inorganic sulfate sources of *Cu*, *Co*, *Mn*, and *Zn* (**INR**), 2) supplementation with an organic source of *Cu*, *Mn*, *Co*, and *Zn* (**ORG**), and 3) no supplementation of *Cu*, *Co*, *Mn*, and *Zn* (**CON**). From day 0 until calving, cows were offered daily 15 lbs of alfalfa hay, 6 lbs of grass straw, 5 lbs of corn, and 0.132 lbs of a macromineral + vitamins + sodium selenite and iodine source mix. Treatments (INR and ORG) were mixed with the corn, and formulated to provide the same daily amount of *Cu*, *Co*, *Mn*, and *Zn* (based on 0.015 lbs/cow daily of the ORG source). Liver samples were collected prior to the beginning of the experiment (day -10), and 2 weeks before the beginning of the calving season. Upon calving, placental cotyledons were collected and liver samples were retrieved from each newborn calf. Cow BW and BCS was evaluated 2 weeks prior to calving to evaluate treatment effects on these variables. After calving, cow-calf pairs were removed from their respective pen, returned to the EOARC general herd, and assigned to the nutritional and overall management of the research center (which included inorganic macro and trace mineral supplementation). Approximately 6 months after birth, calves were weaned and calf weaning BW was recorded. Cows receiving CON had less ($P \leq 0.05$) BCS gain during the last trimester of gestation compared with INR and ORG cows, although cows from all treatments had similar ($P = 0.61$) and adequate pre-calving BCS. Prior to the beginning of the experiment (day -10), no differences were detected ($P \geq 0.38$) among CON, INR, and ORG cows for liver concentrations of *Co*, *Cu*, *Mn*, and *Zn*. Prior to the beginning of the calving season, liver concentrations of *Co*, *Cu*, and *Zn* were greater ($P \leq 0.05$) for INR and ORG compared with CON, whereas INR cows had reduced ($P = 0.04$) liver *Co* but greater ($P = 0.03$) liver *Cu* compared with ORG cows. In the placental cotyledons, *Co* concentrations were greater ($P \leq 0.05$) in ORG and INR compared with CON cows, whereas *Cu* concentrations were only increased ($P = 0.05$) in ORG compared with CON cows. Upon calving, calves from INR and ORG cows had greater ($P < 0.01$) liver *Co* concentrations compared with calves from CON cows. However, liver *Cu* and *Zn* concentrations were

1. This document is part of the Oregon State University – 2014 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.
2. Oregon State University – Eastern Oregon Agricultural Research Center, Burns.
3. North Carolina State University – Mountain Research Station, Waynesville.

greater ($P \leq 0.05$) for calves from ORG cows compared with cohorts from CON cows, but similar ($P \geq 0.17$) between calves from INR and CON cows. No treatment differences were detected ($P = 0.27$) for calving rate (cows that calved a live calf). Calf birth BW and lbs of calf born/cow assigned to the experiment were similar ($P \geq 0.44$) among treatments. At weaning, no treatment differences were detected ($P = 0.46$) for weaning rate (cows that weaned a live calf). Actual and 205-day adjusted weaning BW were the greatest for calves born from ORG cows, intermediate for calves born from INR cows, and the least for calves born from CON cows ($P = 0.04$). In summary, supplementing pregnant beef cows during late gestation with *Co*, *Cu*, *Zn*, and *Mn* increased cow BCS change, improved concentrations of these trace minerals in the placental cotyledon as well as maternal and offspring liver, and resulted in increased calf weaning BW. Moreover, these outcomes were further improved when an organic source of *Co*, *Cu*, *Zn*, and *Mn* was supplemented instead of an inorganic source.

Introduction

Nutritional management of beef cows during late-gestation has direct implications on performance of the subsequent calf crop (Bohnert et al., 2013). However, all of the research conducted to date evaluating this subject focused on energy and protein nutrition, and little is known about the potential impacts of trace mineral status of the dam during late-gestation on offspring performance.

Trace minerals are essential for adequate fetal development in all livestock species (Hostetler et al., 2003). During gestation, the fetus depends completely on the dam for adequate supply of trace minerals to support enzymatic and metabolic processes required for fetal growth. If maternal mineral supply is inadequate, fetal development and postnatal performance can be drastically impaired. As examples, *Zn*, *Cu*, and *Mn* are essential elements for proper development of the fetal nervous, reproductive, and immune systems (Hostetler et al., 2003). Moreover, *Cu* concentrations in bovine fetal liver are greater than maternal liver *Cu* concentrations, suggesting that the maternal system significantly shunts *Cu* to support fetal development. Based on these data, we hypothesized that providing trace mineral supplementation to late-gestating cows is indispensable for optimal performance of the subsequent calf-crop.

One strategy to enhance trace mineral status in livestock is to feed "organic" sources (Hostetler et al., 2003). These are often based on minerals attached to amino acids or short peptide chains, which potentially enhance absorption, retention, and biological activity of specific trace minerals. Hostetler et al. (2000) reported that trace mineral concentrations in tissues of developing fetuses collected from sows supplemented with organic sources of *Cu*, *Mn*, and *Zn* were greater compared to fetuses from sows supplemented with inorganic sources, which translated into reduced fetal degeneration and enhanced fetal survival. Although not directly comparable, these results suggest potential advantages of supplementing organic trace mineral sources to late-gestating cows. Therefore, we also theorized that supplementing organic sources of trace minerals to beef cows during late gestation is an additional alternative to optimize production efficiency of the subsequent offspring.

Based on the aforementioned rationale, the objective of this experiment was to evaluate the effects of organic and inorganic trace mineral supplementation to beef cows during late gestation on production parameters of the subsequent offspring.

Materials and Methods

This experiment was conducted at the Oregon State University – Eastern Oregon Agricultural Research Center (EOARC; Burns, OR). Animals utilized were cared for in accordance with acceptable practices and experimental protocols reviewed and approved by the Oregon State University, Institutional Animal Care and Use Committee.

Animals and diets

Eighty-four multiparous Angus × Hereford cows were ranked by BW and BCS, and allocated to 21 drylot pens (4 cows/pen) at the end of their second trimester of gestation (day 0 of the study). Pens were randomly assigned to receive 1 of 3 treatments: 1) supplementation with inorganic sulfate sources of *Cu*, *Co*, *Mn*, and *Zn* (**INR**), 2) supplementation with an organic source of *Cu*, *Mn*, *Co*, and *Zn* (**ORG**; Availa®4; Zinpro Corporation, Eden Prairie, MN), and 3) no supplementation of *Cu*, *Co*, *Mn*, and *Zn* (**CON**).

During the experimental period (day 0 until calving), all cows were offered daily 15 lbs of alfalfa hay, 6 lbs of grass straw, 5 lbs of corn, and 0.132 lbs of a macromineral + vitamins + sodium selenite and iodine source mix. This diet was formulated to meet requirements for energy, protein, macrominerals, Se, I, and vitamins (Table 1). Treatments (INR and ORG) were included into the corn, and formulated to provide the same daily amount of *Cu*, *Co*, *Mn*, and *Zn* (based on 0.015 lbs/cow daily of Availa®4).

Liver samples were collected from all cows prior to the beginning of the experiment (day -10), and 2 weeks before the beginning of the calving season. Upon calving, the cotyledons from placenta were collected, and liver samples were retrieved from each newborn calf. Liver samples were analyzed for concentrations of trace minerals at the Michigan State Animal Health Diagnostic Laboratory (Lansing, MI). Cow BW and BCS was also evaluated 2 weeks prior to calving to evaluate treatment effects on these variables. After calving, cow-calf pairs were removed from their respective pen, returned to the EOARC general herd, and assigned to the nutritional and overall management of the research center (which included inorganic mineral supplementation). Approximately 7 months after birth, calves were weaned and calf weaning BW was recorded.

Statistical analysis

Pen was considered the experimental unit. All data were analyzed using the MIXED procedure of SAS (SAS Inst., Inc.; version 9.3) and Satterthwaite approximation to determine the denominator df for the tests of fixed effects. Significance was set at $P \leq 0.05$, and tendencies were determined if $P > 0.05$ and ≤ 0.10.

Results

Nutrient composition and profile of diets offered to CON, INR, and ORG cows is described in Table 1. The CON diet provided adequate amounts of all nutrients and trace minerals, based on the requirements of pregnant cows during last trimester of gestation (NRC, 2000). As expected, including the inorganic or organic sources of *Cu*, *Co*, *Mn*, and *Zn* similarly increased intake of these trace elements by INR and ORG cows, respectively (Table 1).

During the experiment, length of treatment administration was similar ($P = 0.36$) among CON, INR, and ORG (Table 2). No differences were detected ($P \geq 0.60$) for BW change or pre-calving BW (Table 2). Cows receiving CON had less ($P \leq 0.05$) BCS gain during the experiment compared with INR and ORG cows (Table 2), although cows from all treatments had similar ($P = 0.61$) and adequate pre-calving BCS (Table 2). Hence, providing supplemental *Co*, *Cu*, *Mn*, and *Zn* to pregnant cows increased BCS gain during the last trimester of gestation, independent if supplemental mineral source was organic or inorganic.

Table 1. Ingredient composition and nutrient profile of diets (CON, INR, and ORG), as well as nutrient requirements (as % of diet, DM basis) of pregnant cows during last trimester of gestation (REQ).

	CON	**INR**	**ORG**	*REQ*
Ingredients, lbs/day *(as-fed basis)*				
Alfalfa hay	15	15	15	-
Grass-seed straw	6	6	6	-
Corn	5	5	5	-
Macromineral mix	0.132	0.132	0.132	-
Inorganic trace mix	-	0.009	-	-
Organic trace mix	-	-	0.015	-
Nutrient profile (dry matter basis)				
TDN, [2] %	61	61	61	*53*
CP, %	14.4	14.4	14.4	*7.8*
Ca, %	0.59	0.59	0.59	*0.26*
P, %	0.35	0.35	0.35	*0.21*
Mg, %	0.32	0.32	0.32	*0.12*
K, %	1.86	1.86	1.86	*0.60*
Na, %	0.44	0.44	0.44	*0.07*
S, %	0.24	0.24	0.24	*0.15*
Co, ppm	1.03	2.18	2.14	*0.10*
Cu, ppm	9.10	20.8	20.6	*10*
I, ppm	0.44	0.44	0.44	*0.50*
Fe, ppm	522	522	522	*50*
Mn, ppm	55.9	74.0	74.3	*40*
Se, ppm	1.07	1.07	1.07	*0.10*
Zn, ppm	30.6	63.9	63.7	*30*
Vit A, IU/lb	9,900	9,900	9,900	*6,160*
Vit D, IU/lb	1,100	1,100	1,100	*605*
Vit E, IU/lb	5.3	5.3	5.3	*10*

Table 2. Performance variables of pregnant beef cows receiving CON, INR, or ORG diets during the last trimester of gestation.

Item	CON	INR	ORG	*P*=
Days receiving diets	99	94	93	0.36
BW				
Initial, lbs	1144	1124	1111	0.60
Pre-calving, lbs	1415	1419	1395	0.85
BW change, lbs	279	295	295	0.61
BCS				
Initial	5.19	5.10	5.04	0.41
Pre-calving	5.75	5.93	5.94	0.61
BCS change,[1]	0.55[a]	0.83[b]	0.82[b]	0.10

[1] Means with different superscripts differ ($P \leq 0.05$).

Prior to the beginning of the experiment (day -10), no differences were detected ($P \geq 0.38$) among CON, INR, and ORG cows for liver concentrations of *Co*, *Cu*, *Mn*, and *Zn* (Table 3). Prior to the beginning of the calving season, liver concentrations of *Co*, *Cu*, and *Zn* were greater ($P \leq 0.05$) for INR and ORG compared with CON, whereas INR cows had reduced ($P = 0.04$) liver *Co* but greater ($P = 0.03$) liver *Cu* compared with ORG cows (Table 3). No treatment differences were detected ($P = 0.67$) on pre-calving liver *Mn* concentration (Table 3). These results indicate that the inorganic and organic trace mineral sources utilized herein successfully increased liver content of *Co*, *Cu*, *Zn*, but not *Mn*.

