2011
Tier III Irrigated Crop and Soil Test Report
Tongue River Information Program

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Table of Contents

Section **Page**

Foreword....iii
1.0 Introduction....1
2.0 Methods....2
2.1 Study Site Selection....2
2.2 Experimental Treatments and Design....2
2.2.1 Irrigation Water....2
2.2.2 Crops....2
2.2.3 Irrigation Method....5
2.3 Treatment Implementation....8
2.3.1 Irrigation Timing and Application Rates....8
2.3.2 Soil Sample Collection and Analysis....9
2.3.3 Crop Yield Determination and Quality....9
3.0 Results....10
3.1 Crop Yields....10
3.2 Forage Sodium Content....13
4.0 Summary....15
5.0 References....16
6.0 Appendices....17
Appendix A Weed management techniques used on the Tier 3 test plots....18
Appendix B Crop Yield Data, 2004-2010....20

Figures

Section **Page**

Figure 1 Water treatment, crop type and irrigation method experimental layout 3
Figure 2 Irrigation system overview, with the flood treatment on the right and sprinkler treatment on the left. Tanks in the upper right of this photo hold Tongue River water (right tank) and CBNG produced water (left tank)..... 6
Figure 3 Sprinkler irrigation system design. Sprinkler heads are attached to steel posts at the middle-edge of each plot. Two opposing heads irrigated each plot 6
Figure 4 Example of flood irrigation plot using a double dike design. Water escaped first border dike but was contained by second border dike..... 7
Figure 5 Plots receiving sprinkler irrigation (left photo), and double diked plot following flood irrigation (right photo) 9
Figure 6 Alfalfa relative yield normalized to Water 1, average of flood and sprinkler irrigation. (Alfalfa was grown only in the years shown) 11
Figure 7 Barley relative yield normalized to Water 1, average of flood and sprinkler irrigations. (Barley was grown only in the years shown) 11
Figure 8 Beans relative yield normalized to Water 1 under flood irrigation (Beans were grown only in the years shown)..... 12
Figure 9 Beans relative yield normalized to Water 1 under sprinkler irrigation (Beans were only harvested in the years shown. Wild turkeys destroyed beans in 2009.) 12
Figure 10 Average forage sodium content of barley and alfalfa hay from 2004 to 2010 13

Tables

Section **Page**

Table 1 Irrigation water treatments consisting of Tongue River and CBNG produced waters 3
Table 2 CBNG produced water quality and spring and fall Tongue River water quality used in the Tier 3 field test 4
Table 3 Calculated water quality of water mixtures used in irrigation water treatments . 4
Table 4 Test plot crop rotations during irrigation seasons 2004 – 2010..... 5
Table 5 Applied irrigation water, 2004 – 2010. 7
Table 6 Forage Sodium Content from 2004 - 2010 13

Foreword

The Tier III Irrigated Crop and Soil Test Report is a companion report to the Agricultural Protection and Monitoring Program (AMPP) Report and the Tongue River Hydrology Report, produced under the auspices of the Tongue River Information Program (TRIP). The Montana Board of Oil and Gas Conservation (MBOGC), a division of the Montana Department of Natural Resources and Conservation, has funded this program since 2006. AMPP was originally launched in 2003 by Fidelity Exploration & Production Company, a subsidiary of MDU Resources Group, Inc., in response to concerns by Tongue River irrigators over whether crop yield, soils or water quality were being affected by discharges from the coal bed methane industry. Soil scientists William Schafer and Kevin Harvey of Bozeman, Montana, and agronomist Neal Fehringer of Billings, Montana developed the scientific methodology and implementation of AMPP (collectively called the Researchers herein).

The principal author of the 2009 report was Dina Brown, Certified Professional Soil Scientist with KC Harvey, Inc. The 2009 report addressed mostly soil test results. The 2011 update is authored by Neal E. Fehringer, Certified Professional Agronomist, C.C.A. The primary focus of the 2011 report is providing updated results of crop yields and sodium content of crops and forage samples. Tom Osborne of HydroSolutions Inc and William Schafer of Schafer Ltd, provided technical reviews of the 2011 report. HydroSolutions Inc, a Montana based environmental science and engineering firm administers the TRIP contract on behalf of the Montana Board of Oil and Gas Conservation (MBOGC). The web site for the MBOGC (located at http://www.bogc.dnrc.mt.gov) contains current and past TRIP reports. The interpretations provided herein are solely those of the authors.

1.0 Introduction

Irrigators that rely on Tongue River water for crop and forage production have expressed concern about potential adverse impacts that produced water discharges from coal bed natural gas (CBNG) development may have on irrigation water quality. Currently, the Tongue River possesses good quality water that is used to irrigate over 20,000 acres of land in Montana while supporting a healthy fishery within and just below the Tongue River Reservoir.

This report contains results of testing conducted under the Tongue River Information Program (TRIP), which was initially commissioned and funded by Fidelity Exploration and Production Company in 2003. Since 2006, TRIP has been supported by the Montana Department of Natural Resources' Board of Oil and Gas Conservation (MBOGC). The objective of TRIP is to collect and analyze scientific information on soils and crops in the Tongue River basin, provide agronomic assistance to participants, help irrigators better understand potential effects of CBNG development on their irrigated fields, and document regional trends in irrigated soil characteristics. TRIP consists of three tiers of monitoring. Tier 3, which is covered in this report, is more specifically named the Irrigated Crop and Soil Test. The objective of this test is to evaluate potential effects of irrigating with blended CBNG produced water and Tongue River water.

