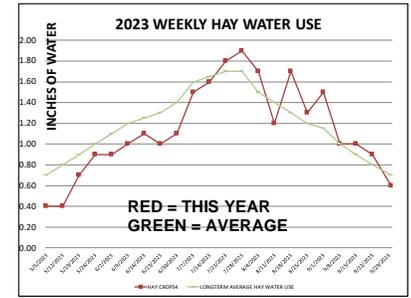




# BLACKFOOT CHALLENGE IRRIGATION SCHEDULING PROGRAM ANNUAL REPORT 2023

Barry Dutton Soil Scientist



## PROGRAM SUMMARY

This is our 14<sup>th</sup> year providing information to irrigators in the Blackfoot Drainage and together we've learned a lot. Our goal is to help apply the right amount of water at the right time to meet crop goals and watershed objectives. Weekly reports are circulated to over 100 irrigators and water managers that include crop water use, irrigation tips, drought strategies, soil and crop management options, soil health concerns and other information. Reports are also posted on the Blackfoot Challenge website. The past six years we helped install, calibrate, and use soil moisture sensors for instant readings by irrigators and to capture permanent records for year-to-year comparisons. Our work together has identified irrigation practices and drought strategies that can provide both good crop production and adequate late-season stream flows during dry years.

## 2023 HIGHLIGHTS

- Snowpack started out near average again on May 1 and mostly melted by early July.
- April, May and June were cool and moist while July through September were hot and dry. It did not rain in July – good for haying, tough for irrigating.
- 5-8 inches of rain fell on Blackfoot croplands during the 2023 growing season depending on location, mostly early-season (the historic average is about 7 inches).
- Soil moisture was high throughout April, May and June due to cool, wet weather then plummeted in mid-July unless well-irrigated.
- 2023 potential crop water use was about average: hay = 26 inches, pasture = 21, grains = 18-20. Crop water use was below average in April, May and June then above average in July, August and September (graph at upper right).
- Years with a cool/moist early season and hot/dry late season seem to be the most productive for local crops.
- Blackfoot River stream flows were average or better until late July when the 700 CFS drought trigger was reached and drought plans were implemented until late September.
- Blackfoot irrigators used soil moisture monitoring equipment for instant answers and year-to-year comparisons.
- Biochar comes to Blackfoot ag lands with applications at 5 fields.

**BLACKFOOT CHALLENGE WEEKLY IRRIGATION REPORT**  
Friday August 5, 2022

Blackfoot watershed irrigators again had little or no rain this week and sunny skies. Temperatures were the highest of the year and average is expected for next week. Soil moisture fell about 2 inches unless irrigated. Crop water use continues to be above average. Remember that water use drops the two weeks after haying. Blackfoot is expected to see below average soil moisture for much of the 2023 growing season this week. We have continued to avoid heat for haying operations due to soil water temperatures.

**HOTTEST WEATHER THIS YEAR**  
The 30-day record high for the week and the hottest temperatures of the year with some slight cooling (50F) this week. Record high for the week and the hottest temperatures of the year with some slight cooling in the 40s and 50s. The 30-day forecast says average rainfall and temperatures. The 30-day forecast says average rainfall and temperatures. The 30-day forecast says average rainfall and temperatures.

**CROP WATER USE - ABOVE AVERAGE WITH HOT WEATHER**  
Crop water use continues to be above average due to hot weather. Heat crop water use for 2023 is about 26 inches for hay and 21 inches for pasture. Reduce these figures by 25 the first week after cutting hay and by 15 the second week.