Table 3. Liver concentrations of *Co*, *Cu*, *Mn*, and *Zn* of pregnant beef cows receiving CON, INR, or ORG diets during the last trimester of gestation. Liver samples were collected prior to the beginning of the experiment (day -10), or 2 weeks prior to the beginning of the calving season.[1]

Item	CON	INR	ORG	*P* =
Co, ppm				
Initial	0.29	0.28	0.27	0.38
Pre-calving	0.21[a]	0.40[b]	0.44[c]	< 0.01
Cu, ppm				
Initial	93	106	95	0.68
Pre-calving	69[a]	155[b]	129[c]	< 0.01
Mn, ppm				
Initial	12.8	12.8	12.2	0.58
Pre-calving	8.7	9.0	8.7	0.67
Zn, ppm				
Initial	171	176	171	0.70
Pre-calving	211[a]	230[b]	235[b]	0.05

[1] Means with different superscripts differ ($P \leq 0.05$).

In the placental cotyledons, *Co* concentrations were greater ($P \leq 0.05$) in ORG and INR cows compared with CON cows, whereas *Cu* concentrations were only increased ($P = 0.05$) in ORG cows compared with CON. Upon calving, calves from INR and ORG cows had greater ($P < 0.01$) liver *Co* concentrations compared with calves from CON cows. However, liver *Cu* and *Zn* concentrations were greater ($P \leq 0.05$) for calves from ORG cows compared with cohorts from CON cows, but similar ($P \geq 0.17$) between calves from INR and CON cows. Therefore, supplementing inorganic and organic trace mineral sources to pregnant beef cows during late gestation increased the concentration of *Co* in the cotyledon and newborn calf liver, suggesting increased passage of this trace mineral through the placenta and into the fetus. Similar outcomes were detected for *Cu* and *Zn* only when comparing ORG and CON cows, suggesting enhanced transfer of these elements from maternal to fetal tissues when the organic trace mineral source was offered.

Table 4. Cotyledon and calf liver concentrations of *Co*, *Cu*, *Mn*, and *Zn* from beef cows receiving CON, INR, or ORG diets during the last trimester of gestation. Cotyledon and calf liver samples were collected after calving.[1]

Item	CON	INR	ORG	*P* =
Co, ppm				
Cotyledon	0.13[a]	0.20[b]	0.24[b]	0.02
Calf	0.09[a]	0.12[b]	0.13[b]	< 0.01
Cu, ppm				
Cotyledon	3.88[a]	4.75[ab]	5.11[b]	0.10
Calf	362[a]	428[ab]	450[b]	0.18
Mn, ppm				
Cotyledon	22.0	18.2	22.9	0.73
Calf	5.82	5.22	5.83	0.43
Zn, ppm				
Cotyledon	65	66	68	0.87
Calf	456[a]	562[ab]	660[b]	0.01

[1] Means with different superscripts differ ($P \leq 0.05$).

No treatment differences were detected ($P = 0.27$) for calving rate (cows that calved a live calf; Table 4). Cows in the CON treatment gave birth to a reduced ($P \leq 0.05$) proportion of male calves compared with INR and ORG cows (Table 4), while calf sex was not controlled in the present design

Table 4. Calving and weaning outcomes from beef cows receiving CON, INR, or ORG diets during the last trimester of gestation

Item	CON	INR	ORG	*P* =
Calving results				
Calving rate, %	95.5	84.6	95.5	0.27
Calf birth BW, lbs	92.6	94.6	91.8	0.68
% of male calves born	25.9[a]	58.3[b]	48.2[b]	0.05
Lbs of calf/cow exposed	89.3	81.2	88.6	0.44
Weaning results				
Weaning rate, %	92.9	82.1	89.3	0.46
% of male calves weaned	23.1[a]	58.3[b]	52.0[b]	0.02
Calf weaning age, days	177[a]	183[ab]	186[b]	0.17
Calf weaning BW, lbs	468[a]	501[ab]	517[b]	0.04
Calf 205-day adjusted weaning BW, lbs	539[a]	568[ab]	579[b]	0.05
Lbs of calf /cow exposed, kg	497	464	515	0.59

[1] Means with different superscripts differ ($P \leq 0.05$).

because pregnant cows were assigned to treatments without knowledge of their fetal gender. However, calf birth BW and lbs of calf born/cow assigned to the experiment were similar ($P \geq 0.44$) among treatments (Table 4), although male calves are heavier than female calves at birth (Bellows et al., 1971).

At weaning, no treatment differences were detected ($P = 0.46$) for weaning rate (cows that weaned a live calf; Table 4). Again, CON cows weaned a reduced ($P \leq 0.05$) proportion of male calves compared with INR and ORG cows (Table 4). For this reason, calf weaning BW was statistically adjusted to calf sex, although weaning BW was similar ($P = 0.93$) between heifers and steers across treatments (495 vs. 497lbs, respectively). Weaning BW was the greatest for calves born from ORG cows, intermediate for calves born from INR cows, and the least for calves born from CON cows ($P = 0.04$). One could attribute this outcome to differences in weaning age among treatments, given that calves born from CON cows were younger ($P = 0.05$) at weaning compared with calves from ORG cows (Table 4). Nevertheless, 205-day adjusted weaning BW (according to BIF, 2010) were also the greatest for calves born from ORG cows, intermediate for calves born from INR cows, and the least for calves born from CON cows ($P = 0.05$). Hence, supplementing pregnant beef cows during late gestation with *Co*, *Cu*, *Zn*, and *Mn* increased weaning BW by nearly 30 pounds when an inorganic source was offered, or by almost 50 pounds when an organic source was offered. Based on current weaned cattle prices (Central OR Livestock Auction, week of 11/3/2014), such differences in actual weaning BW would result in $81 value increase per calf born from INR cows, or $135 value increase per calf born from ORG cows when compared to calves from CON cows.

Conclusions

Results from this experiment indicate supplementing pregnant beef cows during late gestation with *Co*, *Cu*, *Zn*, and *Mn* increased cow BCS change, improved concentrations of these trace minerals in the placental cotyledon as well as maternal and offspring liver, and resulted in increased calf weaning BW. Moreover, these outcomes were further improved when an organic source of *Co*, *Cu*, *Zn*, and *Mn* was supplemented instead of an inorganic source.

Literature Cited

Bellows et al. 1971. J. Anim. Sci. 33, 407-415.

BIF, 2010. 9th ed. BIF, North Carolina State University, Raleigh, NC, USA.

Bohnert et al. 2013. J. Anim. Sci. 91:5485-5491

Hostetler et al. 2003. The Veterinary Journal 166:125–139.

Hostetler et al. 2000. In 14th International Congress Animal Reproduction, pp. 272 (Abstract)

NRC. 2000. 7th rev. ed. Natl. Acad. Press, Washington, DC.

Oregon State University

BEEF131

Beef Cattle Sciences

Oregon Beef Council Report

Modifying the hormone strategy for superovulating donor cows to reduce drug costs without decreasing the number of high quality transferable embryos recovered[1]

Maria K. Gomes,[2] Alex Snider,[3] Nicole Steigerwald,[4] and Alfred R. Menino, Jr.[5]

Synopsis

Two hormone dosing strategies used to superovulate donor cows for embryo transfer were evaluated. Cows superovulated with the standard dose of 400 mg follicle stimulating hormone (FSH) produced more ova compared to the reduced dose of 200 mg but the reduced dose yielded a greater percentage of transferable embryos. Although the total number of transferable embryos recovered was reduced by 1.6 embryos using the reduced FSH dose, the cost per transferable embryo was less with 200 vs. 400 mg FSH ($16 vs. $23 per embryo, respectively).

Summary

The specific aim of this research was to adjust the hormone doses used in a superovulatory protocol to where drug costs can be reduced while still retaining recovery of a satisfactory number of high quality transferable embryos. We proposed to reduce the FSH dose by half and double the gonadotropin-releasing hormone (GnRH) dose. Nineteen crossbred beef cows from the Oregon State University Beef Cattle Ranch were assigned to one of four treatments: 1) 400 mg FSH and 100 µg GnRH, 2) 400 mg FSH and 200 µg GnRH, 3) 200 mg FSH and 100 µg GnRH, or 4) 200 mg FSH and 200 µg GnRH. Embryos were collected non-surgically 7 d after estrus onset and scored for developmental stage and quality. Dose of GnRH had no significant effects on the average numbers of ova, embryos and transferable embryos recovered nor did it have an effect on the percent embryos and transferable embryos recovered. However, twice as many ova were recovered from cows treated with 400 compared to 200 mg FSH but the percentage of transferable embryos of the total number of ova recovered was greater with 200 compared to 400 mgFSH. Both high doses of FSH and GnRH increased the number of unfertilized ova recovered. These data suggest that although the high FSH dose generated more total ova, many were neither fertilized nor transferable. Reduced FSH dosing was also cost-effective. Drug costs to produce transferable embryos were $16 vs. $23 per embryo for cows superovulated with 200 vs. 400 mg FSH, respectively.

Introduction

Embryo transfer is an applied reproductive technology that has been used to improve herd genetics and female reproductive efficiency and propagate offspring from elite sire-dam matings (Bó and Mapletoft, 2013). Although the technique is commonly referred to as "embryo transfer", the

1. This document is part of the Oregon State University – 2014 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.
2. Graduate Student, Oregon State University, ANRS, Corvallis, 97331; gomesm@onid.orst.edu
3. Graduate Student, Oregon State University, ANRS, Corvallis, 97331; snidera@onid.orst.edu
4. Graduate Student, Oregon State University, ANRS, Corvallis, 97331; steigerwaldn@onid.orst.edu
5. Professor, Oregon State University, ANRS, Corvallis, 97331; alfred.r.menino@oregonstate.edu

"transfer" part is only the latter half of the overall procedure where embryos are transferred to timed recipients. The equally, if not more, critical part of an "embryo transfer" is the first half or the embryo collection where in cattle embryos are collected from superovulated donors. Because cows usually ovulate only a single ovum every estrous cycle, donor cows are commonly treated with a 4-day regimen of the pituitary gonadotropic hormone, FSH. Costs associated with FSH are high and with the current standard dosing it costs at least $150 in FSH alone to superovulate one donor (Armstrong, 1993). Besides the high cost, overstimulation of the ovaries by FSH occurs reasonably frequently and is counterproductive to both the numbers of total ova and transferrable embryos recovered. The question remains within the standard dosing of FSH is just how much FSH is required to induce an acceptable superovulatory response where a significant number of high quality transferable embryos can be recovered. Often practitioners will administer a second hormone, GnRH, when the donor first exhibits heat. The notion behind this injection is to increase the number of ova ovulated thereby increasing the total number of embryos produced and collected from a donor within a round of superovulation. Despite the frequency of GnRH use in these protocols, a clear benefit of the GnRH injection to improving overall embryo production has not been realized. The lack of a clear response may be due to either the variation associated with superovulatory responses making it difficult to detect differences or insufficient dosing of GnRH. It may well be that in our attempts to increase ovulation rate, we are actually "under-dosing" donors with the current GnRH dosing strategy. Therefore, the objective of this study was to evaluate the number and quality of embryos recovered from donor cows superovulated with reduced dosing of FSH and increased dosing of GnRH. We hypothesized the reduced dose of FSH and the higher dose of GnRH would yield less total ova but a greater percentage of transferrable embryos.

Materials and Methods

Nineteen crossbred beef cows from the Oregon State University Beef Cattle Ranches were stratified into one of four treatment groups according to age and parity: 1) 400 mg FSH and 100 µg GnRH, 2) 400 mg FSH and 200 µg GnRH, 3) 200 mg FSH and 100 µg GnRH, or 4) 200 mg FSH and 200 µg GnRH. All cows were estrous synchronized and superovulated following the protocol described in Figure 1 with the exception that cows in the 200-mg FSH treatments received eight 25-mg doses twice daily instead of eight 50-mg doses. Estrus detection commenced 24 h after the second injection of Lutalyse and cows were artificially inseminated with one straw of frozen bull semen at 0, 12 and 24 h after onset of estrus. At onset of estrus, cows were injected with 100 or 200 µg of GnRH depending on treatment assignment. Embryos were collected non-surgically 7 d after estrus onset and scored for developmental stage and quality using the four rank grading scheme devised by Lindner and Wright (1983).

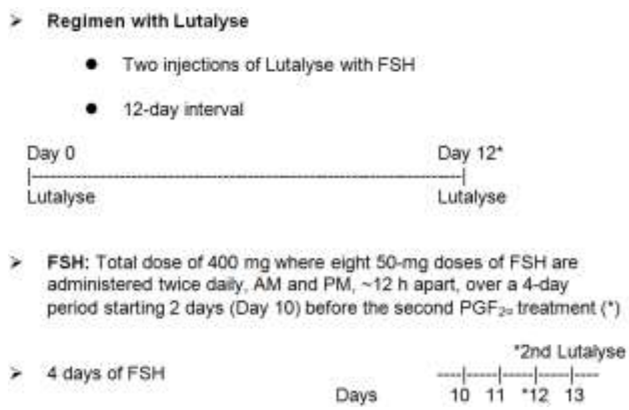

Figure 1. Double injection Lutalyse and FSH protocol for estrous synchronizing and superovulating donor cows for embryo collections.