CBNG operators have developed numerous water management strategies to store, utilize, or discharge CBNG produced water. Some water management strategies may entail discharge of produced water into surface waters, provided that the receiving water can comply with irrigation water quality standards and non-degradation limits. Consequently, irrigators would not be applying undiluted CBNG produced water except in special circumstances where 'managed irrigation' programs are developed near the CBNG fields in cooperation with the landowner.

Irrigators using water from the Tongue River may experience slight changes in electrical conductivity (EC) and sodium adsorption ratio (SAR) in their water supply due to CBNG expansion in the Tongue River Basin. However, EC and SAR must not exceed prescribed water quality limits adopted by the State of Montana (ARM 17.30.670), which were developed to protect irrigation uses of water. For the Tongue River at the USGS gauging station, below the Tongue River Dam, the total CBNG discharges comprised a maximum of 5.6% of the river flow in April 2010, with untreated discharge being 4.6%. During the April-September irrigation season, total CBNG discharges comprised from 0.3% to 3.2% of river flow, with untreated discharge ranging from 0.2% to 2.2% (HydroSolutions, 2011).

In order to evaluate potential crop and soils effects associated with various blends of CBNG produced water and Tongue River water, a series of test plot experiments began in spring 2004. The following report documents these experiments and comprises four sections including this introduction (Section 1), study methodology (Section 2), test results and discussion (Section 3), and references cited (Section 4).

2.0 Methods

The following methods allowed for the analysis of changes in crop yields and properties resulting from irrigation using various blends of Tongue River water and CBNG produced water.

2.1 Study Site Selection

Researchers selected a privately owned ranch in the Tongue River Drainage for the Tier 3 study. The legal description of the test plot area is Section 21 of Township 58 North, Range 83 West, Sheridan County, Wyoming. The site is in the Tongue River floodplain adjacent to the Wyoming-Montana state line. Researchers initiated the Irrigated Crop and Soil Test at this location in April 2004 and completed its seventh season of testing in fall 2010.

2.2 Experimental Treatments and Design

The experimental treatments for this project consisted of four irrigation water mixtures, two sets of cropping sequences, and two irrigation methods. These variables combine to create 16 unique treatments. Each unique treatment was replicated three times, resulting in a total of 48 experimental units.

Researchers established the test location in mid-April 2004. They divided the 0.50-acre area into 48 plots to represent each experimental unit as shown in Figure 1. They then divided the entire experimental area lengthwise, with the east and west portions representing separate cropping systems. They also divided the entire area crosswise, with the north and south portions representing flood and sprinkler irrigation respectively. This created four blocks with each block representing a unique cropping system and irrigation method combination. Each block contained 12 plots, with three replicates of four different water mixtures, randomly applied within the block using a split-plot design (Figure 1). Each flood irrigation plot is 15 by 28 feet. Sprinkler plots are 15 by 30 feet.

2.2.1 Irrigation Water

To test the effects of irrigating with Tongue River water containing CBNG produced water on crops, forages, and soils; researchers applied four irrigation water treatments to test plots. Table 1 describes the water treatments. Table 2 presents chemical analysis results for CBNG produced water and Tongue River water. Table 3 presents the calculated water quality results for each of the four water treatments.

2.2.2 Crops

To determine effects on crop and forage yield of irrigating with Tongue River water containing CBNG produced water, four irrigation water treatments were applied to two crop plantings each irrigation season. The study plot was divided in half from north to south, with each half receiving a unique crop planting (Figure 1). Bean, barley, and alfalfa crops were rotated between the two plots on a yearly basis (Table 4).

