



# BLACKFOOT CHALLENGE IRRIGATION SCHEDULING PROGRAM

## ANNUAL REPORT 2016

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### PROGRAM SUMMARY

The Blackfoot Challenge Irrigation Scheduling Program provides information to help irrigators apply the right amount of water at the right time to meet crop goals. We work with individual irrigators to monitor weather, crops, irrigation and soil moisture across the drainage. Weekly reports give participants detailed information specific to their fields while a more general report is circulated basin-wide to other irrigators and water managers. Both include irrigation tips, drought strategies, soil and crop management options and other information focused on water use and conservation. Reports are also provided on the Challenge website. Our work has identified an overall irrigation strategy that can provide both good crop production and adequate late-season stream flows during dry years. This is the seventh year of the program.

### PROGRAM COMPONENTS

A variety of information and services are delivered in multiple ways. We continue to seek improvements to get information to irrigators when they need it in a form that's easy to use.

Information is distributed to approximately 100 irrigators, water managers and other interested parties throughout the drainage including:

- Weekly reports summarizing weather, crop water use, soil moisture conditions, crop management, drought strategies, and other information with summary tables and graphics
- An annual report summarizing irrigation, drought and other concerns
- A one-page irrigation calendar summarizing our most important recommendations throughout the irrigation season (see page 7)
- The Blackfoot Challenge Web site with our irrigation guide specific to the Blackfoot drainage and other irrigation information.

#### BLACKFOOT CHALLENGE WEEKLY IRRIGATION REPORT Friday July 3, 2015

Independence Day could have been declared as a holiday for irrigators - most of them are extremely independent. This one will be warm and dry following another week of high potential crop water use (4 1/2 inches). A few crops were reported but virtually no rain fell on Blackfoot croplands again. Crops again responded well to warm temperatures and clear skies with impressive growth spurts in some fields. A condensed overview of the entire irrigation season is presented on the last page of this report as a reminder to plan ahead. More information about irrigation is available on the Challenge website.

**WEATHER - WARM LAST WEEK AND WARM NEXT**  
Very warm, dry weather prevailed last week and will continue next week. Only scattered showers are predicted. Temperatures will again be in the 80 and 90s. The 30 and 50 day forecasts continue to suggest above normal temperatures and normal rainfall. Low streamflows are becoming very low streamflows.

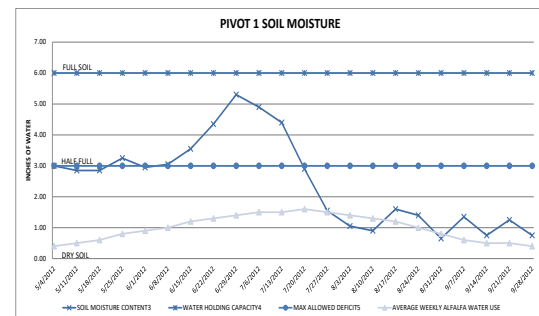
**HIGH CROP WATER USE CONTINUES**  
Crop water use continued to be above 1 1/2 inches for most crops last week - still above normal. It will continue to be high next week with hot temperatures and low humidity. The table and chart on Page 3 illustrate crop water use throughout the whole season.

| WATER USE IN INCHES         | LAST 7 DAYS | NEXT 7 DAYS     | SEASON TOTAL |
|-----------------------------|-------------|-----------------|--------------|
| HAY CROPS                   | 1.7         | 1.7 (1.5 - 1.8) | 13.02        |
| PASTURE                     | 1.4         | 1.4 (1.3 - 1.5) | 11.50        |
| SPRING GRAINS (wheat, corn) | 1.8         | 1.8 (1.7 - 2.1) | 7.8          |
| WINTER WHEAT                | 1.8         | 1.8 (1.7 - 2.1) | 14.0         |
| LEANS                       | 1.8         | 1.8 (1.5 - 1.8) | 12.8         |

**SOIL MOISTURE - ADD WHAT YOU CAN**  
Ideally you have a full soil profile and are ready for your first cutting. However, most of those in the Blackfoot Drainage on Planet Earth are struggling to boost moisture at all. Do the best you can. Leave time for the surface to dry out before cutting and get back on if you can as soon as possible.