Differences in the total numbers of ova, embryos, transferable embryos and unfertilized ova and the percent embryos, transferable embryos and unfertilized ova (UFOs) of the total ova recovered were analyzed using analysis of variance (ANOVA) for a 2 X 2 factorial design. Sources of variation in the ANOVA were FSH dose (200 or 400 mg), GnRH dose (100 or 200 µg) and the FSH X GnRH interaction. If significant effects were observed in the ANOVA, differences between means were evaluated using Fisher's least significant differences procedures. All analyses were performed using the NCSS statistical software program (Number Cruncher Statistical System; 2000, Jerry Hintze, Kaysville, UT).

Results

Mean number of ova collected was less (P = 0.08) for cows treated with 200 vs. 400 mg FSH (4.7 $\pm$ 2.5 vs. 10.5 $\pm$ 1.9, respectively), however no difference (P > 0.10) was observed for cows treated with 100 or 200 µg GnRH (8.5 $\pm$ 2.0 vs. 8.2 $\pm$ 2.3, respectively) (Figure 2). The FSH X GnRH interaction was not significant. Mean number of embryos recovered was not different (*P* > 0.10) between cows treated with 200 vs. 400 mg FSH (4.1 ± 2.0 vs. 7.8 ± 1.5, respectively) and no difference (*P* > 0.10) was observed for cows treated with 100 vs. 200 µg GnRH (7.7 ± 1.6 vs. 4.6 ± 1.8, respectively). The FSH X GnRH interaction was also not significant. Mean number of transferable embryos recovered was not different (*P* > 0.10) between cows treated with 200 vs. 400 mg FSH (3.6 ± 1.5 vs. 5.5 ± 1.1, respectively) and no difference (*P* > 0.10) was observed for cows treated with 100 vs. 200 µg GnRH (5.8 ± 1.2 vs. 3.4 ± 1.4, respectively). The FSH X GnRH interaction was not significant. Mean number of UFOs collected was less (*P* = 0.07) for cows treated with 200 vs. 400 mg FSH (0.6 ± 1.0 vs. 2.8 ± 0.8, respectively) and fewer (*P* = 0.06) UFOs were recovered from cows treated with 100 vs. 200 µg GnRH (0.7 ± 0.8 vs. 3.6 ± 0.9, respectively) (Figure 3). The FSH X GnRH interaction was not significant.

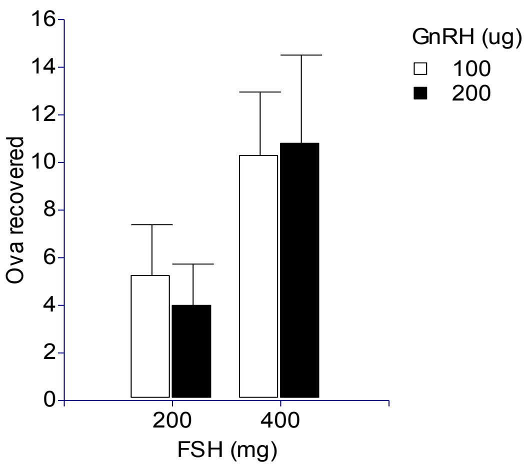

Figure 2. Mean numbers of ova recovered from cows superovulated with two doses of FSH and GnRH.

Mean percentages of embryos recovered was not different (*P* > 0.10) between cows treated with 200 vs 400 mg FSH (88.6 ± 11.0% vs 72.8 ± 8.4%, respectively) and no difference (*P* > 0.10) was observed for cows treated with 100 vs 200□µg GnRH (89.0 ± 8.8 vs 72.4 ± 10.3%, respectively). The FSH X GnRH interaction was also not significant. Mean percentage of transferable embryos recovered was greater (*P* < 0.05) for cows treated with 200 vs 400 mg FSH (81.6 ± 10.5 vs 52.9 ± 8.0%, respectively), however no difference (*P* > 0.10) was observed between cows treated with 100 vs 200 µg GnRH (75.5 ± 8.4 vs 59.1 ± 9.8%, respectively) (Figure 4). The FSH X GnRH interaction was not significant. Mean percentage of unfertilized ova was not different (*P* > 0.10) between cows treated with 200 vs 400 mg FSH (11.3 ± 11.0 vs 27.2 ± 8.4%, respectively) and no difference (*P* > 0.10) was observed between cows treated with 100 vs 200 µg GnRH (11.0 ± 8.8 vs 27.6 ± 10.3%, respectively). The FSH X GnRH interaction was also not significant.

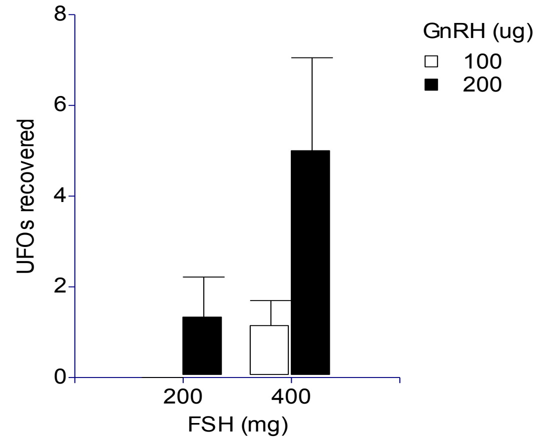

Figure 3. Mean numbers of unfertilized ova (UFOs) recovered from cows superovulated with two doses of FSH and GnRH.

Reduced FSH dosing yielded fewer total transferrable embryos (1.6 embryos) but a greater percentage of transferrable embryos at a reduced (2/3) cost (Table 1). Increased GnRH dosing had a negative effect on transferrable embryos and the reduced FSH and increased GnRH dosing was not cost effective (Table 1).

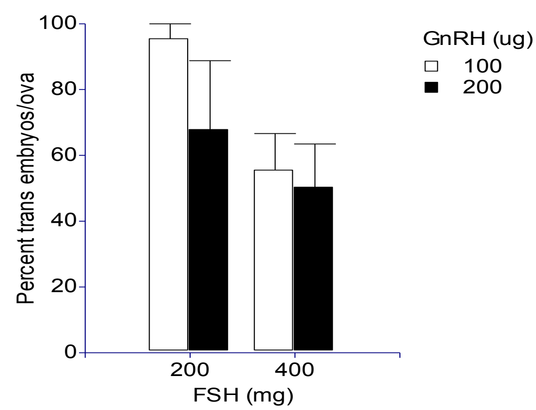

Figure 4. Mean percent transferable (trans) embryos recovered from cows superovulated with two doses of FSH and GnRH.

Conclusions

Although cows superovulated with the standard doses of FSH (400 mg) and GnRH (100 ∝γ) produced more total ova, many were either unfertilized or, if fertilized, not transferrable embryos. These data suggest that the higher dosing is likely inducing ovulation of poorer quality ova which fail to fertilize and generate competent embryos. Producers involved in embryo transfer may be served better by starting their donors on a reduced dose of FSH then adjusting to a higher dose as the superovulatory response is observed to decrease. The reduced FSH dose not only contributes to a reduced cost but also extends the longevity of a cow to serve as a donor.

Table 1. Mean numbers of transferable embryos and costs per embryo recovered ($) from donor cows superovulated with 200 or 400 mg FSH and 100 or 200 µg GnRH.

	GnRH dose (mg)	
FSH dose (mg)	**100**	**200**
200	4.8 ($16)	2.0 ($40)
400	6.4 ($23)	4.2 ($36)

Acknowledgements

This research was supported by a grant from the Oregon Beef Council.

Literature Cited

Armstrong. 1993. Theriogenology 39:7-24.

Bó and Mapletoft. 2013. Theriogenology 81:38-48.

Lindner and Wright. 1983. Theriogenology 20:407-416.

Oregon State University

Beef Cattle Sciences

BEEF132

Oregon Beef Council Report

Serum Malondialdehyde Concentrations are Elevated in Dairy Cows that Subsequently Develop Left Displaced Abomasum[1]

Gerd Bobe[2]

Synopsis

Serum malondialdehyde concentrations are elevated in cows that subsequently develop left displaced abomasum. Therefore, oxidative damage may play a role in the development of diseases in early lactation.

Summary

Most multiparous dairy cows have during the first weeks after calving an impaired immune response and energy metabolism, resulting in various infectious and metabolic diseases. Oxidative damage and inflammation may contribute to the high incidence and severity of diseases in early lactation by decreasing metabolic and immune function. Malondialdehyde (MDA) is a derivative of the major degradation product of lipid hydroperoxides and can be used to determine oxidative damage. Malondialdehyde is increased in diseased cattle but it has not been measured before the disease developed. Serum MDA concentrations were compared from blood samples taken from 4 weeks before calving to 7 weeks after calving in two groups of cows that either developed in early lactation left displaced abomasum (LDA, n=7) or remained healthy (n=10). Cows that developed in early lactation left displaced abomasum had 2-fold higher serum MDA concentrations than healthy cows (5.63±0.99 µMol/L vs. 2.82±0.84 µMol/L; *P*=0.05). Group differences were consistent throughout the sampling period. In conclusion, serum MDA concentrations are elevated in cows that subsequently develop LDA and that oxidative damage may play a role in the development of LDA in early lactation.

Introduction

Most multiparous dairy cows have during the first weeks after calving an impaired immune response and energy metabolism, resulting in various infectious and metabolic diseases. Oxidative damage and inflammation of liver and muscle tissues may contribute to the high incidence and severity of diseases in early lactation. Vitamin E, the biologically the active form of vitamin E is α-tocopherol, is known to protect against lipid peroxidation and thereby prevent oxidative tissue damage and inflammation. We previously reported that serum α-tocopherol concentrations decrease by 40% in the first week after calving and that deficient serum α-tocopherol concentrations precede disease (Qu et al., 2013). Furthermore, we reported that cows inflammation, as indicated by elevated haptoglobin concentrations during the first week after calving, precede clinical disease onset (Sabedra, 2012).

Little is known about the link between oxidative tissue damage and diseases in dairy cows because it is difficult to measure oxidative tissue damage (Celi, 2011). Malondialdehyde (**MDA**) is a derivative of the major degradation product of lipid hydroperoxides and can be used to determine oxidative damage.

1. This document is part of the Oregon State University – 2014 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.
2. Assistant Professor, Oregon State University, Corvallis 97731. Email: gerd.bobe@oregonstate.edu

MDA is increased in sick cows (Mudron et al., 1999; Kizil et al., 2010) but MDA has not been measured before disease onset. The hypothesis of this study was that serum concentrations of MDA are higher in cows that subsequently become sick compared with cows that remain healthy in early lactation. Such an association would suggest that oxidative tissue damage may play a role in the development of diseases in early lactation. To test the hypothesis, serum MDA, α-tocopherol, haptoglobin, and serum amyloid A concentrations were measured from blood samples taken from 4 weeks before calving to 7 weeks after calving in two groups of cows that either developed in early lactation left displaced abomasum (**LDA**, n=7) or remained healthy (n=10). Left displaced abomasum is an economically important disease that affects approximately 3.5% of U.S. dairy cows (USDA, 2009). The cost per case, including surgery, milk loss, and mortality, has been estimated 20 years ago to be between U.S. $ 250 and 400 (Bartlett et al, 1995).

Materials and Methods

The study was conducted on a 1,000-head commercial dairy farm in Oregon's Central Willamette Valley during Spring and Summer 2010. We only collected blood samples and monitored the health of purebred pregnant Holstein cows that had completed ≥ 1 lactation, were free of diseases, and had a body condition score of ≥ 3.0 at the start of the study. The cohort consisted of 161 multiparous Holstein cows (upcoming parity 2 to 7). Using a nested case-control design, we identified cows that developed LDA (n = 7) or remained healthy (n = 10) during the first 35 days after calving. Cows were matched based on parity and calving season.

During the last 4 weeks before expected calving, cows were housed in a straw-bedded free stall barn and were fed once in the morning (7:30 AM) a total mixed ration based on corn, corn silage, and alfalfa and triticale hay, which met National Research Council (**NRC**) guidelines (NRC, 2001). After calving, healthy cows stayed the first two days in the hospital pen, and then for 4 weeks in the early lactation pen, and then for weeks 5 to 17 after calving based on body size (largest, medium, and smallest based on height and depth of cows) in three mid-lactation pens. Cows diagnosed with diseases were moved back to the hospital pen for treatment. Cows were fed around 8:00 AM and 1:30 PM a total mixed ration based on corn, corn silage, and alfalfa hay, which met NRC guidelines (NRC, 2001).