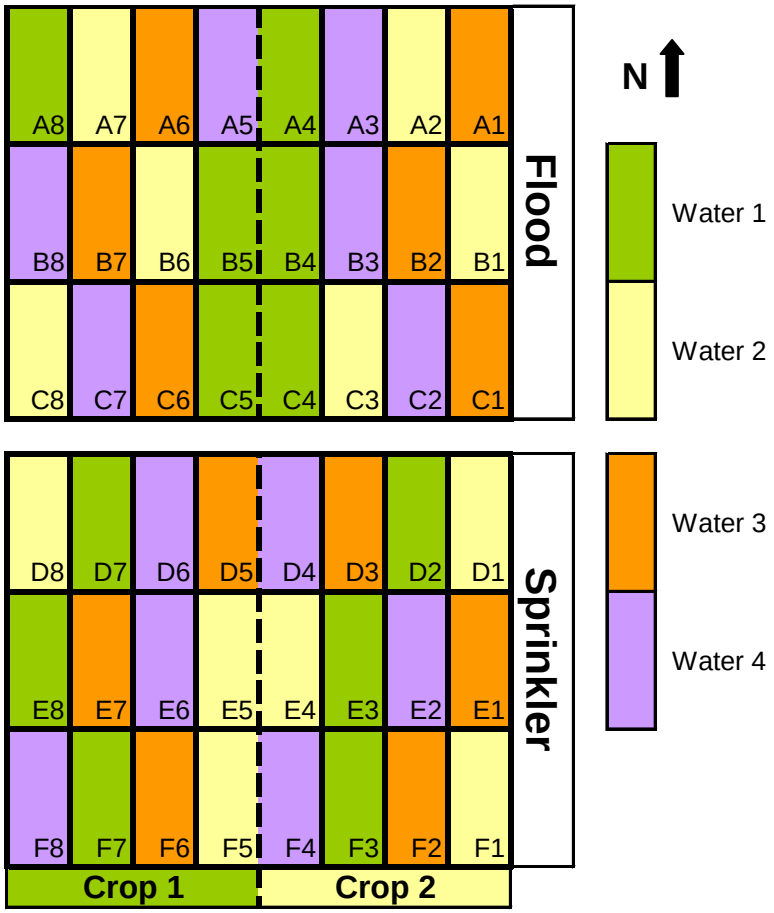

Figure 1 Water treatment, crop type and irrigation method experimental layout

Table 1 Irrigation water treatments consisting of Tongue River and CBNG produced waters

Water Number	Tongue River Water	CBNG Produced Water
1	100%	0%
2	93%	7%
3	85%	15%
4	50%	50%

Table 2 CBNG produced water quality and spring and fall Tongue River water quality used in the Tier 3 field test

Analyte[1]	Units[2]	CBNG Produced Water	Tongue River, Spring[3]	Tongue River, Fall[4]
pH	*s.u.*	8.6	8.2	7.9
Electrical Conductivity (EC)	*dS/m*	2	0.23	0.64
Sodium Adsorption Ratio (SAR)		54	0.35	0.8
Anions				
Bicarbonate	*mg/L*	1290	145	270
Chloride	*mg/L*	20	4	5
Sulfate	*mg/L*	56	38	122
Cations				
Calcium	*mg/L*	4	31	41
Magnesium	*mg/L*	2	11	39
Sodium	*mg/L*	523	8.8	30

Notes:

1. Samples were analyzed by Energy Laboratories, Inc.
2. Abbreviations used are as follows: s.u. = standard units; dS/m = decisiemens per meter; mg/L = milligrams per
3. Sample was collected on May 9, 2004.
4. Sample was collected on September 23, 2004.

Table 3 Calculated water quality of water mixtures used in irrigation water treatments

Constituent	Units	CBNG Produced Water	Average Tongue River Water	Tongue River Composition			
				Water 1	Water 2	Water 3	Water 4
				100%	93%	85%	50%
Electrical Conductivity (EC)	*dS/m*	2	0.44	0.44	0.54	0.67	1.2
Calcium	*mg/L*	4	36	36	33.8	31.2	20
Magnesium	*mg/L*	2	25	25	23	22	14
Sodium	*mg/L*	523	19	19	55	95	271
Sodium Adsorption Ratio (SAR)	-	54	0.6	0.6	1.7	3.2	11

Notes:

1. Abbreviations used are as follows: dS/m = deciSiemens per meter; mg/L = milligrams per liter.
2. Average Tongue River water quality was calculated by averaging the spring and fall results from Table 2.
3. Tongue River Composition was calculated using a flow weighted average of the CBNG produced water and the average Tongue River water.

Table 4 Test plot crop rotations during irrigation seasons 2004 – 2010

Irrigation Season	Crop 1	Crop 2
2004	Barley	Beans
2005	Beans	Barley
2006	Barley	Alfalfa
2007	Beans	Alfalfa
2008	Barley	Alfalfa
2009	Beans	Alfalfa
2010	Barley	Alfalfa

2.2.3 Irrigation Method

To determine whether the effects of irrigation treatments are dependent upon irrigation method, researchers applied water using two methods, sprinkler and flood. They divided the study plot in half from east to west, with each half receiving a different irrigation method (Figure 2). Sprinkler heads attached to steel posts located at the edges of each plot comprised the sprinkler irrigation system (Figure 3). Two opposing heads irrigate each plot, both watering a 180 degree arc. Heads are in the middle of the 30 foot side of each replication. Setting sprinkler head pressure to 10 psi limited cross contamination between plots and resulted in a 15 foot pattern. The sprinkler irrigation treatment applied water at a rate of one inch in 2.75 hours to the area of each plot that was applied by both heads.

Constructing the flood irrigation treatment areas using an earthen double dike system limited cross contamination between plots (Figure 4). The system was designed to apply three inches of water to the flood plots every nine days during the growing season, requiring 0.75 hours. Normally, flood irrigation to crop fields requires six total inches of water per acre and assumes a maximum of 50% application efficiency maximum. Thus, the net amount of water normally applied to flood irrigated crops is three inches. Less than 100% efficiency is attributed to tail water losses off the end of the field and/or leaching through the soil profile. However, this is not the case with the double dike system used in this study. Because water is contained, the flood system is assumed to have 100% application efficiency. Figure 4 illustrates the design of the double diked system. Table 5 lists water applied per crop for 2004 through 2010.

Figure 2 Irrigation system overview, with the flood treatment on the right and sprinkler treatment on the left. Tanks in the upper right of this photo hold Tongue River water (right tank) and CBNG produced water (left tank)

Figure 3 Sprinkler irrigation system design. Sprinkler heads are attached to steel posts at the middle-edge of each plot. Two opposing heads irrigated each plot

Figure 4 Example of flood irrigation plot using a double dike design. Water escaped first border dike but was contained by second border dike

Table 5 Applied irrigation water, 2004 – 2010.