Additional Information is provided to individual irrigator participants:

- Soil evaluations for texture and moisture holding capacity
- Soil moisture monitoring throughout the growing season
- Application amount and uniformity evaluations for each system
- Training in soil moisture evaluation
- Customized weekly reports with timely irrigation information and management options
- An annual report summarizing the season and future options



## 2016 PROGRAM HIGHLIGHTS

- 3 farms monitored for weekly soil moisture and crop water use totaling approximately 400 acres. These farms have a total of 800 acres of irrigation where this information will be applied.
- 4 application/uniformity tests performed on pivot irrigation systems
- 2016 growing season rainfall on croplands in was 4-7 inches (long term average = 6-8 inches)
- 2016 potential crop water use in inches: hay = 28, pasture = 24, grains = 14-20 (above average)
- No over-irrigation among irrigation participants – all applied less than crop water use
- 2016 was the 3<sup>rd</sup> drought year out of the last 5 and the 5<sup>th</sup> with above average crop water use.
- 2016 river flows approached the lowest recorded levels ever triggering drought response plans .
- The Deer Lodge Agrimet weather station showed a dramatic increase in crop water use since its installation in 1998. 16 inches in 1998 and 28 inches this year.
- Despite the drought, those who irrigated with enthusiasm early in the season had good yields from first cuttings and were able to reduce irrigation withdrawals when river flows became low.

## 2016 WEATHER

2016 was another dry year similar to 2013 and 2015. It was much drier than 2011 which was extremely wet and cold. Growing season rainfall in 2016 was below average for most local croplands. Temperatures fell below average for a few scattered weeks throughout the growing season but were above average most of the time.



|  | <u>2016</u> | <u>AVERAGE</u> |
|--|-------------|----------------|
| Total (gross) growing season rainfall (May1-Sept30): | 4-7 inches  | 6-8 inches     |
| Effective (net) growing season rainfall:             | 2-4 inches  | 3-4 inches     |

2016 was another warm, dry year that created above average crop water use. It is increasingly important for irrigators to pay attention to spring conditions and weather predictions which seem to be getting warmer and more variable. In the past few years the active part of the growing season has started anywhere from late-April to mid-June. This year again saw warm temperatures in April and early May with crops starting growth early as well. This year (like 2013 and 2015) those who irrigated early had a good crop by the time river flows caused drought restrictions. The lesson is to look ahead and be flexible, especially at the start of the season.

## 2016 CROP WATER USE

Crop water use in 2016 was the second highest since our program started in 2010. Crop water use for hay this year was 28 inches compared with an average of 24 over the past 7 years and a range of 21–29 inches.



Figure 1 lists potential crop water use for all crops in 2016. Hay used 28 inches, pasture 24 inches and small grains 14-20 inches. The lower crop water use for small grains shows how putting a portion of your acreage into small grains can reduce your overall water use. Irrigation of small grains, especially winter wheat also can also end sooner.