During the study period, cows were monitored daily for abnormal milk, gait, appetite, general appearance, alertness, vaginal discharge, and retained placenta. Uterine discharge and milk somatic cell scores were checked twice per week. Urinary ketones and body temperature were checked if cow appeared not healthy, which included depressed feed intake (all cows were monitored if they consumed feed), lethargy, cold ears, and rapid body condition score loss. Diseases were diagnosed and treated based on Standard Operating Procedures developed by the Oregon State University veterinary staff and consistent with standard of care veterinary practices. Diagnosis and treatment of diseases was done by the herd manager, who was trained and supervised by the Oregon State University veterinarian. The veterinarian visited at least once per week to supervise diagnosis and treatment of diseases.

Blood samples were taken at da y -28 (-31 to 25), d -21 (-24 to -18), -14 (-17 to -11), -7 (-10 to -5), -3 (-4 or -3), -1 (-2 or -1), 0, 1, 3, 7, 14, 21, 28, 35, 42, and 49 after calving within 10 min after morning feeding. Blood (5 to 8 mL) was obtained from the coccygeal vein or artery in 10 mL serum vacutainer tubes (BD Vacutainer® Plus Plastic Serum Tubes, BD Diagnostics, Franklin Lakes, NJ), placed on ice, and transported to the laboratory, where serum was separated by centrifugation at room temperature for 20 minutes. Serum samples were stored at -20°C until chemical analysis. Serum concentrations of MDA were measured using reversed-phase HPLC with fluorometric detection (Lykkesfeldt, 2001). Serum concentrations of α-tocopherol were measured using reversed-phase HPLC with electrochemical detection, as previously described (Qu et al., 2013). We used commercially available kits according to manufacturer's instructions to measure serum concentrations of haptoglobin (Catalog No. 2410-70, Life Diagnostics, Inc., West Chester, PA) and serum amyloid A (Catalog No. KAA0021; Life Technologies, Grand Island, NY).

Data were analyzed as repeated-measures-in-time ANOVA study using the PROC MIXED procedure of SAS version 9.2 (SAS Institute, 2009). Normality of data distribution were evaluated using the Shapiro-Wilk test in PROC UNIVARIATE. As the Shapiro-Wilk test is very sensitive to deviations from normality, we tested several distributions (non-transformed, square root, natural logarithm, and twice natural logarithm) and chose the transformation that resulted in the highest W value. Concentrations of haptoglobin were twice natural logarithm transformed and concentrations of serum amyloid A were once natural logarithm transformed. Repeated measures within cow were modeled using the heterogeneous first-order autoregressive variance-covariance matrix (REPEATED STATEMENT). Fixed effects were group (LDA and healthy), parity (2, > 2), sampling time, and the interaction between group and sampling time. For MDA, we also included the day of analysis as fixed effect in the model. To obtain the correct degrees of freedom, the KENWARDROGER option was invoked. Economic data were analyzed as t-test (PROC TTEST).

Values presented in the figures are least-squares means (**LSM**) and their standard errors (**SEM**) that are transformed back to their original measurement scale. All statistical tests were two-sided. Statistical significance was declared at $P \leq 0.05$ and a tendency at $0.05 < P \leq 0.10$.

Results

Left displaced abomasum (LDA) in dairy cows is an expensive disease (**Figure 1**). The losses associated with LDA, calculated as sum of treatment costs and lost milk income (milk had to be discarded), were for the first 28 days after calving U.S. $0/cow in the healthy cows and $ 408/cow or $14.6 ± 1.0 per cow and day in the LDA cows ($P < 0.0001$). We estimated the cost for the LDA surgery at $100 per cow. The daily income generated from milk sales was for the first 28 days in milk $18.1 ± 0.8 per cow in the healthy cows and $11.3 ± 1.1 per cow in the LDA cows ($P < 0.0001$). The daily net gain, calculated as difference between income and losses was for the first 28 days in milk ± 0.8 per cow in the healthy cows and $-3.3 ± 1.0 per cow in the LDA cows ($P < 0.0001$). The daily net gain for the first 100 days in milk $13.8 ± 0.7 per cow in the healthy cows and $8.4 ± 3.8 per cow in the LDA cows ($P = 0.21$). The large variability in the net gain for the LDA cows can be explained by the fact that some cows recovered, whereas others had to be sold because they did not completely recover or did not conceive.

Serum concentrations of MDA were elevated in cows that subsequently developed LDA (**Figure 2**). Cows that developed LDA in early lactation (day 6 to 32 after calving) had 2-fold higher serum MDA concentrations compared with healthy cows (5.63±0.99 µMol/L vs. 2.82±0.84 µMol/L; P=0.05). Group differences were consistent throughout the sampling period. Prior studies reported that cows with hepatic lipidosis and metritis and have higher plasma MDA concentrations than healthy cows (Mudron et al., 1999; Kizil et al., 2010). I am not aware of literature that reported concentrations of MDA before cows became sick. Malondialdehyde is a derivative of the major degradation product of lipid hydroperoxides and has been used to determine oxidative damage. Based on the results of this study, I conclude that oxidative damage may play a role in the development of LDA in early lactation.

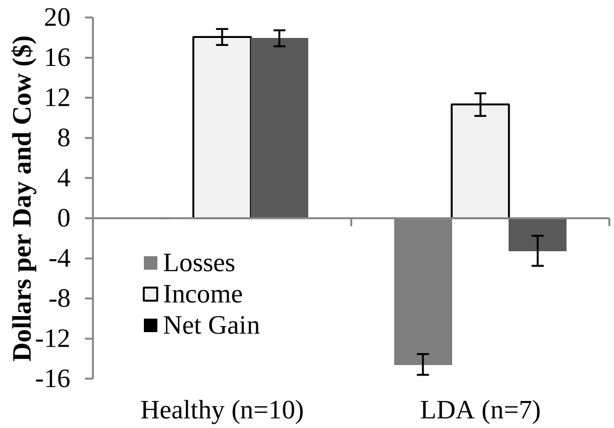

Figure 1. Economic data for the first 4 weeks after calving in healthy cows and cows that developed left displaced abomasum (LDA) between 6 and 32 d after calving. Left displaced abomasum increased losses and decreased income and net gain (all $P < 0.0001$).

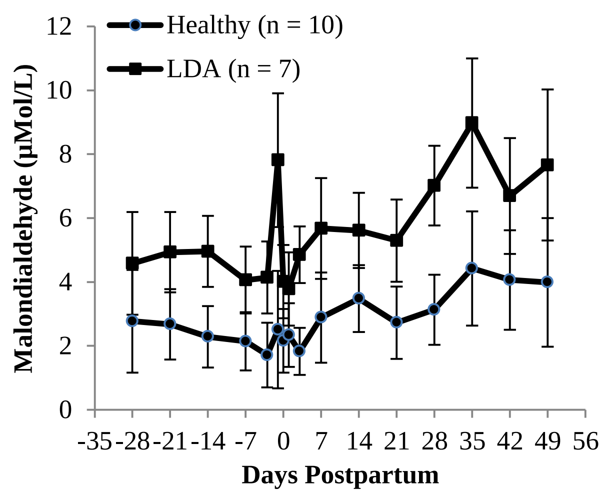

Figure 2. Serum concentrations of malondialdehyde (MDA) between d -28 and 49 after calving in healthy cows and cows that developed left displaced abomasum (LDA) between 6 and 32 d after calving. Cows that developed in early lactation LDA had 2-fold higher serum MDA concentrations compared with healthy cows (5.63±0.99 µMol/L vs. 2.82±0.84 µMol/L; P=0.05).

The lowest MDA concentrations were observed between 7 days before and 3 days after calving (with the exception of 1 day before calving) and the highest MDA concentrations were observed between 28 and 49 days after calving (**Figure 2**). Increases in MDA concentrations of red blood cells after calving have been reported (Sharma et al., 2011). Furthermore, a numerical but highly variable increase in plasma MDA concentrations has been reported for the last week before and after calving (Castillo et al., 2006). In this study, serum α-tocopherol concentrations (α-tocopherol is the biologically active form of vitamin E), decreased strongly in the first week after calving and then slowly increased back to concentrations before calving at 4 weeks after calving (Qu et al., 2013; **Figure 3**). Vitamin E is known to protect against lipid peroxidation and thereby prevent oxidative tissue damage and inflammation. Furthermore, serum MDA concentrations have been reported to be lower in early lactation in cows that were supplemented with vitamin E during the dry period compared with control cows (Bouwstra et al., 2009). Thus, the hypothesis of this study was that serum MDA concentrations would be elevated in the first week after calving and would decrease as serum α-tocopherol concentrations increased.

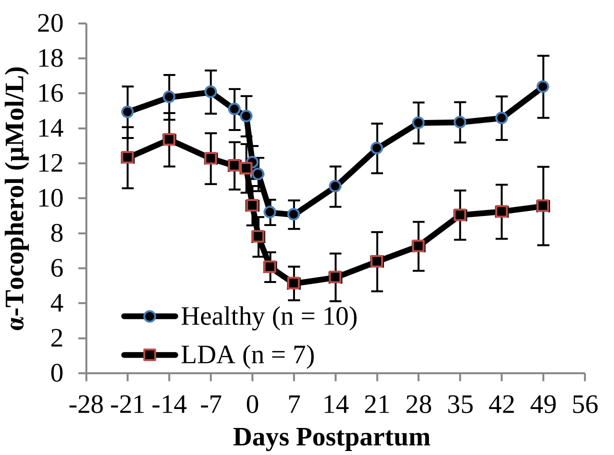

Figure 3. Serum concentrations of α-tocopherol between d -28 and 49 after calving in healthy cows and cows that developed left displaced abomasum (LDA) between 6 and 32 d after calving. Cows that developed in early lactation LDA had throughout the sampling period lower α-tocopherol concentrations compared with healthy cows.

Furthermore, I anticipated elevated serum MDA concentrations in the first two weeks after calving because serum markers of inflammation, haptoglobin (**Figure 4**) and serum amyloid A (**Figure 5**; Cray et al., 2009), were elevated during the first two weeks after calving in LDA cows (Qu et al., 2013). Inflammation and oxidative tissue damage are closely associated with each other, as inflammation causes oxidative tissue damage and vice versa (Sordillo and Aitken, 2009). We did not observe consistent correlations between serum concentrations of MDA, α-tocopherol, haptoglobin and serum amyloid A during the sampling period. We, however, observed cows that developed LDA had throughout the sampling period higher MDA values than cows that remained healthy during early lactation. Therefore, elevated serum MDA concentrations may not be able to indicate acute tissue damage but rather chronic tissue damage, which may play a role in the development of LDA in early lactation by decreasing metabolic and immune function.

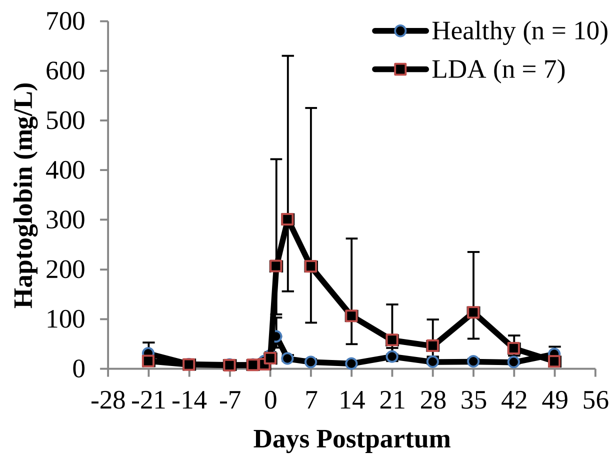

Figure 4. Serum concentrations of haptoglobin between d -28 and 49 after calving in healthy cows and cows that developed left displaced abomasum (LDA) between 6 and 32 d after calving. Elevated haptoglobin concentrations were observed in all cows; however, they were greater and remained elevated during early lactation in LDA compared with healthy cows.

Conclusions

Left displaced abomasum (LDA) is an economically important disease for the dairy cows, substantially limiting profits. Serum concentrations of MDA, haptoglobin, and serum amyloid A are higher and serum concentrations of α-tocopherol are lower in cows that subsequently develop LDA compared with cows that remain healthy. Thus, inflammation and oxidative damage may play a role in the development of LDA in early lactation.