	East Flood		West Flood		East Sprinkler		West Sprinkler	
Year	Crop	Inches	Crop	Inches	Crop	Inches	Crop	Inches
2004	Beans	24.0	Barley	18.0	Beans	21.0	Barley	14.0
2005	Barley	6.0	Beans	15.0	Barley	4.0	Beans	13.0
2006	Alfalfa	25.6	Barley	19.6	Alfalfa	17.0	Barley	13.0
2007	Alfalfa	13.5	Beans	16.5	Alfalfa	15.0	Beans	13.0
2008	Alfalfa	18.0	Barley	3.0	Alfalfa	17.0	Barley	3.0
2009	Alfalfa	21.0	Beans	21.0	Alfalfa	17.0	Beans	17.0
2010	Alfalfa	9.0	Barley	0.0	Alfalfa	9.0	Barley	0.0
	TOTALS	**117.1**		**93.1**		**100.0**		**73.0**

2.3 Treatment Implementation

Researchers began treatment implementation in April 2004. Neal E. Fehringer, Certified Professional Agronomist, C.C.A., has either performed or supervised all farming activities performed at the test plots. The following methods were used to prepare study plots for seeding, implement seeding, and maintain plots:

- Fertilizer. To determine fertilizer requirements, the agronomist collected soil samples in 2004, prior to water application. Using a hand-held Oakfield probe, Fehringer collected samples from the 0 to 6 and 6 to 24 inch depths, and composited them by depth for analysis. Energy Laboratories, Inc. (Billings, MT) conducted the soil analysis. Fehringer used analysis results to recommend fertilizer application rates. Fehringer applied fertilizer prior to seeding and according to soil tests for each crop. Soil samples for fertilizer recommendations have collected every fall from each side.

- Tilling and Leveling. A three-point tractor mounted unit roto-tilled the entire plot to a depth of eight inches. A standard agricultural land plane leveled the test area with two passes. In subsequent years, the tractor mounted roto-tiller has been used to incorporate plant residue, fertilizer, and herbicides (beans). Hand rakes have been used to level the flood replications and rebuild the inside dike for proper water distribution and retention. Minor raking has occurred on sprinkler plots to levels between roto-tiller passes. No tillages have occurred on the east half since alfalfa was planted spring 2006.

- Seeding. Seeding occurred annually in accordance with the crop rotations listed in Table 4 and employed the following methods:

    - **Hay barley.** Both drill and broadcast seeding equipment applied hay barley seed at a rate of 100 pounds per acre. The drill seeder placed seeds at a depth of 1.5 inches using either seven inch row spacing (International double disk small grain drill) or 12 inch row spacing (Tye Estate drill). When broadcast seeding, a Brillion planter was used.

    - **Beans.** A John Deere 71 unit planter seeded beans at a rate of 65 pounds per acre to a depth of 2.0 inches. Row spacing was 22 inches.

    - **Alfalfa.** A Brillion broadcast seeder applied alfalfa seed at a rate of 20 pounds per acre. Operators lightly hand raked the seed, then pressed it into the soil by running over each plot with an ATV pulling a sod roller filled with water.

- Weed Control. Operators implemented weed control prior to seeding and/or as needed throughout the growing seasons. Appendix A details weed management techniques used in this study.

2.3.1 Irrigation Timing and Application Rates

Average weekly water consumptive use data developed by the University of Nebraska Research Station (Scottsbluff, Nebraska) allowed determination of water use demands.

Researchers periodically monitored soil moisture by probing the soil to three feet and determining soil moisture by feel in each crop and irrigation system. Daily consumptive use rates and available soil moisture determined adjustments to water application intervals. Irrigation scheduling was under the direction of Neal Fehringer.

Sprinkler irrigated plots received one inch of water every three to four days, depending upon crop growth stage. Each flood replication plot received three inches of water every nine to twelve days, depending upon consumptive water use (Figure 5).

Figure 5 Plots receiving sprinkler irrigation (left photo), and double diked plot following flood irrigation (right photo)

2.3.2 Soil Sample Collection and Analysis

A soil sampling team of soil scientists, an agronomist, and technicians collected soil samples from each replication prior to initial water application (referred to as year 0), and following each irrigation season (years 1 through 7). A truck mounted Giddings Probe (Giddings Machine Company, Inc., Windsor, Colorado) collected samples at five depths: 0 to 6, 6 to 12, 12 to 24, 24 to 36, and 36 to 48 inches. Operators collected three sub-samples in each replication and composited them by depth for analysis. Samples were shipped to Energy Laboratories, Inc. (Helena, Montana) for analysis of pH, EC, SAR, saturation percentage, calcium, magnesium, sodium, cation exchange capacity, exchangeable sodium percentage (ESP), and lime content (0 to 6 inch samples only). The laboratory also determined soil texture (percent sand, silt, and clay) for samples collected prior to initial irrigation.