**FIGURE 1. POTENTIAL CROP WATER USE THROUGHOUT THE 2016 IRRIGATION SEASON**

| <b>BLACKFOOT 2016 GROWING SEASON WEEKLY RAINFALL &amp; CROP WATER USE (INCHES OF WATER)</b> |                   |   |              |                         |                          |              |              |   |                        |                         |
|---|-------------------|---|--------------|-------------------------|--------------------------|--------------|--------------|---|------------------------|-------------------------|
|   | RAIN <sup>1</sup> | 2016 WEEKLY POTENTIAL CROP WATER USE <sup>2</sup> |              |                         |                          |              |              | AVERAGE POTENTIAL CROP WATER USE <sup>3</sup> |                        |                         |
|   |                   | HAY CROPS <sup>4</sup>                            | PASTURE      | SPRING GRAINS 5-1 START | SPRING GRAINS 5-15 START | WINTER WHEAT | LAWNS        | LONGTERM AVERAGE HAY WATER USE                | HOT WEEK HAY WATER USE | COOL WEEK HAY WATER USE |
|   | RAIN              |   |              |                         |                          |              |              |   |                        |                         |
| 5/6/2016  | 0.20              | 0.80  | 0.70         | 0.25                    | 0.25                     | 0.90         | 0.70         | 0.50  | 0.80                   | 0.20                    |
| 5/13/2016   | 0.30              | 0.90  | 0.80         | 0.25                    | 0.25                     | 1.10         | 0.80         | 0.80  | 1.00                   | 0.50                    |
| 5/20/2016   | 0.01              | 1.00  | 0.90         | 0.50                    | 0.25                     | 1.10         | 1.00         | 1.00  | 1.10                   | 0.70                    |
| 5/27/2016   | 1.00              | 0.60  | 0.50         | 0.30                    | 0.25                     | 0.70         | 0.60         | 1.20  | 1.20                   | 0.80                    |
| 6/3/2016  | 0.20              | 1.00  | 0.90         | 0.70                    | 0.40                     | 1.10         | 1.00         | 1.30  | 1.30                   | 0.90                    |
| 6/10/2016   | 0.10              | 1.50  | 1.40         | 1.25                    | 0.70                     | 1.60         | 1.50         | 1.40  | 1.50                   | 1.00                    |
| 6/17/2016   | 0.20              | 1.25  | 1.20         | 1.30                    | 0.70                     | 1.40         | 1.20         | 1.50  | 1.70                   | 1.10                    |
| 6/24/2016   | 0.10              | 1.50  | 1.40         | 1.60                    | 1.20                     | 1.50         | 1.50         | 1.50  | 1.90                   | 1.10                    |
| 7/1/2016  | 0.01              | 1.70  | 1.50         | 1.80                    | 1.80                     | 1.10         | 1.60         | 1.50  | 2.00                   | 1.20                    |
| 7/8/2016  | 0.01              | 1.70  | 1.60         | 1.80                    | 1.80                     | 0.50         | 1.50         | 1.60  | 2.10                   | 1.30                    |
| 7/15/2016   | 1.25              | 1.20  | 1.00         | 1.30                    | 1.30                     | 0.10         | 1.20         | 1.60  | 2.00                   | 1.20                    |
| 7/22/2016   | 0.10              | 1.60  | 1.40         | 1.90                    | 2.00                     | 0.10         | 1.50         | 1.50  | 1.90                   | 1.20                    |
| 7/29/2016   | 0.00              | 1.70  | 1.50         | 1.90                    | 1.90                     | 0.10         | 1.60         | 1.50  | 2.20                   | 1.10                    |
| 8/5/2016  | 0.00              | 1.70  | 1.50         | 1.90                    | 1.90                     | 0.10         | 1.60         | 1.40  | 1.70                   | 1.00                    |
| 8/12/2016   | 0.25              | 1.30  | 1.00         | 1.00                    | 1.20                     | 0.10         | 1.20         | 1.20  | 1.50                   | 0.90                    |
| 8/19/2016   | 0.01              | 1.30  | 1.00         | 0.75                    | 0.50                     | 0.10         | 1.20         | 1.00  | 1.30                   | 0.70                    |
| 8/26/2016   | 0.10              | 1.20  | 1.00         | 0.50                    | 0.25                     | 0.10         | 1.10         | 0.80  | 1.00                   | 0.50                    |
| 9/2/2016  | 0.25              | 1.30  | 1.00         | 0.25                    | 0.10                     | 0.10         | 1.20         | 0.60  | 0.80                   | 0.40                    |
| 9/9/2016  | 0.30              | 0.70  | 0.60         | 0.10                    | 0.10                     | 0.10         | 0.70         | 0.60  | 0.70                   | 0.30                    |
| 9/16/2016   | 0.20              | 1.00  | 0.70         | 0.10                    | 0.10                     | 0.10         | 0.90         | 0.50  | 0.70                   | 0.30                    |
| 9/23/2016   | 0.40              | 0.80  | 0.60         | 0.10                    | 0.10                     | 0.10         | 0.80         | 0.40  | 0.60                   | 0.20                    |
| 9/30/2016   | 0.10              | 0.80  | 0.60         | 0.10                    | 0.10                     | 0.10         | 0.80         | 0.40  | 0.60                   | 0.20                    |
| <b>TOTAL</b>  | <b>5.79</b>       | <b>28.05</b>                                      | <b>24.05</b> | <b>20.40</b>            | <b>17.90</b>             | <b>13.95</b> | <b>26.45</b> | <b>24.80</b>                                  | <b>31.10</b>           | <b>17.30</b>            |

<sup>1</sup> Rainfall should be reduced to account for immediate evaporation from crop and soil surfaces (0.1-April,May and Sept, 0.15-June and August, 0.2-July)

<sup>2</sup> **This years** maximum water use by healthy crops that are well-fertilized and irrigated, disease and insect-free. Will vary slightly across the drainage.

<sup>3</sup> **Longterm average** water use for each crop each week based on long-term historic data.