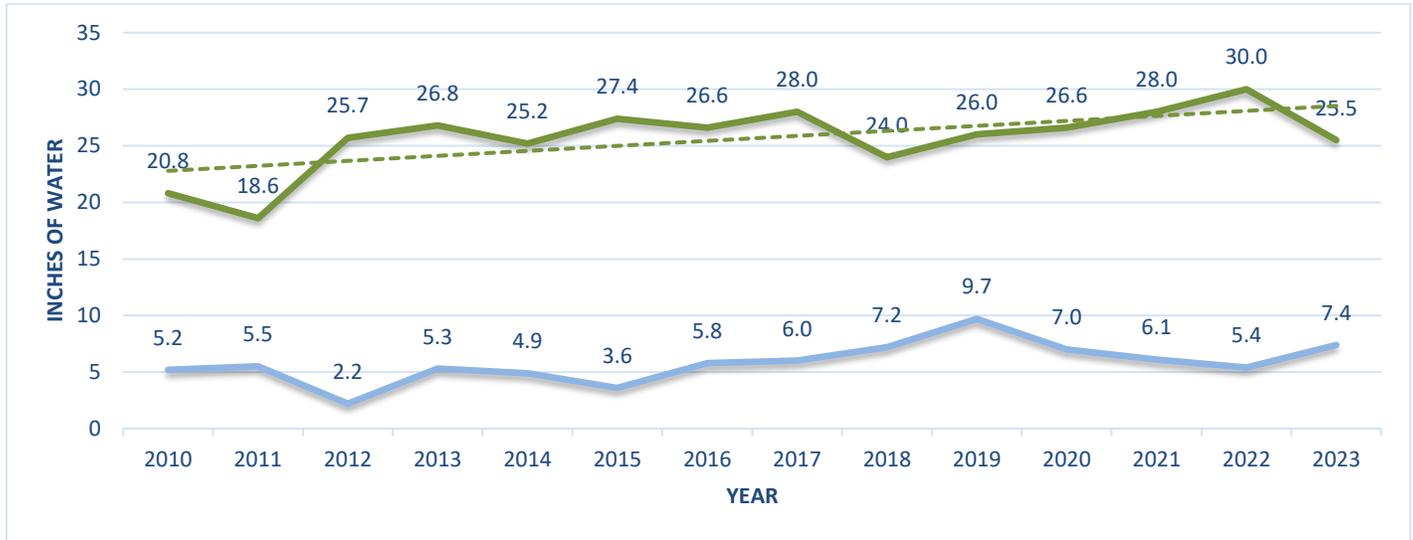
WATER USE IN INCHES	LAST YEAR	HOT 7-DAYS TOTAL	HOT 7-DAYS DAILY AVE	SEASON TOTAL
PASTURE	21	22	22	18.9
PASTURE	21	15	21	16.9
CROPPED LAND	21	20	21	17.9
WHEAT	18	18	18	14.9
GRAIN	18	18	18	14.9

**SOIL MOISTURE AGAIN DROPS 2 INCHES UNLESS IRRIGATED OR CUT**  
Soil moisture again drops by about 2 inches this week. Continue to check soil moisture and soil with at least as much as the weekly crop water use. Remember that soil moisture use drops to 1/2 the first week after cutting and by 1/3 the second week after cutting. Haying is a good time to rehydrate cropland while crop water use is reduced and there is less haying in each and everyone's water.

## 2023 WEATHER

2023 again was a tale of two weathers starting with early cool/wet conditions then switching to extra hot/dry conditions mid-season. Blackfoot croplands had cool weather throughout May and June with rain every week. When July arrived, a switch was flipped to hot and dry conditions that persisted until the end of September (but not quite as hot as 2022). There was no rain in July which was good for haying but tougher to irrigate. August and September had a few significant storms. Rainfall for the entire season was an inch or so above average on most croplands (**Figure 1**) and mostly fell in May and June. **Figure 3** lists weekly rainfall throughout the 2023 season. Remember that these rainfall figures are a rough average for croplands across the drainage and vary considerably during individual events and by specific locations. Irrigators are reminded to rely on their own rain gauges. Temperatures were below average in April through June and then above average through late-September. I guess the days of early September snowstorms are gone. The snowpack on May 1 was 88% of average compared with 96% last year.