2.3.3 Crop Yield Determination and Quality

Neal Fehringer, agronomist, conducted annual forage harvests within each replication plot. For hay barley and alfalfa, samples were collected, allowed to dry, then weighed and processed through a chipper-shredder. Olsen's Agricultural Laboratory (McCook, Nebraska) analyzed representative samples for complete feed and total mineral analyses. Yields were then standardized at 12% moisture. For beans, samples were collected, dried, and processed using a stationary thresher. Following threshing, bean samples were cleaned and weighed. Bean samples were not analyzed for feed quality or mineral content. Bean yields were reported on an "as is" basis.

3.0 Results

3.1 Crop Yields

To make comparisons of crop yields across the years, all yields were normalized based on average yield for Water 1 (100% Tongue River). Normalized yields were calculated to minimize yield variation attributed to factors other than the water source. Crop data are shown with respect to water type in figures 6 through 10.

For hay barley and alfalfa, relative yields have been unchanged between the four water treatments since test plot initiation. Average hay barley yield has been 2.81 tons per acre for Water 1 (e.g. Tongue River water). Relative hay barley yield for water source 2 (93% Tongue & 7% CBNG), 3 (85% Tongue & 15% CBNG) and 4 (50% each of Tongue & CBNG water) has ranged from 75% to 120% from 2004 to 2010, with no statistically significant differences between water sources (KC Harvey and Fehringer Agricultural Consulting 2009). Beans were grown in the west half of the test plots in 2007 and 2009 after alfalfa was established on the east half in 2006. For alfalfa, yields averaged 2.26 tons per acre for Water 1. Relative yield was 99%, 103%, and 96% water sources 2 through 4 in two cuttings per year. Alfalfa yields have been less than expected because of deer grazing.

Pinto beans have been grown in 2004, 2005, 2007, and 2009. No beans were harvested in 2009 due to all pods being eaten by wild turkeys prior to harvest. The average yields for years when harvest occurred were 22.51 hundred weight (cwt) for Water 1 and relative yields were 99%, 94%, and 83% for water sources 2 through 4. Average bean yield for Water 4 is substantially below yields for the other three waters. This reduction most likely occurred because the salinity yield threshold for beans was exceeded with Water 4. Yield threshold is the soil salt level at which yield begins to decline. Apparently, these tolerances were not exceeded for hay barley and alfalfa even with the 50/50 blend of water and after seven years of irrigating with 73.0 to 117.1 inches being applied (Table 5).

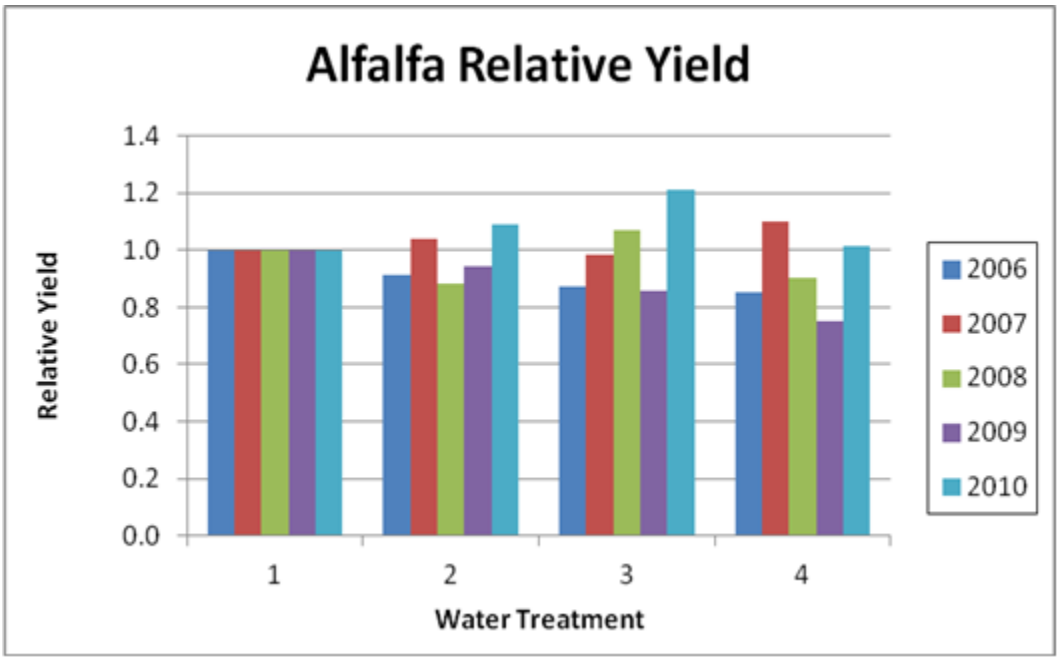

Figure 6 Alfalfa relative yield normalized to Water 1, average of flood and sprinkler irrigation. (Alfalfa was grown only in the years shown)