<sup>4</sup> Hay Crop water use is reduced by approximately 2/3 the first week after cutting, 1/2 the second and 1/3 the third.

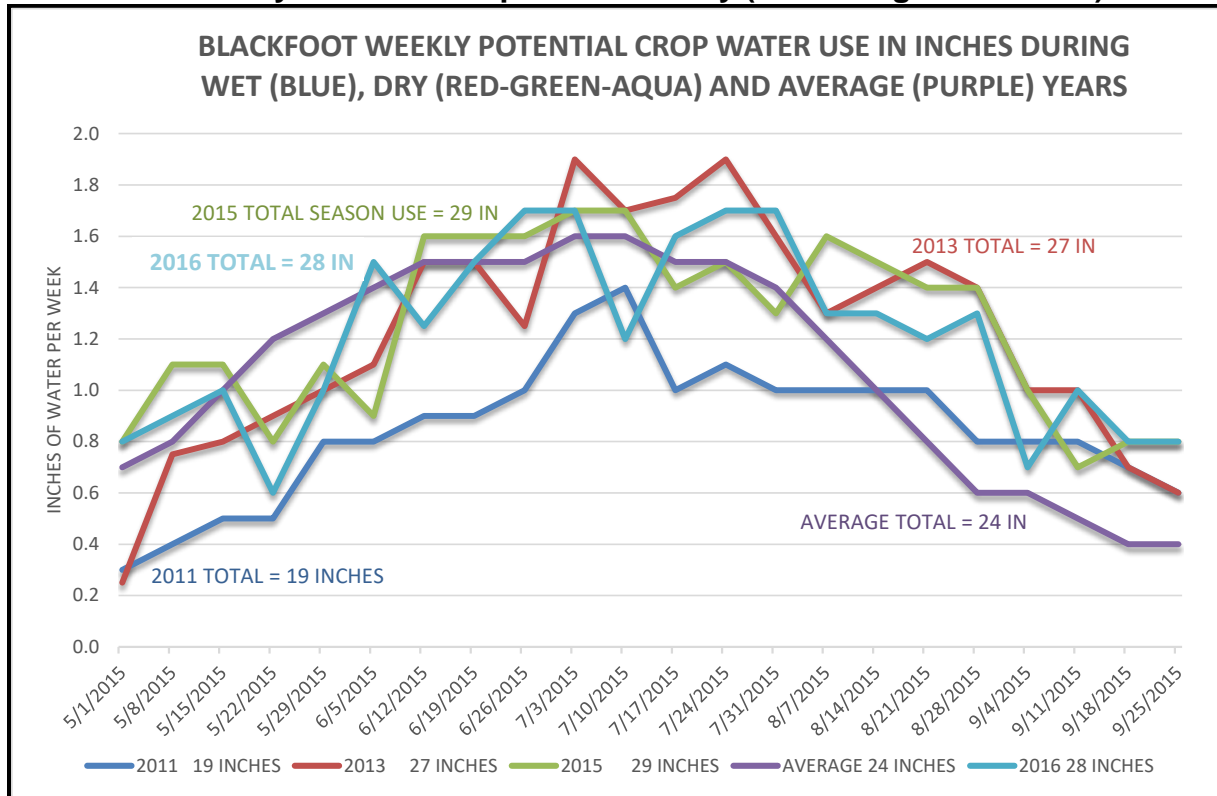
It is important to remember that these **potential crop water use** figures are for a dense, robust stand that is well-irrigated, well-fertilized and mostly disease/insect free. Crops not in such good condition use less water. Actual crop water use across the drainage varies dramatically due to water availability, fertilizer, stand quality, micro-climate, management style, and many other factors. Working with individual irrigators across the drainage allows us to re-calibrate regional crop water use information to the Blackfoot area. It also provides accurate information for these irrigators at specific fields throughout the season and a record of using water efficiently.

One of the most significant results of this program is that it continues to reveal that over-irrigation is not common among sprinkler irrigators. Many sprinkler irrigators in the drainage apply only 50-75% of the **potential** crop water use when you consider the entire irrigation season. However, if you just consider the period before cutting, many irrigators participating in this program apply 75-100% of the **potential** crop water demand. This suggests irrigators are smartly concentrating on their first cutting which is where the most production is and the biggest bang for the buck. They then may irrigate in a more relaxed manner to produce pasture for the remainder of the season or cease irrigating due to water availability, water rights, stream flows or other reasons (fishing?).