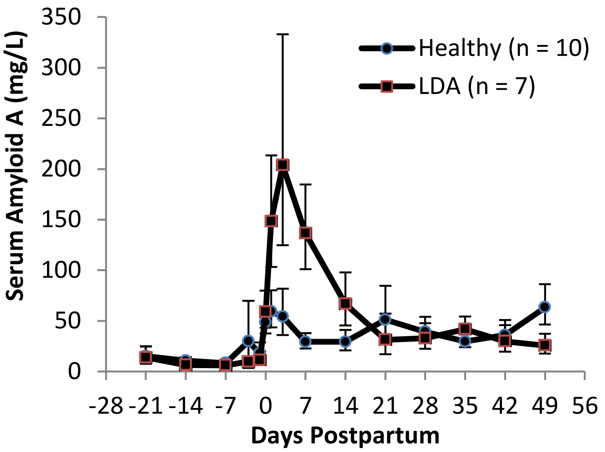

Figure 5. Serum concentrations of serum amyloid A between d -28 and 49 after calving in healthy cows and cows that developed left displaced abomasum (LDA) between 6 and 32 d after calving. Elevated serum amyloid A concentrations were observed after calving in all cows; however, they were greater and remained stronger elevated until day 14 after calving in LDA cows compared with healthy cows.

Acknowledgements

This study was financially supported by the Oregon Beef Council, Oregon State University (Corvallis, OR), the Oregon State University Agricultural Research Foundation, the Eckelman graduate student scholarship, and a grant from Diamond V (Cedar Rapids, IA). The author wishes to acknowledge the owners and staff of VanBeek Dairy for use of their animals; B. Bledsoe, B. Block, B. Bronson, A. Fadden, M. Keller, M. McGuire, P. Ramsing, A. Rudolph, D. Sabedra, C. Sause, C. Shriver-Munsch, M. Swearingen, and E. Zaworski for their assistance with sample collection and data entry (all in Department of Animal and Rangeland Sciences, Oregon State University, Corvallis); E. Bobe, A. Fadden, S. Leonard, K. Lytle, Y. Qu, and E. Watts for technical assistance with sample analysis (Department of Animal and Rangeland Sciences and Linus Pauling Institute, Oregon State University, Corvallis).

Literature Cited

Bartlett et al. 2006. J. Dairy Sci. 206”1156-1162

Bouwstra et al. 2009. Tijdsch. Diergemeeskd. 134:656-661.

Castillo et al. 2006. Res. Vet. Sci. 80:133-139.

Celi. 2011. Immunopharm Immunotoxicol. 33:233-240.

Cray et al. 2009. J. Am. Assoc. Lab. Anim. Sci. 59:517-526.

Kizil et al. 2010. Rev. Med. Vet. 161:353-357.

Lykkesfeldt. 2001. Clin. Chem. 57:1725-1727.

Mudron et al. 1999. J. Vet. Med. A 46:219-224.

National Research Council (NRC). 2001. 7th rev. ed. National Acad. Sci., Washington, DC.

Qu et al. 2013. J Dairy Sci. 95:7331-7335

SAS Institute. 2009. SAS Inst. Inc., Cary, NC.

Sabedra. 2012. Senior Research Project. Oregon State University, Corvallis, OR.

Sharma et al. 2011. Asian-Aust. J. Anim. Sci. 24:479-484.

Sordillo and Aitken. 2009. Vet. Immunol. Immunopath. 128:104-109.

United States Department of Agriculture (USDA). 2009. Dairy 2007. USDA-APHIS-VS, CEAH, Fort Collins, CO.

Oregon State University **BEEF133**

Oregon Beef Council Report

Beef Cattle Sciences

The Effect of Western Juniper on the Estrous Cycle in Beef Cattle[1]

Kevin D. Welch[2,5], Clint A. Stonecipher[2], Dale R. Gardner[2], Kip E. Panter[2], Cory Parsons[3], Tim Deboodt[4], and Bryan Johnson[2]

Synopsis

- Bark and needles from western juniper trees can be abortifacient to cattle.
- Western juniper bark does not affect estrus in cattle.
- Western juniper bark does not affect conception rates in cattle.

Summary

Numerous evergreen trees and shrubs contain labdane acids, including isocupressic acid, which can cause late-term abortions in cattle. Recent research has shown that the bark from western juniper trees can also cause late-term abortions in cattle. Additionally, ranchers have observed that cattle in western juniper-infested rangelands tend to have decreased conception rates. The objective of this study was to determine if western juniper alters the estrous cycle of cattle. Fourteen heifers (10 treated and 4 control) were monitored for 74 days for signs of normal estrous behavior, with a 21 day feeding trial with western juniper bark from days 28-48, after which the cattle were bred naturally with a bull. The cattle were checked for pregnancy 30 days after all cattle had been bred. The data from this study indicate that exposure to western juniper bark does not affect normal estrus, estrous cycle or conception rates of cattle.

Introduction

Needles from ponderosa pine (*Pinus ponderosa*) trees are known to cause late-term abortions in cattle (Gardner et al., 1999; James et al., 1994; James et al., 1989). Isocupressic acid (ICA), a labdane resin acid in the needles of ponderosa pine, was identified as the abortifacient agent (Gardner et al., 1994). In addition to ICA, pine trees also contain other labdane acids including imbricataloic acid (IMB), agathic acid (AA) and dihydroagathic acid (DHAA). The bark of Utah juniper (*Juniperus osteosperma*), which contains a high concentration of AA (1.5% by dry weight) but no ICA, will induce abortions in cattle, demonstrating that AA is also abortifacient in cattle (Gardner et al., 2010).

There have been several reports of abortion rates of 10-15%, within cattle herds in Oregon, after cattle were pastured in areas with an abundance of western juniper trees (*Juniperus occidentalis*; personal communications). In each of these instances, there was no ponderosa pine, or other trees known to contain ICA, found in these areas. There was clear visual evidence that cattle had consumed the bark

1. This document is part of the Oregon State University – 2014 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.
2. United States Department of Agriculture – Agricultural Research Service, Poisonous Plant Research Laboratory, Logan, UT, USA
3. Oregon State University, Baker County Extension Service, Baker City, OR, USA
4. Oregon State University, Crook County Extension Service, Prineville, OR, USA
5. Poisonous Plant Research Laboratory, USDA/ARS, 1150 E 1400 N, Logan, UT 84321, USA. Tel.: +1 435 752 2941x1113; fax: +1 435 753 5681. E-mail address: Kevin.Welch@ars.usda.gov (K.D. Welch).

and needles from the western juniper trees. The reported losses occurred most often after a significant weather incident, such as high winds that knocked limbs onto the ground or heavy snow fall that covered available forage, which can result in cattle eating large amounts of needles and/or juniper bark in a short period of time. Ranchers also reported cattle consuming large amounts of juniper from slash piles or riparian projects where western juniper trees were used for restoration. Analysis of the bark, needles, and berries from western juniper trees determined that all contain labdane acids similar to those found in ponderosa pine needles, albeit in lower concentrations (Welch et al., 2011). Additionally, feeding western juniper bark to late-term pregnant cattle demonstrated that the bark from western juniper trees could induce abortions in cattle (Welch et al., 2011). Analyses of samples of bark, needles, and berries from western juniper trees collected across the state of Oregon, determined that there is considerable variation in the concentration of the abortifacient compounds in western juniper trees (Welch et al., 2013). However, in general, most western juniper trees have the potential to cause late term abortions in cattle.

Several livestock producers in Oregon have also reported irregular estrous cycles and lower reproductive rates in cattle that utilize juniper-infested summer rangelands (personal communications). There are numerous plants that are known to adversely affect the estrous cycle of cattle including several phytoestrogen containing plants (soybeans and clovers) and locoweeds (Evans, 2012; Panter et al., 1999). Consequently, exposure to these plants during the breeding season could effectively prevent the cattle from becoming pregnant, delaying pregnancy, or resulting in an inability to maintain pregnancy. Therefore, the objective of this study was to determine if consumption of western juniper alters the estrous cycle of beef cows and therefore could extend the calving interval or reduce conception rates.

Materials and Methods

For this study, bark from western juniper trees (*Juniperus occidentalis*) was collected in August of 2012 from trees that had been cut down 1-2 years previously near Durkee and Brothers, Oregon. The bark was allowed to dry at ambient temperature. The dried bark was ground to pass a 2mm screen using a Gehl Mix-All model 55 (Gehl Company, West Bend, WI, USA) and stored in a plastic bag in an enclosed, non-heated, un-insulated building at ambient temperature. The concentration of labdane acids in the bark was measured by gas chromatography following previously published methods (Gardner and James, 1999). The composite collection of bark contained 0.09% ICA, 0.42% IMB, 0.15% DHAA, 0.52% AA, and 1.19% total labdane acids, on a dry weight basis.

Fourteen Black Angus heifers were evaluated via rectal palpation and ultrasound imaging to determine reproductive status i.e. active reproductive tract, stage of estrous cycle, normal tone and size of the uterus, and ovarian parameters. The estrous cycle of all 14 heifers was synchronized by administering 5 ml of Lutalyse (Pfizer, New York, NY) intramuscularly followed by a second 5 ml injection 10 days later. Heifers were then observed and handled for 28 days prior to dosing with juniper. Ten heifers were dosed via oral gavage with western juniper bark (35 mg of total labdane acid / kg BW / day; half in the morning and half in the evening) for 21 days. Four control heifers were handled the same as the treatment heifers except ground barley straw was substituted for the juniper bark. Daily blood samples were collected from 3 of the treated heifers for the duration of the study, 74 days, to evaluate serum progesterone profiles as a physiological indication of their estrous cycle. Serum progesterone concentrations were determined using a commercial direct solid-phase radioimmunoassay kit (Siemens Healthcare Diagnostics, Duluth, MN). Validation of the human kit for bovine serum was performed according to previously published methods (Panter et al., 1995). Inter- and intra-assay coefficients of variation were 5.1% and 6.6%, respectively.

All cattle were observed daily for standing estrus and their reproductive tracts were evaluated by rectal palpation and ultrasound imaging prior to the start and immediately following the feeding trial. The size of each ovary was determined by measuring the vertical and horizontal diameter of each ovary via ultrasound imaging techniques. One month after the end of the feeding trial, heat detection patches were placed on all heifers, and they were introduced into a pen with a Red Angus bull. Cattle were monitored daily for evidence of breeding and the date the heat detection patch changed color was noted as the breed date. A new heat detection patch was placed on each heifer after breeding and they were monitored for an additional 30 days for repeat breeding. All heifers were evaluated for pregnancy by rectal palpation and ultrasound imaging approximately 30 days after the last heifer was bred. All animal work was done under veterinary supervision with the approval and supervision of the Utah State University Institutional Animal Care and Use Committee.

Results

In this study, all animals appeared healthy and normal throughout the study. There was no change in feed intake or any clinical signs of poisoning observed in the cattle. The cattle were evaluated by rectal palpation and ultrasound imaging 11 days after the second injection of Lutalyse. They were all found to have a prominent corpus luteum (CL) present on one of their ovaries, indicating that they were each exhibiting a normal estrous cycle. There was no difference in the size of the ovaries between the control and treated cows, either before or after juniper treatment (Table 1), suggesting the juniper treatment did not affect ovarian function. Juniper treatment had no effect on serum progesterone concentrations, as the cows had a normal 21 day cycle before treatment, during treatment, and immediately after treatment (Figure 1). There was no difference in the average time it took for the control and treated heifers to be bred by the bull (Table 1), however, there were two of the treated heifers that rebred (Table 1), suggesting that they did not conceive the first time they were bred. However, there was not a statistically significance difference ($P = 1.0$) between the control and treated groups. Finally, all the cattle were evaluated for pregnancy by rectal palpation and ultrasound imaging approximately 30 days after the last cows had been bred. All of the cattle were found to be pregnant (Table 1). The data presented in this study indicate that exposure of cattle to western juniper, at the dose administered in this study, will not adversely affect estrus or the estrous cycle in cattle, their ability to become pregnant, or their ability to maintain pregnancy during the first trimester. However, cattle producers should still be cognizant of the potential of western juniper trees to cause late-term abortions in cattle.

Due to the small sample size of this study, these results may not be a true reflection of the total population. Consequently, there is still a possibility that western juniper could adversely affect the normal estrous cycle of some cattle. However, encroachment of western juniper is known to adversely affect grass productivity as well as soil hydrologic and nutrient cycles (Bates and Svejcar, 2009; Miller et al., 2000; Roberts and Allen Jones, 2000). Therefore, it is possible that cattle grazed in juniper-infested rangelands may suffer from slight nutritional deficiency, which could impact their overall mineral status including copper, selenium and other trace minerals that are vital for normal reproductive efficiency. Therefore, the reports of increased numbers of open cows observed when cattle graze western juniper-infested rangelands may more likely be due to poor nutritional status or mineral deficiencies. It is well known that deficiencies in key minerals in cattle will adversely affect the ability of cattle to either become pregnant and/or maintain pregnancy (Jainudeen and Hafez, 1993). Additionally, if the cattle are nutritionally deficient, they may eat more juniper bark and needles, as research has shown that cattle in lower body condition eat more pine needles than cattle in better body condition (Pfister et al., 2008). Consequently, future experiments will evaluate the nutritional and mineral status of cattle grazing in western juniper-infested rangelands.