**FIGURE 1. POTENTIAL CROP WATER USE FOR HAY AND GROWING SEASON RAINFALL ON BLACKFOOT WATERSHED CROPLANDS 2010-2023**



**2023 POTENTIAL CROP WATER USE APRIL 1 TO OCTOBER 1 = 25.5 INCHES (25.7 AVERAGE)**

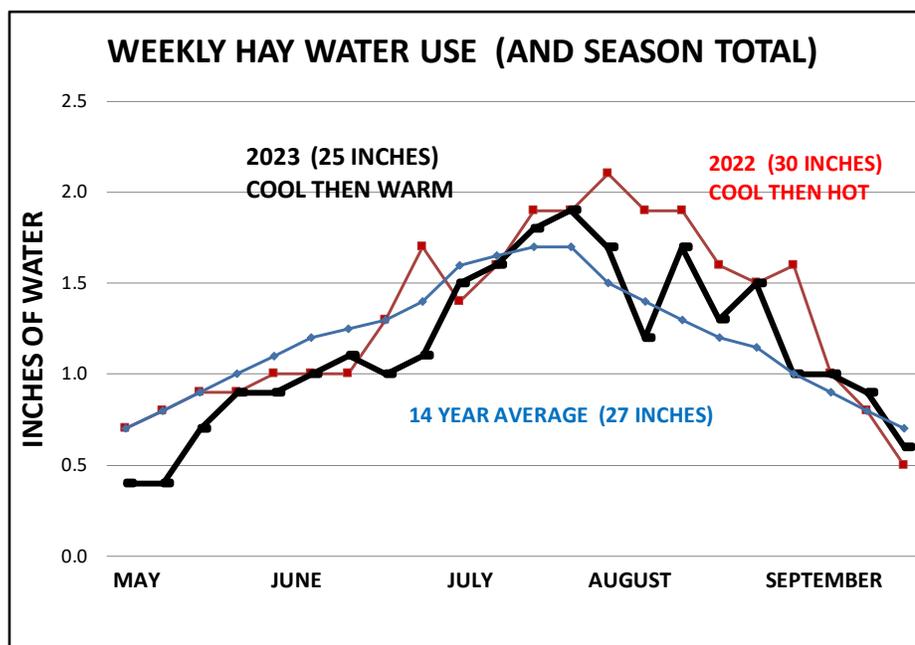
This is an average across the entire watershed and does not vary as much as rainfall at individual sites. It shows a steady increase over these 14 years. Dashed line represents the general upward trend over time.

**2023 CROPLAND RAINFALL APRIL 1 TO OCTOBER 1 = 7.4 INCHES (5.7 AVERAGE)**

This is a rough average of cropland rainfall across the entire watershed and varies widely by individual location. It does however, represent the general pattern for rainfall over these years which has remained relatively steady.

## 2023 CROP WATER USE

Figure 1 above shows that rainfall was slightly above average in 2023 and potential crop water use was below average for the overall season. Although below average for the season, it was a year of sharp contrasts. Figure 2 shows that weekly hay water use in 2023 (black line) stayed below average (green line) throughout May and June then rose above average until late-September. Daily crop water use for hay and small grains exceeded **1/4 inch per day** during this period. Irrigators struggled to boost soil moisture during this hot, dry period of high crop water use. Figure 3 lists weekly water use for each crop throughout the irrigation season.



**FIGURE 2. WEEKLY POTENTIAL HAY WATER USE IN 2023 COMPARED WITH 2022 THE AVERAGE**

It's 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 watershed varies due to water availability, fertilizer, stand quality, micro-climate, management style, and many other factors.