### CROP WATER USE TRENDS

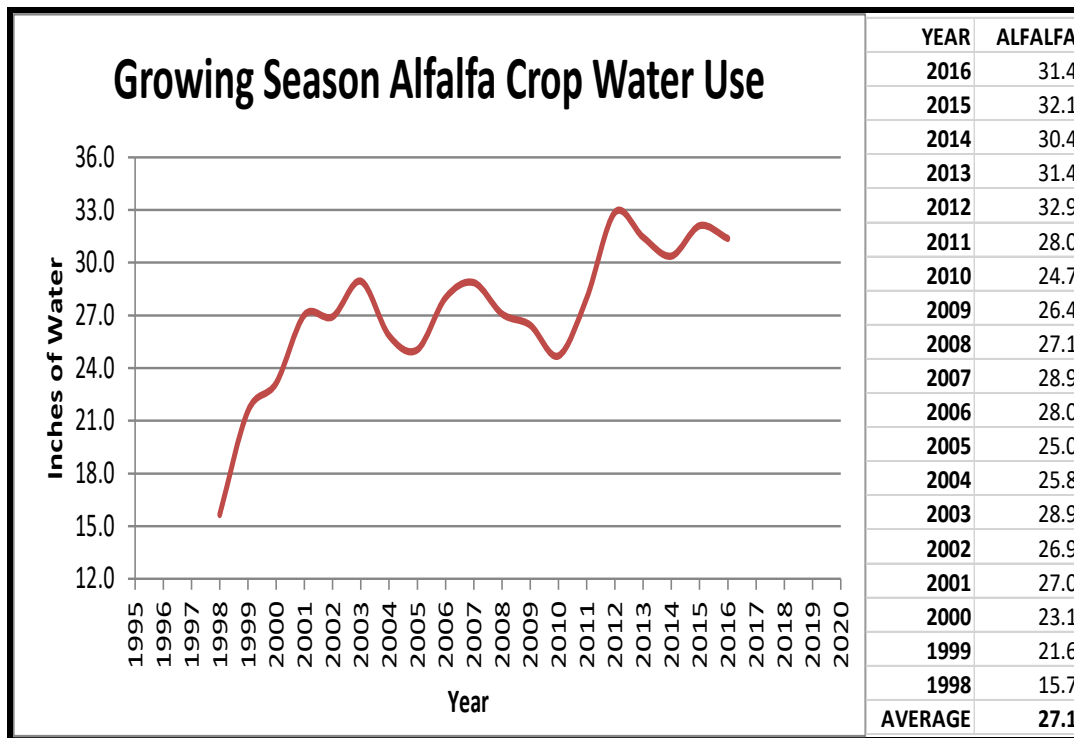
Average annual crop water use in the Blackfoot Drainage is about 24 inches for hay. Annual crop water use in 2016 was the second highest during our 7 year irrigation scheduling program and only 1 inch less than 2015. The last 5 years have all been above average. You have to go back to cold, rainy 2011 when hay crop water use was 19 inches to get below average. Figure 2 illustrates annual crop water use comparing recent warm and cool years with the average. When **all** of the last 5 years are above average, you have to ask if this trend will continue and if it reflects global warming.

**FIGURE 2. Weekly Potential Crop Water for Hay (2016 = Light Blue Line)**



This trend of increasing crop water use is also reflected in the Deer Lodge Agrimet weather station data. Figure 3 illustrates annual hay water use since the station was installed in 1998. Crop water use for 2016 was almost twice what it was in 1998. This has serious implications for the future of local irrigation. Water rights adjudication and low flow restrictions on the Blackfoot river prevent future irrigation increases despite this apparent potential need for adjustments. The only option for local irrigators will be to increase water use efficiency through irrigation management practices and crop selection. Drought management will likely be a routine instead of a rarity. I want to thank our Blackfoot Challenge intern Joe Zimbric for his great work to assemble the Agrimet Data from Deer Lodge and Round Butte used in this report. I will be making further analyses of these data this winter for use in future water management and drought planning. NRCS irrigation guides suggest a similar increase in crop water use over the past 3 decades.