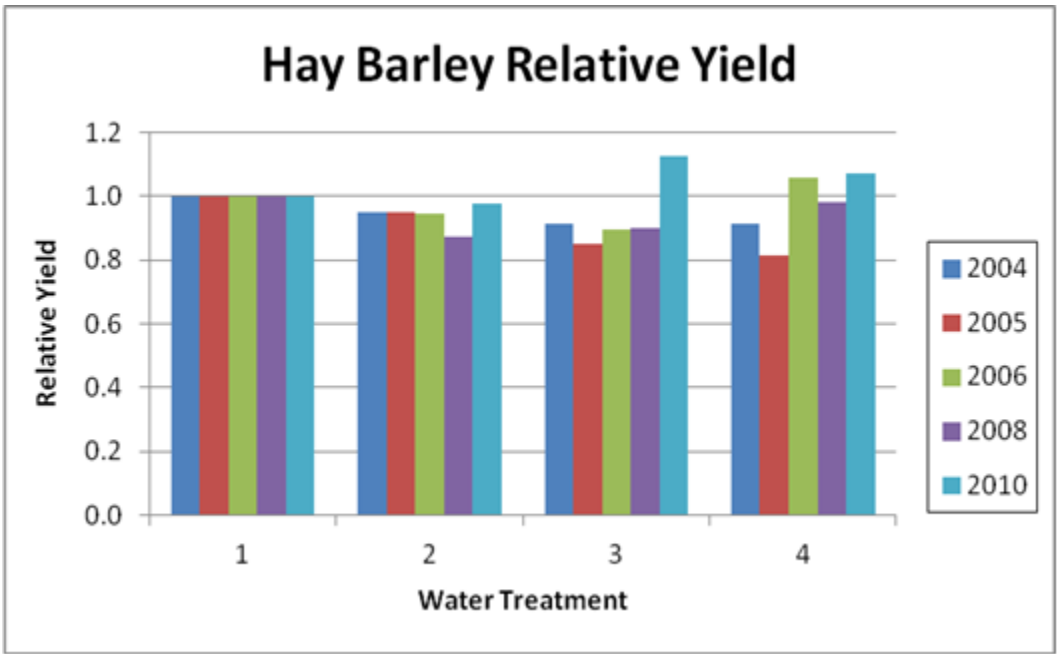

Figure 7 Barley relative yield normalized to Water 1, average of flood and sprinkler irrigations. (Barley was grown only in the years shown)

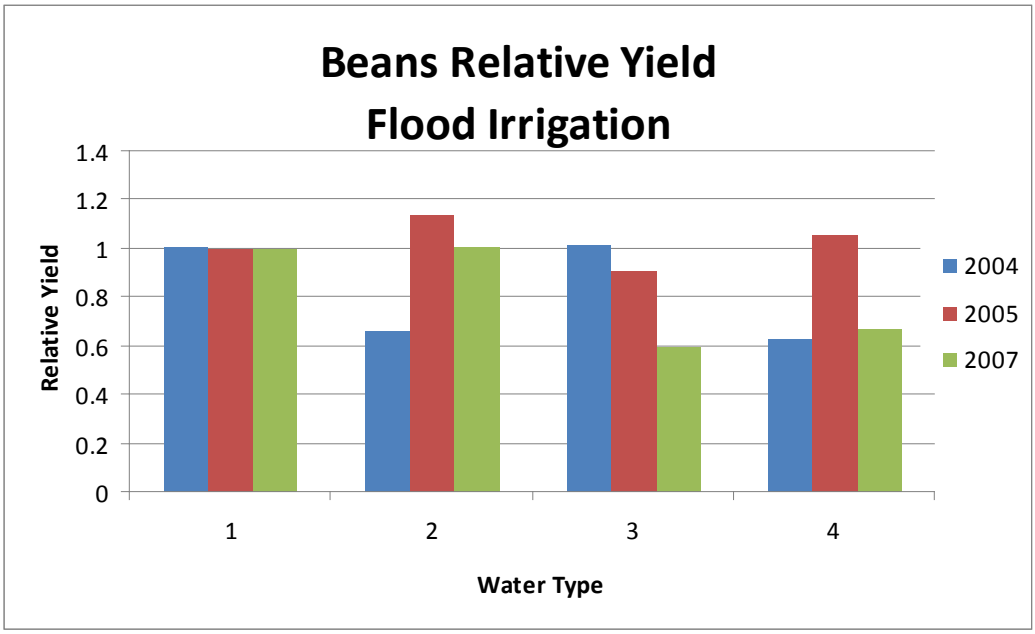

Figure 8 Beans relative yield normalized to Water 1 under flood irrigation (Beans were grown only in the years shown)