**FIGURE 3. POTENTIAL WEEKLY CROP WATER USE THROUGHOUT THE 2023 IRRIGATION SEASON FOR ALL CROPS INCLUDING COMPARISONS TO AVERAGE, HOT AND COOL WEEKS**

<b>BLACKFOOT 2023 GROWING SEASON WEEKLY RAINFALL &amp; CROP WATER USE</b> (INCHES OF WATER)										
WEEK ENDING	RAIN <sup>1</sup>	2023 WEEKLY POTENTIAL CROP WATER USE <sup>2</sup>						AVERAGE WEEKLY CROP WATER USE <sup>3</sup>		
	RAIN	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
APRIL	0.25	0.25	0.25	0.00	0.00	0.25	0.25			
5/5/2023	0.10	0.40	0.40	0.00	0.00	0.50	0.40	0.70	1.00	0.40
5/12/2023	1.50	0.40	0.50	0.20	0.00	0.60	0.50	0.80	1.10	0.60
5/19/2023	0.25	0.70	0.70	0.30	0.00	0.80	0.80	0.90	1.20	0.70
5/26/2023	0.75	0.90	0.80	0.50	0.30	1.00	1.00	1.00	1.30	0.70
6/2/2023	0.25	0.90	0.80	0.60	0.40	1.00	0.90	1.10	1.50	0.80
6/9/2023	0.25	1.00	0.90	0.80	0.60	1.10	1.00	1.20	1.70	0.80
6/16/2023	0.40	1.10	0.90	1.00	0.80	1.20	1.00	1.25	1.90	0.90
6/23/2023	0.25	1.00	0.80	1.00	0.90	1.10	0.90	1.30	2.00	1.00
6/30/2023	0.40	1.10	0.90	1.20	1.10	1.20	1.00	1.40	2.00	1.00
7/7/2023	0.01	1.50	1.20	1.70	1.60	1.70	1.40	1.60	2.10	1.10
7/14/2023	0.01	1.60	1.30	1.70	1.60	1.70	1.50	1.65	2.20	1.10
7/21/2023	0.01	1.80	1.50	2.00	2.00	1.80	1.70	1.70	2.20	1.10
7/28/2023	0.01	1.90	1.60	2.20	2.20	2.00	1.80	1.70	2.20	1.10
8/4/2023	0.10	1.70	1.50	2.10	2.10	1.25	1.70	1.50	2.20	1.00
8/11/2023	1.00	1.20	0.90	1.40	1.40	0.50	1.10	1.40	2.20	1.00
8/18/2023	0.01	1.70	1.40	1.50	1.50	0.25	1.60	1.30	2.00	0.90
8/25/2023	0.50	1.30	1.10	1.20	1.20	0.00	1.30	1.20	1.80	0.90
9/1/2023	0.50	1.50	1.10	0.50	0.50	0.00	1.40	1.15	1.60	0.70
9/8/2023	0.35	1.00	0.90	0.00	0.00	0.00	1.00	1.00	1.40	0.60
9/15/2023	0.00	1.00	0.70	0.00	0.00	0.00	0.90	0.90	1.40	0.50
9/22/2023	0.50	0.90	0.70	0.00	0.00	0.00	0.90	0.80	1.20	0.50
9/30/2023	0.25	0.60	0.40	0.00	0.00	0.00	0.50	0.70	1.00	0.40
<b>TOTAL</b>	<b>7.40</b>	<b>25.45</b>	<b>21.25</b>	<b>19.90</b>	<b>18.20</b>	<b>17.95</b>	<b>24.55</b>	<b>26.25</b>	<b>37.20</b>	<b>17.80</b>

<sup>1</sup> Average across watershed (50-80% gets to the crop depending on irrigation method, weather, evaporation from crop and soil surfaces)

<sup>2</sup> This years potential water use by healthy crops that are well-fertilized and irrigated, disease and insect-free. Varies across watershed.