**FIGURE 3. Annual Crop Water Use Trend for Hay from the Deer Lodge Agrimet Station**



### 2016 SOIL MOISTURE

Early season soil moisture in 2016 was again below average. At the beginning of May most local root zones had soil moisture contents of  $\frac{1}{4}$  to  $\frac{1}{2}$  their full water holding capacity. This was due to low snow and rainfall combined with early snowmelt and warm temperatures. Many irrigators had difficulty keeping soil moisture high due to higher than average crop water use throughout the season. Significant rainstorms in late-May and mid-July boosted soil moisture temporarily but crop water use quickly exhausted this moisture. Remember that soil moisture levels do not have to be kept high to produce a decent (if not superior) crop. The crop will use moisture as it is applied and if you keep applying it, the crop will respond. We encourage folks to keep soil moisture levels high because this is how you get the best production. This is also how you provide a reserve in case of equipment problems, water shortage or other irrigation interruption.

## **2016 IRRIGATION TIPS**

Irrigation tips were provided each week according to crop stage, weather conditions and other factors. This year's tips concentrated on application rates, uniformity, above average crop water use due to warmer weather and critical crop watering periods. We emphasized early season water applications to promote growth and fill up soil root zones before stream flows dropped. Tips were expanded this year to include soil health concerns and to respond to irrigator questions.

## **2016 DROUGHT INFORMATION AND STRATEGIES**

This year was the second driest during our seven year program and almost as dry as 2015. All of the last 5 years have had above average crop water use. Three of the past five years have seen drought plans implemented suggesting a warming/drying climate in the Blackfoot drainage. Our weekly reports included streamflow information for the Blackfoot River, tips on how to irrigate during drought and perspectives on drought from elsewhere. This year we reached critical streamflow levels and drought response efforts were implemented. Observations throughout the drainage suggested that most irrigators responded to low streamflow by cutting back on irrigation withdrawals during the critical low flow period in August. Drought strategies include irrigating earlier in the season, growing crops that use less water, keeping soil water holding capacities full and others.

## **SOIL HEALTH**

As a soil scientist, I am encouraged by recent interest in soil health and soil quality. I believe the future of our civilization continues to be rooted in our soil and our ability to maintain its productivity. The Blackfoot Challenge has helped organize a Soil Health Committee to increase awareness and identify local opportunities to apply these practices. Our weekly reports included information on soil health and local workshops/field days to learn about results. We plan to expand our participation in soil health activities and identify specific options for use in the Blackfoot Drainage. We will share the experience of local irrigators trying new methods and keep folks informed of soil health education opportunities. Please contact Jennifer Schoonen or myself with your suggestions for topics, areas of interest and experiences.

## **PRODUCTION MEASUREMENTS**

This year we evaluated a common production measurement method. We are especially interested in production related to water use, soil health, soil inputs and other management activities including aeration and no-till. Most folks count bales and many weigh a few. This works for most, especially if everyone agrees during sales. However, folks sometimes want a more accurate way to evaluate experiments or track production over time. The method we used included clipping the crop on ten 1/1000<sup>th</sup> acre plots (2.35 foot diameter hoop), weighing and drying the samples and calculating yields per acre. I want to thank Blackfoot Challenge intern Joe Zimbric and local rancher/philosopher Logan Mannix for their help in collecting samples.



The results of our experiment were mixed. We measured production at 12 hayfield sites. Production in most fields ranged from 1.0 to 2.2 tons per acre. Production was lowest in hay fields dominated grass alone and without fertilization. Production was higher in fields with grass/alfalfa mixes,

especially when fertilized. Most folks thought it was kind of a mediocre year for production. However, one of our better local farmers managed 2.1 tons per acre on his fertilized grass, 3.8 t/a on his fertilized winter wheat and 4.4 t/a on his unfertilized oat/barley/pea mix. I am very impressed by the potential for feed winter wheat in the drainage and the high production of oat/pea mixes in short periods with limited water.

#### 4 Ton/Acre Oat/Barley/Pea Mix



Statistical analysis of our production measurements suggested that clipping 10 plots is sufficient for giving an approximation of yield. However our standard deviations suggested we could be off by  $\frac{1}{4}$  -  $\frac{1}{2}$  ton per acre. To be more accurate, you need to measure more plots. Our observations also suggest we must be very careful to ensure areas for comparison testing are uniform before we apply treatments. Topography, soils, vegetation must be very similar. Most of the treatments we evaluated did not show significant differences from the untreated areas but this may have been due to site differences and not the treatments. The treatments were only applied this one year. This method can be useful in the future for measuring yields and making comparisons but requires careful site selection and 10-20 plots per site.