Table 1. The effect of western juniper on several reproductive parameters.

Group		**Control**		**Treated**	
Number of cattle		4		10	
Ovary size (cm^2)		**AVG**	**SD**	**AVG**	**SD**
Day -11[a]	Left	4.3	1.8	3.5	0.7
	Right	2.9	1.3	4.3	1.5
Day 22 [b]	Left	6.3	4.0	6.7	3.6
	Right	10.0	4.4	8.4	4.1
Day 57 [c]	Left	5.0	2.9	5.3	2.2
	Right	8.0	2.7	6.5	2.5
# days to breed [d]		14	0	9	5
# repeat breeders [e]		0		2	
% pregnant [f]		100%		100%	

[a] 11 days prior to start of the feeding trial
[b] 1 days after end of the feeding trial
[c] 36 days after end of the feeding trial
[d] # days after introduction to bull before confirmation of breeding
[e] # of animals who bred more than once
[f] % of animals in each group that were pregnant 50 days after the last positive breeding date

Acknowledgements

The authors wish to thank Rex Probst, Kendra Dewey, Scott Larsen, Daniel Grum, Charles Hailes, Edward Knoppel, Kermit Price, Terrie Wierenga, and Jason Tuttle for their technical assistance.

This work was supported in part by the Oregon Beef Council and by direct congressional appropriations via the United State Department of Agriculture to the Poisonous Plant Research Laboratory, which is part of the Agricultural Research Service.

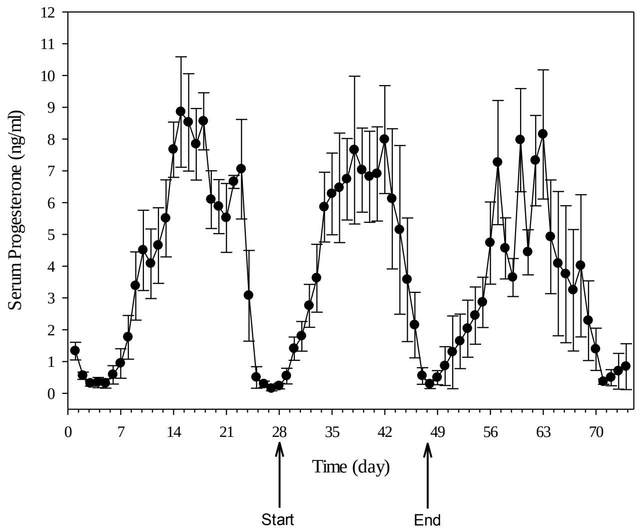

Figure 1. Cows fed western juniper have normal progesterone profiles. Blood was collected from three cows for 28 days prior to the juniper treatment, during the 21 days of the treatment, and for 26 days after the treatment for analysis of serum progesterone concentrations. Data represent the average and standard deviation.

Literature Cited

Bates and Svejcar. 2009. West. N. Am. Nat. 69, 9-25.

Evans, T.J. 2012. Veterinary Toxicology Basic and Clinical Principles, 2 ed. Academic Press, New York, New York, pp. 287-318.

Gardner and James. 1999. Phytochem. Anal. 10, 132-136.

Gardner et al. 1999. J. Nat. Toxins 8, 27-34.

Gardner et al. 1994. J. Agric. Food Chem. 42, 756-761.

Gardner et al. 2010. J. Appl. Toxicol. 30, 115-119.

Jainudeen and Hafez. 1993. Reproduction in Farm Animals, 6 ed. Williams & Wilkins, Media, PA.

James et al. 1994. Cornell Vet. 84, 33-39.

James et al. 1989. Cornell Vet. 79, 39-52.

Miller et al. 2000. Journal of Range Management 53, 574-585.

Panter et al. 1995. Vet. Hum. Toxicol. 37, 30-32.

Panter et al. 1999. J. Nat. Toxins 8, 53-62.

Pfister et al. 2008. J. Anim. Sci. 86, 3608-3616.

Roberts and Jones. 2000. Plant Soil 223, 47-61.

Welch et al. 2013. Rangelands 35, 40-44.

Welch et al. 2011. International Journal of Poisonous Plants 1, 72-79.

Oregon Beef Council Report

Progress Reports – Animal Sciences[1]

Influence of supplement type and monensin addition on utilization of low-quality, cool-season forage by beef cattle

Contact Person: David Bohnert & Reinaldo Cooke – EOARC Burns
Address: 67826A Hwy 205; Burns, OR 97720
Phone Number: (541) 573-8910
Email: dave.bohnert@oregonstate.edu and reinaldo.cooke@oregonstate.edu

Project Objectives: The objectives of the two funded experiments are: 1) determine the influence of supplement composition and monensin addition on forage intake, nutrient digestibility, ruminal fermentation, and blood metabolites of steers consuming low-quality forage and 2) determine the influence of supplement composition and monensin addition on cow BW and body condition score change, calf birth weight, forage offered, and blood metabolites of cows consuming low-quality forage during late-gestation.

Our hypothesis is that we anticipate monensin addition to decrease forage intake while maintaining animal performance; thereby, decreasing the required winter feed allocation and feed costs (per head basis). Also, we anticipate that that monensin will benefit both starch- and fiber-based supplements.

Project Start Date: November of 2014
Expected Project Completion Date: December of 2015

Project Status: Currently, we have secured the necessary feedstuffs to complete the research this fall/winter. The animals required for the research (cannulated steers and gestating beef cows) have been reserved and we have the necessary labor allocated. In addition, we have obtained IACUC approval from OSU for the project (ACUP # 4613). We anticipate starting the steer digestion/metabolism study in November of 2014 and the cow performance study in late December (2014) or early January (2015).

Impacts of cow nutritional management during gestation on future performance of the offspring

Contact Person: Reinaldo Cooke and David Bohnert – EOARC Burns
Address: 67826A Hwy 205; Burns, OR 97720
Phone Number: (541) 573-4083
Email: reinaldo.cooke@oregonstate.edu and dave.bohnert@oregonstate.edu

Project Objectives:
Evaluate the importance of cow nutritional status (BCS 4 or 6) and timing of nutritional intervention (increase BCS from 4 to 6) during gestation on productive parameters of the in utero offspring.

Project Start Date*:* September 1, 2013

1. This document is part of the Oregon State University – 2013 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.

Expected Project Completion Date: July 1, 2016

Project Status: This is a 3-year study (cows pregnant to AI on 2013, 2014, and 2015) to ensure that we have an adequate number of animals enrolled (300 pregnant cows total; approximately 100 cows per year).

In June 2013, 97 cows pregnant to AI and to the same sire were evaluated for BCS approximately 40 days after AI. Cows were assigned based on their initial BCS to the following treatments:

1- **Positive**: Cows with initial BCS = 6, and managed to maintain BCS 6 until calving.
2- **Negative**: Cows with initial BCS = 4, and managed to maintain BCS 4 until calving.
3- **Early**: Cows with initial BCS = 4, supplemented during the first trimester of gestation to achieve and maintain BCS 6 until calving.
4- **Mid**: Cows with initial BCS = 4, supplemented during the second trimester of gestation to achieve and maintain BCS 6 until calving.
5- **Late**: Cows with initial BCS = 4, supplemented during the third trimester of gestation to achieve and maintain BCS 6 until calving.

Cows calved in March 2014. In May 2014, cow milk production and composition was evaluated via weigh-suckle-weigh technique. Calves were weaned in September 2014. Data collected to date are reported below

Table 1. Actual BCS change during the experiment

Item	Negative	Early	Mid	Late	Positive	*P* =
1st trimester	4.51	4.43	4.46	4.49	5.70	< 0.01
BCS increase, 1st to 2nd trimester	*0.08*	*1.02*	*0.06*	*0.13*	*0.07*	*< 0.01*
2nd trimester,	4.60	5.46	4.52	4.60	5.77	< 0.01
BCS increase, 2nd to 3rd trimester	*0.09*	*0.57*	*1.58*	*0.19*	*0.37*	*< 0.01*
3rd trimester	4.73	6.00	6.09	4.76	6.14	< 0.01
BCS increase, 3rd trimester to calving	*0.12*	*0.07*	*0.07*	*1.09*	*0.13*	*< 0.01*
Calving	4.86	6.07	6.16	5.86	6.27	< 0.01

Table 2. Calving, milk production, and weaning results

Item	Negative	Early	Mid	Late	Positive	*P* =
Calving results						
Calving rate, %	92.3	92.3	100.0	100.0	100.0	0.50
Calf birth BW, lbs	99.4	95.0	97.5	92.9	94.1	0.46
Milk production						
Daily milk yield, lbs/d	32.6	29.5	31.2	34.5	30.1	0.42
Weaning results						
Weaning rate, %	92.3	92.3	100.0	100.0	100.0	0.50
Calf weaning age, days	192	193	195	192	192	0.14
Calf weaning BW, lbs	557	572	590	581	552	0.04

These preliminary results suggest that increasing BCS during gestation benefits weaning BW of the offspring. However, additional data is still needed (data from the subsequent 2 years of experiment) to properly assess treatment effects on the parameters reported herein, as well as additional responses not yet evalauted, including:

- Steers were transferred to a commercial feedlot in late November 2014, and data will be collected until slaughter
- Heifers are being raised as replacements in the EOARC herd, and data will be collected until their first breeding season.

Energetic output of mature beef cows based on lactation traits and calf crop performance grouped by historical weaning performance.

Contact Person: Chad J Mueller – EOARC-Union/EOU Ag & NR Program, La Grande
Address: One University Blvd, 205F Badgley Hall, La Grande, OR 97850
Phone Number: 541-962-3789
Email: chad.mueller@oregonstate.edu

Project Objectives: The project is attempting to: 1) quantify milk output of mature cows at 30, 90, 120, and 150 days of lactation; 2) quantify milk quality (i.e. protein, fat, and water) of mature cows at 30, 90, 120, and 150 days of lactation; 3) correlate lactation characteristics to changes is cow weight and condition score during the pre-weaning period; and 4) correlate lactation characteristics to offspring gain performance.

Project Start Date: February 2014
Project Completion Date: September 2015

Project Status: The project compared milk production and blood analytes between beef cow's that weaned a greater percentage (based on the group's weaning history) of the cow's body weight (> Group mean; HIGH) versus a reduced percentage of the cow's body weight (< Group mean; LOW). The first year of collections are completed. During collections cows and calves were separated for 24 hours, while blood and milk samples were collected from the cows. Blood samples were also collected from the calves. We used the weigh-suckle-weigh technique to estimate milk output. Preliminary statistical analyses indicate potential differences ($P < 0.15$) for many production and milk quality traits. As of this progress report blood analyses are in the final stages of completion, and baseline blood samples for year 2 (cows only) are being collected.

Identification of predictive metabolomic markers of diseases in transition dairy cows

Contact Person: Gerd Bobe – Oregon State University
Address: 112 Withycombe Hall - Corvallis, OR 97331
Phone Number: (541) 737-1898
Email: gerd.bobe@oregonstate.edu

Project Objectives: The objective of this study is to identify a panel of serum metabolites that can predict if and what type of disease a cow will get sick of in early lactation.

Project Start Date*:* January 2014
Expected Project Completion Date: October 2015

Project Status: Cows are during early lactation very susceptible to diseases. Metabolomics provides a global analysis of metabolites (proteins, lipids, carbohydrates) in biological samples that can help us to identify previously unknown metabolic reasons why animals are getting sick. Using liquid chromatography combined with mass spectrometry, we compared serum metabolite concentrations 3, 2, and 1 week before calving and at calving of three groups of cows that either developed after calving retained placenta (n=8), mastitis (n=8), or remained healthy (n=9). We identified 5,757 features, with over 300 being different between groups. At each of the four sampling times, global analysis of metabolites separated the three cow groups. We conclude that specific diseases in early lactation can be predicted in dairy cattle before their development using a panel of metabolites. We are currently validating our results. The results will be published as update in the next edition of the Oregon Beef Council Report, and presented at extension and scientific meetings. The results will be published into extension materials and scientific literature.