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

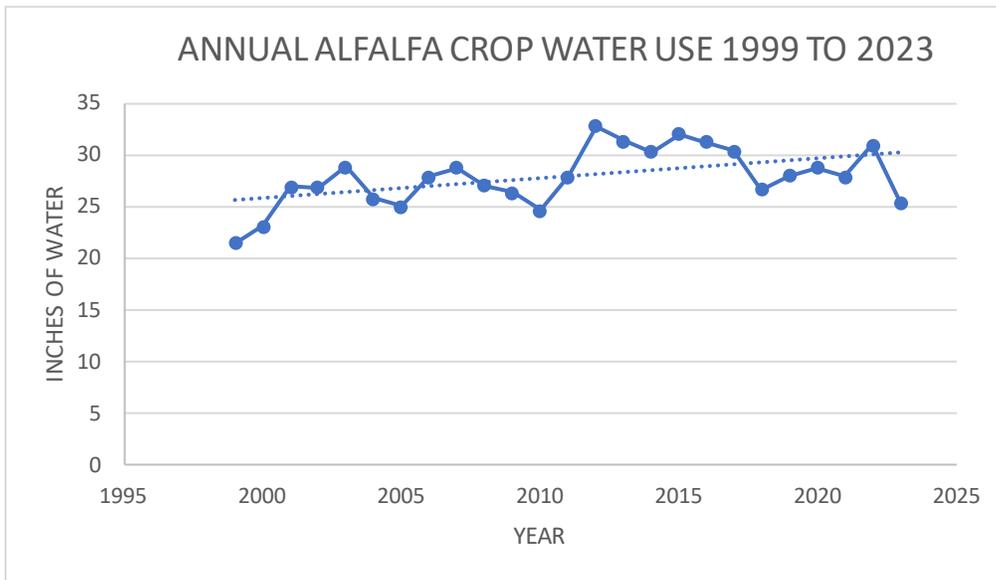
<sup>4</sup> Hay Crop water use drops from these figures approximately 2/3 the first week after cutting, 1/2 the second and 1/3 the third.

## CROP WATER USE TRENDS

Potential crop water use for hay in 2023 was about 26 inches, which is slightly below the 28 inch average over the past 14 years of this program (Figure 1). There is a general increase in crop water use across all years with 2018 the most recent dip. This trend of increasing crop water use is also reflected in the Deer Lodge Agrimet weather station data (Figure 4). These two sources suggest the local crop water use for hay is now 25-33 inches per year. It's interesting to note that the local NRCS irrigation guides from the 1980s listed crop water use for hay as only 15 inches. With all water rights already allocated in the Blackfoot watershed it will be increasingly important for irrigators, especially those with junior rights, to recognize seasonal conditions early and take advantage of above average water years. Another important consideration is year-to-year variation. Crop water use for hay ranged from 19 inches to 30 inches in our data and from 22 to 33 inches at the Deer Lodge Agrimet Station.

**FIGURE 4. ANNUAL POTENTIAL CROP WATER USE FOR ALFALFA HAY SHOWING AN UPWARD TREND OVER THE PAST 23 YEARS.** Data from Deer Lodge Agrimet Weather Station

<https://www.usbr.gov/pn/agrimet/agrimetmap/drlmda.html>



### 2023 SOIL MOISTURE

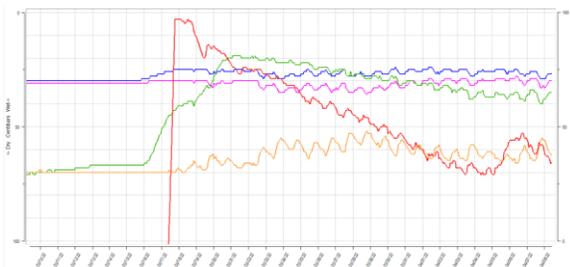
Soil moisture started out great again this year. While last year, soils dried out quickly in March and April, this year high soil moisture levels were maintained into June. Cool, wet weather made irrigation relatively easy with many irrigators keeping soil moisture at optimum levels until the first cutting in July. After mid-July, a dramatic change occurred to hot/dry conditions causing soil moisture to drop quickly in fields not well-irrigated. Hot conditions presented a special challenge for boosting soil moisture after cutting since there is more evaporation loss in hot conditions. Irrigation was also reduced in August when drought response measures were implemented.