#### A BEST-MANAGEMENT STRATEGY FOR BLACKFOOT IRRIGATORS?

This program was designed to help individual irrigators which in turn might help water management across the entire drainage. We have combined experience from the best local irrigators with our own knowledge and with results from monitoring to fine-tune recommendations. We have spread this wealth of information as Irrigation Tips in our weekly reports and irrigation guide. This strategy is condensed into our irrigation calendar (page 8). Our work in 2016 continues to confirm the validity and value of this strategy.

Our individual recommendations have come together in an overall strategy for irrigation that can **provide both good crop production and late-season stream flows** for fish and recreationists. This might be considered a best management practice for irrigation in the Blackfoot drainage and a landscape-scale solution for water resources. The main points of this practice are:

- early evaluation of the coming irrigation season in April,
- heavy irrigation early in the season to fill up the soil water holding capacity,
- heavy irrigation throughout June and up to cutting in early-mid July
- reduced irrigation or no irrigation during low water flows in late July and August

Despite the very dry year, irrigators who applied water early and kept pouring it on up until haying in mid-July had excellent crops. This same thing happened in 2013 and 2015 when warm temperatures gave us an extra month of very active growing season on the front end (April-May). Irrigators who recognized the early year took advantage of it and had some of the best crops ever, then felt good about reducing irrigation during the low flow period.

There is little doubt that the future will only get more challenging for Blackfoot irrigators. However, with this challenge will likely come opportunities to influence critical water decisions and participate in future water markets from here to the Pacific Ocean. All while living and irrigating in a great place!

## THE BLACKFOOT DRAINAGE IRRIGATION SEASON IN BRIEF

This is a summary of general activities and recommendations with more detail provided throughout our irrigation guide.

### APRIL – GET READY AND PLAN YOUR IRRIGATION STRATEGY!

- Get your irrigation system ready, evaluate spring soil moisture and weather to determine start date.
- Evaluate season weather predictions then plan for drought if needed.



### MAY – CHECK SOIL MOISTURE & BE READY FOR UNUSUAL HEAT OR COLD!

- Check the soil moisture content at the start of growing season (May 1) and fill up the soil to its water holding capacity during early irrigations (2-4 inches).
- Watch for dry soil conditions, especially with new plantings and apply water to ensure good germination and emergence.
- Irrigate deeply at least once early in the season to promote deep root growth.
- Apply 2-5 inches of irrigation to hay and pasture crops in May depending on weather. Apply 0-2 inches to spring grains and new plantings as needed based on weather and growth. Apply extra water to fill up the soil (2-4 in).

### JUNE – THIS IS THE TIME TO MAKE YOUR BIGGEST EFFORT SO POUR IT ON!

- Apply 6-8 inches of irrigation in June to hay and pasture crops and winter wheat depending on weather.
- Apply 5-8 inches to spring grains and new plantings as needed based on weather and growth.
- Consider irrigating deeply to fill up soil root zone and promote deep root growth.
- Be sure small grains are irrigated well during their critical periods of boot, bloom and early heading.



### JULY – POUR IT ON UNTIL HARVEST AND RETURN QUICKLY

- Apply 1 - 2 ½ inches of irrigation per week in July to all crops - depending on weather.
- Cutting is a critical stress period for hay crops, especially alfalfa so irrigate deeply to fill up the root zone before cutting then get back across the field quickly after cutting. Crop water use declines when hay is cut so this is a good opportunity to fill up the soil again. Irrigate at least once after cutting.
- Stop irrigating small grains at the milk to soft dough stage but be sure there are 1- 2 inches of soil moisture left at this stage to prevent kernels from shrinking.

### AUGUST- KEEP IRRIGATING SMALL GRAINS UNTIL KERNELS MATURE, BE DROUGHT AWARE!

- Apply 1 - 2 inches of irrigation per week in August to hay and pasture crops for full production depending on weather. Irrigate new plantings as needed.
- Many folks irrigate for pasture following their one hay cutting. Irrigate according to how much pasture you seek and with consideration for other water needs in the drainage, especially in drought years.
- Reduce river withdrawals by rotating systems and reducing the amount of irrigation at one time.



### SEPTEMBER – APPLY AS NEEDED/AVAILABLE & GET READY FOR SPRING!

- Apply ½ - 1 ½ inches of irrigation per week in September to hay and pasture crops for full production depending on weather. Irrigate new plantings as needed. Prepare the system for winter and an early start next spring