Western juniper - induced abortions in beef cattle

Contact Person: Tim Deboodt – OSU Crook County Extension
Address: 498 SE Lynn Blvd, Prineville OR, 97754
Phone Number: (541)447-6228
Email: tim.deboodt@oregonstate.edu

Project Objectives: The objective of this study is to determine high, medium and low risk areas in eastern and central Oregon for potential juniper induced abortions in cattle and provide management recommendations to OSU extension, and Oregon cattle producers to reduce cattle losses.
The objectives of this study are three fold:

1- Determine the extent of the potential variation in the concentration of abortifacient compounds in western juniper trees across cattle grazing regions of Oregon.
2- Determine if there are seasonal, geographical, or other factors which alter the concentration of abortifacient compounds in western juniper trees in Oregon.

Further assess the potential of western juniper trees to induce late term abortions in beef cattle by dosing more animals with plant material

Project Start Date*:* Not informed
Expected Project Completion Date: December 31, 2015

Project Status: Objective 1 has been accomplished with the final chemical analysis results having been summarized and interpreted, with results being submitted in manuscript form and accepted for publication in Rangelands (publication pending). The results of objective 2 were that two out of the six pregnant heifers that were fed Western juniper bark prematurely aborted their calves. That is 33% of exposed cows aborting their calves, which would be beyond the point of recovery for most beef cattle producers to recuperate from and would be economically devastating to most any operation. We are also going to repeat the feeding trial in conjunction with another research trial we are conducting and are aiming for more pregnant cattle to be exposed. This second feeding trial will take place during the calving season of 2013. Objective 3 has been initiated in the summer of 2012 with field data collection ending June, 2014. Beginning in September, 2014, we have begun to analyze the samples and create a geographical and seasonal report on Labdane acid concentration of Juniper in Eastern Oregon. The results of these studies will then be published in appropriate publications with the beef cattle producers across the state being better informed and educated regarding the potential of Western juniper to cause premature births, (abortions) in beef cattle.

Beef Cattle Sciences

Oregon Beef Council Report

Use of Herbicides for Control of Western Juniper (*Juniperus occidentalis*) in Early Stages of Sagebrush Community Encroachment[1]

Tim Deboodt[2] and Sasha Twelker[3]

Synopsis

Western juniper control with herbicides, in the early stage of encroachment varied between tested herbicides around 365 days after spot or basal bark applications.

Summary

The objective of this study is to determine if herbicides can provide an effective way to control Western Juniper in sagebrush communities in the early stages of encroachment. For this purpose two field studies were conducted near Prineville, Oregon. In a first study the active ingredients picloram, fluroxypyr, aminocyclopyrachlor, metsulfuron, triclopyr, imazapyr, and glyphosate were tested with a foliar coverage application. The levels of chlorosis on Western juniper foliage 365 days after treatment (DAT), were 99% for picloram alone or mixed with fluroxypyr and 98% for glyphosate, tanked mixed with imazapyr. Lower levels of damage were observed on trees treated with aminocyclopyrachlor combined with metsulfuron (55%) or with triclopyr (71%).

In the second study picloram, hexazinone, aminocyclopyrachlor and triclopyr were tested with spot and basal bark as applications methods. A year after the application, the highest level of chlorosis were recorded with picloram applied either as spot treatment (96%) or as basal bark (99%). Tree damage with spot application of hexazinone reached 90% and 67% for aminocyclopyrachlor plus triclopyr when applied as a basal bark treatment. The high levels of chlorosis observed with many of the tested treatments a year after the application, suggests that Western juniper trees suffered damage as result of herbicide activity. Further evaluations will confirm if these high levels of tree damage will result in the mortality of the treated trees.

Introduction

The range of Western Juniper has dramatically expanded since the late 1800's, occupying 3.7 million acres in Oregon (Miller et al. 2005). Once Western Juniper becomes established in a community, it competes with the native vegetation for space, light, and nutrients; more importantly, however, it uses a tremendous amount of water that is no longer available to the existing native plant communities. In regions of low annual precipitation such as Central and Eastern Oregon, water use and interception by the Western Juniper has a dramatic effect on the amount of water available for other species (Barrett, 2007). As result of the diminished supply available to the dominant plant community, the existing shrubs, grasses, and forbs are significantly reduced. The change in composition of the existing plant community has a correspondingly negative affect on the livestock and wildlife that

1. This document is part of the Oregon State University – 2014 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.
2. Agriculture County Leader, Oregon State University, Prineville OR, 97754. Email: tim.deboodt@oregonstate.edu
3. Natural Resource Specialist, Oregon Department of Agriculture, Madras OR, 97741. Email:sasha.twelker@yahoo.com

depend on them. The encroachment of sagebrush plant communities by Western Juniper is an important factor contributing to the degradation of the sage grouse habitat. Western Juniper not only competes for water with existing plants, but also provides perches for the bird species that prey on sage grouse, further negatively affecting survival, productivity, and recruitment.

There are three distinct stages in the encroachment of juniper into sagebrush communities (Miller et al. 2005). In phase I, the Western Juniper trees are generally less than six feet tall, and shrubs and grasses persist as the dominant species. In phase II, Juniper trees are co-dominant with shrubs and grasses, and by the end of this phase the percent area cover by Western Juniper can reach 20 percent. In phase III, Western Juniper trees are dominant and dictate the ecological process affecting the plant community. This phase is characterized by the dramatic decline in the species richness of the understory. Control of Western Juniper in phase I of the encroachment is critical because the negative impacts on the plant community are still minimal. The reestablishment of plant communities in phases II or III of the Western Juniper is much more costly.

Options for Western Juniper control in phase I include mechanical removal (chainsaw, machinery) prescribed fire, and herbicides (Barrett, 2007). One advantage offered by the application of herbicides is that large areas can be treated quickly, but the use of herbicides for Western Juniper control to date has been limited. Currently there is little or no information regarding the effectiveness of active ingredients such as metsulfuron, triclopyr, imazethapyr, hexazinone and aminocyclopyrachlor for Western Juniper control in Central Oregon.

The objective of this study is to determine if herbicides might provide an effective way to control Western Juniper in sagebrush communities in the early stages of encroachment.

Materials and Methods

A study is being conducted eight miles east of Prineville, Oregon, on a site currently in phase I of Western juniper encroachment. Foliar coverage and spot-basal bark herbicide applications techniques are being tested in two separate studies. Each study was designed as a randomized complete block design replicated four times with a total of ten Western juniper trees in each plot. Individual trees were tagged for identification and height; trunk and foliage diameters at the base of the tree were measured. Herbicides in the foliar application study were applied with a single nozzle backpack sprayer calibrated to deliver 20 gallons of spray solution per acre at 40 psi pressure using XR 8002 Teejet® nozzles. In the spot-basal bark study, herbicides were applied using a spot gun with an adjustable graduated cylinder for the spot applications and a single nozzle backpack sprayer for the basal bark applications. In this last study mechanical removal was included as a treatment for comparison and to verify if Western juniper trees would re-sprout after cutting. Application dates and environmental conditions are detailed in Table 1. Active ingredients tested in the foliar application study include: picloram, fluroxypyr, aminocyclopyrachlor, metsulfuron, triclopyr, imazapyr and glyphosate, rates and adjuvants are detailed in Table 2. Active ingredients tested in the spot-basal application study include: picloram, hexazinone, aminocyclopyrachlor and triclopyr, rates and adjuvants are detailed in Table 3. Treatments were visually evaluated for foliar chlorosis 120 and 365 days after treatment (DAT) on a scale of 0 no injury to 100 total chlorosis.

Data was subject to ANOVA using the GLM procedure from SAS. Means were separated using Fischer's Protected LSD test at a 0.05.

Table 1. Application dates and environmental conditions.

	Foliar	Spot-basal
Application Date	6/22/13	6/21/13
Time of Day	8 AM	10 AM
Air temperature (F)	49	52
Relative Humidity (%)	78	68
Wind Speed (MPH)	3	5
Wind Direction	W	NW

Results and Discussion

Foliar coverage application

The first visual evaluation was performed in fall of 2013, 120 DAT, and showed that the highest percent of foliar chlorosis on Western juniper trees was recorded with applications of picloram (98%), picloram + fluroxypyr (98%) and glyphosate + imazapyr (93%) (Table 2). Lower levels of chlorosis were observed when aminocyclopyrachlor was combined with metsulfuron (78%) or with triclopyr (86%). These levels of herbicide damage observed in the Western juniper trees only 120 DAT were considered satisfactory.

In spring of 2013 a second evaluation was done approximately 365 DAT. Control with picloram and picloram + fluroxypyr remain excellent (99%). Control with glyphosate + imazapyr increased to 98% a year after the application. Meanwhile, control with treatments that included aminocyclopyrachlor declined to 55% when combined with metsulfuron and to 71% when mixed with tryclopyr. Trees sprayed with these treatments showed signs of recovering from the initial injury observed during the first evaluation. All treatments will be further evaluated in late fall of 2014 and spring of 2015.

Despite the excellent control obtained with several of the tested treatments, this application method deserves several important considerations. First, the need of enough spray volume to obtain good foliar coverage required can present a serious limitation in remote or hard to access areas. Second the risk of accidental exposure for the applicator should be considered with this application method, particularly when Western juniper trees exceed the three feet height.

Table 2. Herbicides applied as foliar coverage for Western juniper control and percent chlorosis recorded 120 and 365 DAT.

	Treatment[1]	Rate	Unit	120 DAT[2]	365 DAT
1	Picloram	4	qt/100 gal	98[a]	99[a]
	Syl-Tac	0.5	% v/v		
2	Picloram + fluroxypyr	6	fl oz./acre	98[a]	99[a]
	Syl-Tac	0.5	% v/v		
3	Aminocyclopyrachlor + metsulfuron	3	qt/acre	76[c]	55[c]
	MSO	1	% v/v		
4	Aminocyclopyrachlor + triclopyr	3	fl oz./acre	86[b]	71[b]
	MSO	1	% v/v		
5	Imazapyr + Glyphosate	1+5	% v/v	93[ab]	98[ab]
	COC	1	% v/v		
6	Untreated Check	1	lb./acre	0[d]	0[d]
	LSD (P=.05)			8	11

[1] MSO = methylated seed oil; COC = crop oil concentrate.
[2] Means followed by different letters are significantly different at p=0.05.

Spot-basal bark application

The highest percent of foliar chlorosis recorded during the first evaluation (120 DAT) on Western juniper trees was when picloram was applied either as spot treatment (90%) or as basal bark (98%). A year after the application, control with picloram remained high with the basal bark (99%) and increased to 96% for the spot treatment. Tree chlorosis with spot application of hexazinone was 67% during the first evaluation and averaged 90% for the second. Since this active ingredient requires moisture for soil incorporation and plant uptake, results suggest that with time plant uptake continued as moisture was available after rainfall or snow. When aminocyclopyrachlor was combined with triclopyr, tree chlorosis was 70% at 120 DAT and remained similar (67%) 365 DAT. Even though aminocyclopyrachlor is known to be slow acting molecule, it would be expected to see increased control after a year. All treatments will be further evaluated in late fall of 2014 and spring of 2015.

Picloram and hexazinone when applied as spot or basal bark are so far the most promising treatments. These treatments provided excellent control, didn't require high volumes of spray solutions, while the exposure for the applicator was minimal. As result, numerous trees can be treated in a relative short period of time.

Table 3. Herbicides applied as spot-basal bark applications for Western juniper control and percent chlorosis recorded 120 DAT.

	Treatment[1]	Rate	Unit	120 DAT[2]	365 DAT
1	Picloram	0.2	fl oz/tree	90[a]	96[a]
2	Picloram	20	% v/v	98[a]	99[a]
	NIS	0.5	% v/v		
3	Hexazinone	0.13	fl oz/ft. height	67[b]	90[c]
4	Aminocyclopyrachlor	5	% v/v	70[b]	67[b]
	Triclopyr	15	% v/v		
5	Untreated Check	1	lb./acre	0[c]	0[c]
	LSD (P=.05)			8	11

[1] NIS = non-ionic surfactant.
[2] Means followed by different letters are significantly different at p=0.

Acknowledgements

The authors would like to take this opportunity to thank the Oregon Beef Council for funding this project.

Literature Cited

Barrett, H. 2007. Western Juniper Management: A field guide prepared for the Oregon Watershed Enhancement Board.

Miller et al. 2005. Oregon State University. Technical Bulletin 152.