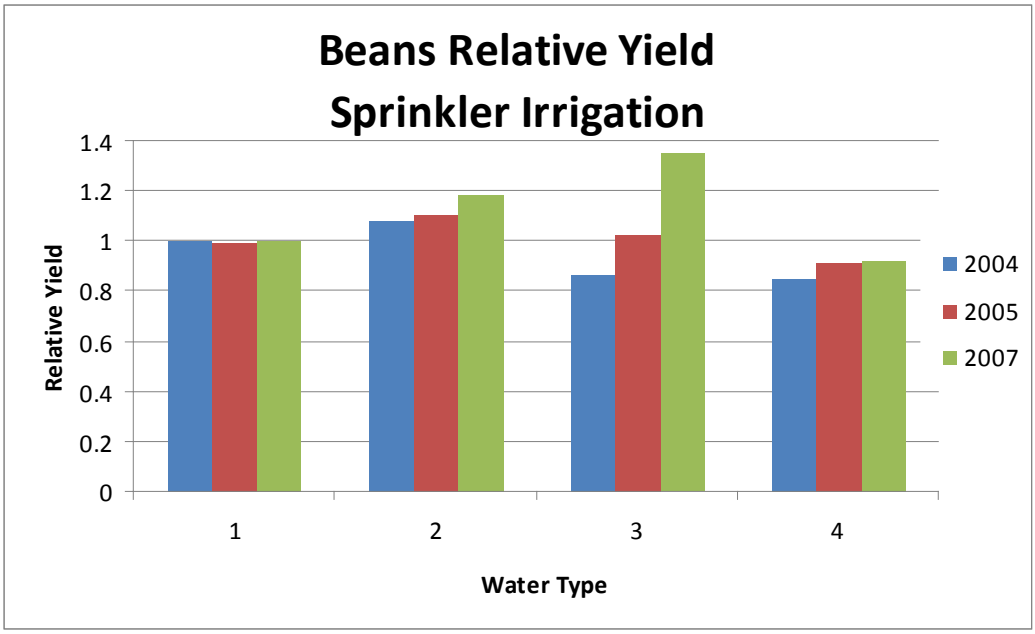

Figure 9 Beans relative yield normalized to Water 1 under sprinkler irrigation (Beans were only harvested in the years shown. Wild turkeys destroyed beans in 2009.)

Yield data from 2004 to 2010 is found in Appendix C.

3.2 Forage Sodium Content

Figure 10 shows average percent sodium in forages harvested (dry matter basis) from the Irrigated Crop and Soil Test plots for 2004 to 2010. Water 1 (100% Tongue River) forages have always had the lowest sodium content. The 2004 to 2010 average sodium content and ranges for barley and alfalfa are shown in Table 6. The 2004 to 2010 average sodium content for barley is 0.21%, while alfalfa averaged 0.06% for that same period. Water 2 barley and alfalfa averaged 0.30% and 0.10% sodium, respectively. Water 3 barley and alfalfa sodium content averaged 0.41% and 0.14%, respectively. Lastly, Water 4 barley had 0.64% and alfalfa had 0.37% average sodium. For Water 1, sodium ranged from 0.11% to 0.77% for barley and 0.03% to 0.10% for alfalfa. For Water 2, sodium ranged from 0.12% to 0.76% for barley and 0.06% to 0.28% for alfalfa. For Water 3, barley sodium ranged from 0.19% to 1.18% and 0.07% to 0.28% for alfalfa. Water 4 barley sodium content ranged from 0.31% to 1.56% and 0.24% to 0.82% for alfalfa. It is evident that as sodium increased in soil and/or water, sodium also increased in plant material grown from that soil and water. Also, sodium content varies between crops. In Tier 2 of this monitoring program, barley has always had the highest sodium content, then hay millet, alfalfa, grass (orchard, brome and Blue), and lastly corn.

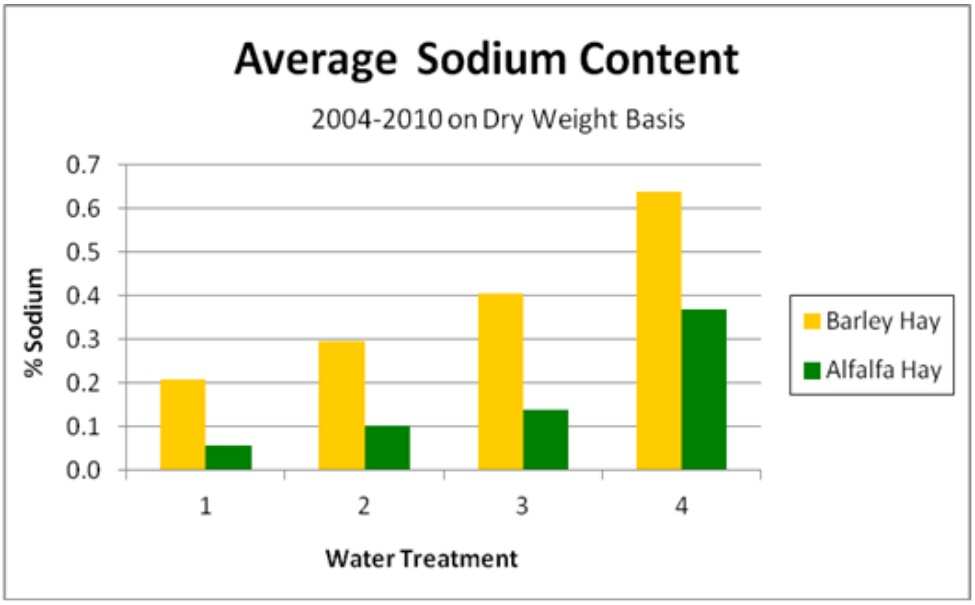

Figure 10 Average forage sodium content of barley and alfalfa hay from 2004 to 2010

Table 6 Forage Sodium Content from 2004 - 2010

		Water Treatment 1	Water Treatment 2	Water Treatment 3	Water Treatment 4
Barley	Average Sodium Content	0.21%	0.30%	0.41%	0.64%
	Sodium Content range	0.11% - 0.77%	0.12% - 0.76%	0.19% - 1.18%	0.31% - 1.56%
Alfalfa	Average Sodium Content	0.06%	0.10%	0.14%	0.37%
	Sodium Content range	0.03% - 0.10%	0.06% - 0.28%	0.07% - 0.28%	0.24% - 0.82%

No significant differences in crop or forage sodium levels were detected in the Tier 2 program indicating that the proportion of CBNG produced water in actual Tongue River irrigation water is less than any of the water sources used in the Tier 3 test plots (7% to 50% CBNG water).

No other feed quality parameter was significantly different between water treatments and/or irrigation method. Other parameters analyzed were: percent crude protein, acid detergent fiber (ADF), and total digestible nutrients (TDN); lactation, maintenance, and gain energies; and mineral content. Minerals tested for in addition to sodium were: calcium, phosphorus, potassium, magnesium, sulfur, iron, manganese, zinc, and copper.

4.0 Summary

The findings of the 2011 Tier III irrigated crop and soils study can be summarized as follows:

- Relative crop yields were not substantially changed based on water treatments or method of irrigation for alfalfa and hay barley initially or over time.
- Relative crop yields for beans irrigated with Water 4 (50% Tongue River and 50% CBNG waters) declined substantially over time. This decline is most likely due to the lower salt tolerance of beans.
- Alfalfa and hay barley forage sodium content increased significantly as water SAR increased. No other feed parameter was changed with different water treatments.
- Sodium content in barley is higher than in alfalfa.

Additional evaluation of the Tier III crops and soils study are anticipated to be performed for the 2012 report.

5.0 References

KC Harvey Associates and Fehringer Agricultural Consulting, 2009. 2009 Irrigated Crop and Soils Test Report. Prepared for the Montana Department of Natural Resources and Conservation Board of Oil and Gas Conservation. Tongue River Information Program: http://bogc.dnrc.mt.gov/PDF/TRIPpdfFiles/Draft%20Tier%203%20Report%209_30_09.pdf

6.0 Appendices

Appendix A

Weed management techniques used on the Tier 3 test plots

Management Type	Method (s)	Rate	Plot	Growth Stage
Chemical	Unison®	1.5 pt/acre	Barley	Post-emergence
	Outlook®	1 pt/acre	Beans	Pre-planting
	Prowl® 3.3 EC	3 pt/acre	Beans	Pre-planting
	Basagran®	2 pt/acre	Beans	Post-emergence
	Crop oil	Per label Instructions	Beans	Post-emergence
	Round-up®	1-2 qt/acre	All plots post-harvest and/or preplant. Areas around test site and water tanks.	Post-emergence
	Raptor®, surfactant	5oz/acre, per label instructions	Alfalfa	Post-emergence
	Ammonia sulfate	Per label Instructions	Applied with Roundup and Raptor	Post-emergence
Mechanical	Hoeing	As needed	Beans	Post-emergence
	Hand pulling	As needed	Beans	Post-emergence

Appendix B

Crop Yield Data, 2004-2010

AMPP Tier 3 Yield Data

Hay Barley

-	Yield @ 12% Moisture(T/A)								Sodium Content (%)							
Water	2004	2005	2006	2007	2008	2009	2010	**AVE**	2004	2005	2006	2007	2008	2009	2010	**AVE**
1	1.6	3.6	2.7	n/a	2.9	n/a	3.3	**2.8**	0.11	0.16	0.15	n/a	0.41	n/a	0.21	**0.21**
2	1.6	3.4	2.5	n/a	2.5	n/a	3.2	**2.6**	0.12	0.17	0.28	n/a	0.54	n/a	0.37	**0.30**
3	1.5	3.0	2.4	n/a	2.6	n/a	3.7	**2.6**	0.19	0.22	0.30	n/a	0.64	n/a	0.68	**0.41**
4	1.5	2.9	2.8	n/a	2.8	n/a	3.5	**2.7**	0.31	0.33	0.66	n/a	1.02	n/a	0.88	**0.64**

Pinto Beans

-	Yield (cwt/acre)								Sodium Content (%)							
Water	2004	2005	2006	2007	2008	2009	2010	**AVE**	2004	2005	2006	2007	2008	2009	2010	**AVE**
1	18.95	21.04	n/a	27.53	n/a	0.00	n/a	**22.51**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2	16.23	23.54	n/a	29.78	n/a	0.00	n/a	**23.18**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	17.92	20.44	n/a	25.01	n/a	0.00	n/a	**21.12**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	13.88	20.63	n/a	21.38	n/a	0.00	n/a	**18.63**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

cwt: hundred weight @ air dried moisture.
Beans were not tested for sodium content
2009 beans were destroyed by wild turkeys.

Alfalfa

-	Yield @ 12% Moisture(T/A)								Sodium Content (%)							
Water	2004	2005	2006	2007	2008	2009	2010	**AVE**	2004	2005	2006	2007	2008	2009	2010	**AVE**
1	n/a	n/a	0.47	3.32	3.03	2.01	2.46	**2.26**	n/a	n/a	0.06	0.04	0.05	0.04	0.09	**0.06**
2	n/a	n/a	0.43	3.46	2.67	1.90	2.68	**2.23**	n/a	n/a	0.09	0.08	0.09	0.10	0.16	**0.10**
3	n/a	n/a	0.41	3.27	3.25	1.72	2.98	**2.33**	n/a	n/a	0.13	0.11	0.15	0.14	0.16	**0.14**
4	n/a	n/a	0.40	3.65	2.73	1.51	2.49	**2.16**	n/a	n/a	0.33	0.28	0.40	0.42	0.41	**0.37**