Oregon Beef Council Report

Progress Reports – Rangeland Ecology and Management[1]

Techniques to improve seeding success of forage kochia in exotic annual grass invaded sagebrush rangelands

Contact Person: Dustin Johnson – OSU Department of Animal and Rangeland Sciences
Address: 67826-A Hwy 205, Burns, OR 97720
Email: dustin.johnson@oregonstate.edu

Project Objectives: The objective of the study is to determine which seeding techniques are appropriate for enhancing the establishment of forage kochia; a promising restoration plant for improving the diversity, productivity, and later-season forage quality of degraded arid sagebrush rangelands. Specifically, we will evaluate two seeding methods, two seasons of seeding, two seed treatments and the efficacy of stored versus freshly harvested seed to determine which combination of seeding techniques produces the best results.

Project Start Date: Summer 2014
Expected Project Completion Date: Fall 2016

Project Status: Three study sites were selected and exclosures were erected around each site during the summer of 2014. Also in 2014, existing vegetation within the exclosures was treated with glyphosate during the summer and then burned with a trailer mounted propane torch in the fall to prepare a seedbed for seeding treatments. The following seeding treatments will applied to 6 X 18 ft plots arranged in a randomized block design, with 5 replicate blocks per study site:

1. Fall broadcast of old seed
2. Fall drill of old seed
3. Fall broadcast of pellets made with old seed
4. Fall drill of pellets made with old seed
5. Winter broadcast of old seed
6. Winter drill of old seed
7. Winter broadcast of pellets made with old seed
8. Winter drill of pellets made with old seed
9. Winter broadcast of freshly harvested seed
10. Winter drill of freshly harvested seed
11. Winter broadcast of pellets made with freshly harvested seed
12. Winter drill of pellets made with made with freshly harvested seed
13. Unseeded control

Fall seeding treatments will be conducted during early November 2014 and winter seeding treatments will be completed during early to mid January of 2015. Forage kochia will be seeded at 2 lbs/ac in all plots that received a seeding treatment. Vegetation cover and density by species will be measured during the summers of 2015 and 2016 in each treatment. Analysis of variance (ANOVA) will be used to determine treatment effects. Results will

1. This document is part of the Oregon State University – 2013 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.

be published in a final report to the Oregon Beef Council and a scientific journal during the fall of 2016 and winter of 2017, respectively.

Research on Stream Water Temperature and Sediment Load in Riparian Systems.

Contact Person: Carlos Ochoa – OSU Department of Animal and Rangeland Sciences
Address: 112 Withycombe Hall, Corvallis, OR 97331
Email: Carlos.Ochoa@oregonstate.edu

Project Objectives: 1) To better understand how stream water temperature is affected by the interactions between surface water and shallow groundwater. 2) To determine the overall effects that land and vegetation management practices have in stream water temperature and runoff/sediment generation processes.

Project Start Date: Summer 2014
Expected Project Completion Date: Summer 2017

Project Status: Six temperature monitoring stations (3 sensors in water, 1 sensor in air) were installed at selected locations along the creek during the summer of 2014. Additional monitoring stations will be installed during the spring of 2015. A new weather station was installed on-site in October 2014. Equipment for measuring tree stem flow has been acquired and will be tested and calibrated prior to deployment in the spring. Weather and tree stem flow data will be used to estimate riparian vegetation uptake. We have acquired supplies and sensors for installing transects of piezometers that will be used to monitor shallow groundwater level and temperature fluctuations. These piezometer-transects will be installed prior to the spring of 2015. Additional equipment for monitoring runoff/sediment load is being acquired. This equipment will be deployed during the spring/summer of 2015. A new M.S. student in the Department of Animal and Rangeland Sciences who will work on this research project will be starting in January of 2015.

Effect of Wolves on Cattle Production Systems - Continuation.

Contact Person: John Williams – OSU OSU Department of Animal and Rangeland Sciences
Address: 668 NW 1st St, Enterprise, OR 97828
Email: john.williams.1@oregonstate.edu

Project Objectives: The project is a continuation of 6 years of data collection and analysis. The main project continued to collect, analyze and report information as it becomes available. Emphasis is shifting from data collection and analysis to analysis and writing.

Project Status:

- A total of 100 cows were collared again this year approximately half in Idaho and half in Oregon
- A new version of the collar was used on 20 of the cows. It is a collar that does not use an external antenna and has a "mother board" designed by the OSU engineering program. This design puts many of our previous parts together on one board. This decreases the effort needed to assemble each collar and hopefully improves its reliability as some of our older original collars are beginning to fail. These collars also use regular "D" & "C" cell alkaline batteries. This reduces cost and allows us to ship our collars via regular transportation.
- The following papers are in progress:
  - Occupancy and Activity of Cattle Grazing Riparian Pastures. Larry Larson etal. Submitted to the Journal of Rangeland Management, (accepted with revisions).
  - Effect of wolf presence on daily travel distance of free-roaming cattle. D.E. Johnson, P.E. Clark, L.L. Larson, M. Louhaichi, T. Freeburg, and J. Williams. (being formatted to be submitted in Oct 2014.
  - Assessing spatial risk to wolf depredation for cattle on extensive landscapes. Clark etal. Expected submission by Feb 1 2015
- The research team has also been active in disseminating preliminary information being gleaned from the study. Presentations were given at the Society for Rangeland Management in Orlando Florida, to students in

two different college classes, producers and agency people in Ontario, teachers during the ag in the classroom and to producers in Cambridge Idaho. All of the above presentations were invited.

- Our team continues to evolve. The one change in the team is that Shanna Hamilton has resigned as the area Extension Agent in Idaho and been replaced by Tyanne Freeburg. Tyanne has embraced our project and is covering the on-the-ground needs in Idaho. All other members are still active.

REPORT STATUS OF STUDIES FUNDED BY THE OREGON BEEF COUNCIL

Progress report not required for studies funded prior to 2010-2011 FY and with a full report submitted.

Projects funded in 2007 – 2008 FY

Abbreviated Project Title	Senior Investigator	Report Status Progress	Report Status Full
Rangeland Ecology and Management			
Wolf impact on cattle productivity and behavior	D.E. Johnson		X
Development of digital charting system for range health	D.E. Johnson		X
Livestock, plant community, and sage-grouse food sources	J. Miller		X
Animal Sciences			
Digestibility of cool-season in dairy farms	T. Downing		X
Female hormones and immune cells in cattle	M. Cannon		X
Diagnostic test for pregnancy detection in cattle	F. Menino		X
Assay to assess bovine embryo viability during transfer	F. Menino		X
Farm-based livestock manure/biogas production	M. Gamroth		X
Glycerol supplementation to cattle	C. Mueller		X
Copper and Zinc in dairy forage systems	T. Downing		X

Projects funded in 2008 – 2009 FY

Abbreviated Project Title	Senior Investigator	Report Status Progress	Report Status Full
Rangeland Ecology and Management			
Wolf impact on cattle productivity and behavior (cont.)	D.E. Johnson		X
Rangeland vegetation and sediment monitoring	L. Larson	X	X
Animal Sciences			
Late gestation protein supplementation of beef cows	D. Bohnert		X
Grazing options with *Brassicas* and Fodder Radishes	C. Engel		X
Maternal marbling potential and ultrasound technology	C. Mueller		X
Replacement heifers sired by high or low-marbling bulls	C. Mueller	X	X
BVDV and BVDV PI screening to initiate BVDB control	B. Riggs		X
Selenium supplementation and retention in beef cattle	G. Pirelli	X	X
Farm-based livestock manure/biogas production (cont.)	M. Gamroth		X

Projects funded in 2009 – 2010 FY

Abbreviated Project Title	Senior Investigator	Report Status Progress	Report Status Full
Rangeland Ecology and Management			
Wolf impact on cattle productivity and behavior (cont.)	D.E. Johnson		X
DNA analysis for cattle diet in sagebrush rangelands	R. Mata-Gonzales	X	X
Behavior and distribution of cattle grazing riparian zones	D.E. Johnson		X
Animal Sciences			
PFG2α to improve uterine health and reproductive efficiency	M. Cannon		X
Disposition and reproductive performance of brood cows	R. Cooke	X	X
Acclimation to handling and heifer development	R. Cooke	X	X
Farm-based livestock manure/biogas production (cont.)	M. Gamroth		X

Projects funded in 2010 – 2011 FY

Abbreviated Project Title	Senior Investigator	Report Status Progress	Report Status Full
Rangeland Ecology and Management			
Conflict stressors, spatial behavior and grazing budgets of cattle	D.E. Johnson	X	X
Behavior and distribution of cattle grazing riparian zones **(cont.)**	D.E. Johnson		X
Grazing and medusahead invasion in sagebrush steppe	D. Johnson	X	X
Weeds to suppress cheatgrass and medusahead	P. Dysart	X	X
Effects of wolves on cattle production systems **(cont.)**	D.E. Johnson		X
Quantities diet analysis in cattle using fecal DNA	R. Mata-Gonzales	X	X
Animal Sciences			
Protein supplementation to low-quality forage	D. Bohnert	X	X
Disposition, acclimation, and steer feedlot performance	R. Cooke	X	X
Nutrition during bull development on calf performance	C. Mueller	X	X
Metabolic disorders and incidence of anoestrus in dairy cows	A. Villarroel	X	
Extending grazing season with warm season and Brassica forages	S. Filley	X	X
Oral Selenium drench at birth to calves	J. Hall	X	X

Projects funded in 2011 – 2012 FY

Abbreviated Project Title	Senior Investigator	Report Status Progress	Report Status Full
Rangeland Ecology and Management			
Revegetating sagebrush rangelands Invaded by Medusahead	D. Johnson	X	X
Potential benefits of Sagebrush consumption by cattle	R. Mata-Gonzales	X	X
Effect of wolves on cattle production systems **(cont.)**	D.E. Johnson		X
Conflict stressors, spatial behavior and grazing budgets **(cont.)**	D.E. Johnson	X	X
Animal Sciences			
Effects of camelina meal supplementation to beef cattle	R. Cooke	X	X
The economics of grassed-based dairying in Oregon	T. Downing	X	X
Yeast culture supp. improves feed consumption in cattle	G. Bobe	X	X
Western Juniper - Induced Abortions in Beef Cattle	C. Parsons	X	
Metabolic disorders and incidence of anoestrus in dairy cows	A. Villarroel	X	

Projects funded in 2012 – 2013 FY

Abbreviated Project Title	Senior Investigator	Report Status Progress	Report Status Full
Rangeland Ecology and Management			
Assessing landscape scale cheatgrass fuel load reduction	M. Borman		
Effect of wolves on cattle production systems (cont.)	D.E. Johnson		
Modification of livestock and sage-grouse habitat after juniper control	R. Mata-Gonzales	X	X
Prescribed burning and herbicide appl. to revegetate rangelands	D. Johnson	X	X
Animal Sciences			
Comparison of Ivomec Plus and a generic anthelmintic to beef cattle	R. F. Cooke	X	
Influence of supplement composition on low-quality forages	D. W. Bohnert	X	X
Yeast culture supplementation and dairy reproductive performance	G. Bobe	X	X
The effect of western juniper on the estrous cycle of beef cattle	C. Parsons	X	

Projects funded in 2013 – 2014 FY

Abbreviated Project Title	Senior Investigator	Report Status Progress	Report Status Full
Rangeland Ecology and Management			
Development of forage value index for Ryegrass	T. Downing		
Effect of wolves on cattle production systems (cont.)	J. Williams		**X**
Use of herbicide for control of Western Juniper	G. Sbatella		**X**
Animal Sciences			
Oxidized lipid metabolites to predict disease in dairy cows	G. Bobe	**X**	**X**
Cow nutritional status during gestation and offspring performance	R. F. Cooke	**X**	**X**
Modifying the hormone strategy for superovulating donor cows	F. Menino	**X**	**X**

Projects funded in 2014 – 2015 FY

Abbreviated Project Title	Senior Investigator	Report Status Progress	Report Status Full
Rangeland Ecology and Management			
Development of forage value index for Ryegrass	T. Downing		
Research on stream water temperature and sediment loads	C. Ochoa	**X**	
Techniques to improve seedling success of forage kochia	D. D. Johnson	**X**	
Animal Sciences			
Identification of predictive metabolomics markers in dairy cows	G. Bobe	**X**	
Cow nutritional status during gestation and offspring performance	R. F. Cooke	**X**	
Modifying the hormone strategy for superovulating donor cows	F. Menino	**X**	
Energetic output of beef cows based on lactation and calf crop	C. Mueller	**X**	
Influence of supplement type and monensin on forage utilization	D. W. Bohnert	**X**	

Oregon State University | Extension Service

Oregon State University

Beef Cattle Sciences

Eastern Oregon Agricultural Research Center

USDA-Agricultural Research Service | Oregon State University

We acknowledge Mrs. Flavia Cooke (Faculty Research Assistant – OSU, EOARC Burns) for replicating and assembling all reports.