The charts below are examples from our soil moisture sensor program. The chart on the left shows a sharp decrease in soil moisture in the surface foot (red line) starting when snow melted in early March of 2022. By April 1 the surface soil had dried out significantly. The chart on the right shows that in 2023, the snow didn't melt until late April and soil moisture in the surface foot didn't begin to decrease until the end of the month – almost 6 weeks later than in 2022.

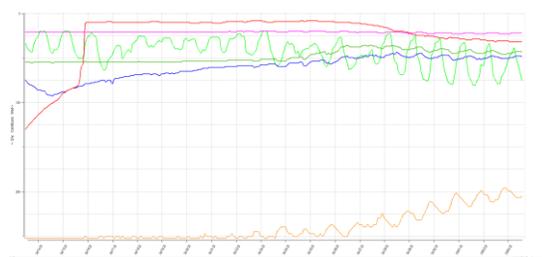
**2022 - Surface soil dries out in March and April**

**2023 - Soil remains moist through May**



March

April



April

May

## DROUGHT

Drought was not a concern this year throughout May and June but hot weather in July reduced river flows dramatically. Although the snowpack was 88% on May 1 it slowly diminished with the cool, wet weather until melting accelerated in July. **The Blackfoot Challenge Drought Response Plan was implemented in late July.** Notices were sent out to participating irrigators that they should initiate their individual drought plans. Blackfoot streamflows at Bonner dropped below the 700 CFS initial trigger level in late July and the 600 CFS level in mid-August. Low stream flows kept the Drought Plan in effect until late September. These weekly irrigation reports illustrated stream flow conditions and provided irrigation options to reduce water diversions. **Thanks to all those irrigators who cut back using water they are legally entitled to under our concept of “shared sacrifice” - it’s works!**

## 2023 IRRIGATION TIPS AND SPECIAL EFFORTS

Irrigation tips were provided each week according to crop stage, weather conditions and other factors. This year’s tips concentrated on early season good moisture conditions, irrigation during cooler periods (May and June), later season drought concerns and irrigation during hotter weather (July – September). Drought conditions here and elsewhere were highlighted. Other tips this year discussed soil health concerns, soil moisture monitoring equipment and biochar.

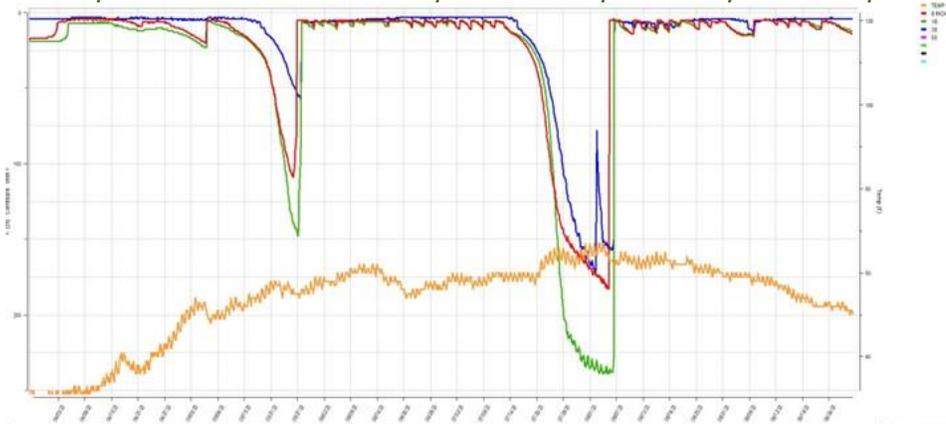
### Soil Moisture Sensor Program for Irrigators

The Challenge continued to help irrigators calibrate maintain and monitor soil moisture sensors at 17 sites throughout the watershed. These sensors provide instant soil moisture and temperature readouts at each field. Data recorders collect moisture readings from several depths and provide a permanent record for year-to-year comparisons. New options are now available for instant reporting to cell phones where coverage is adequate. Contact Clancy Jandreau if you are interested in sensors for your fields.



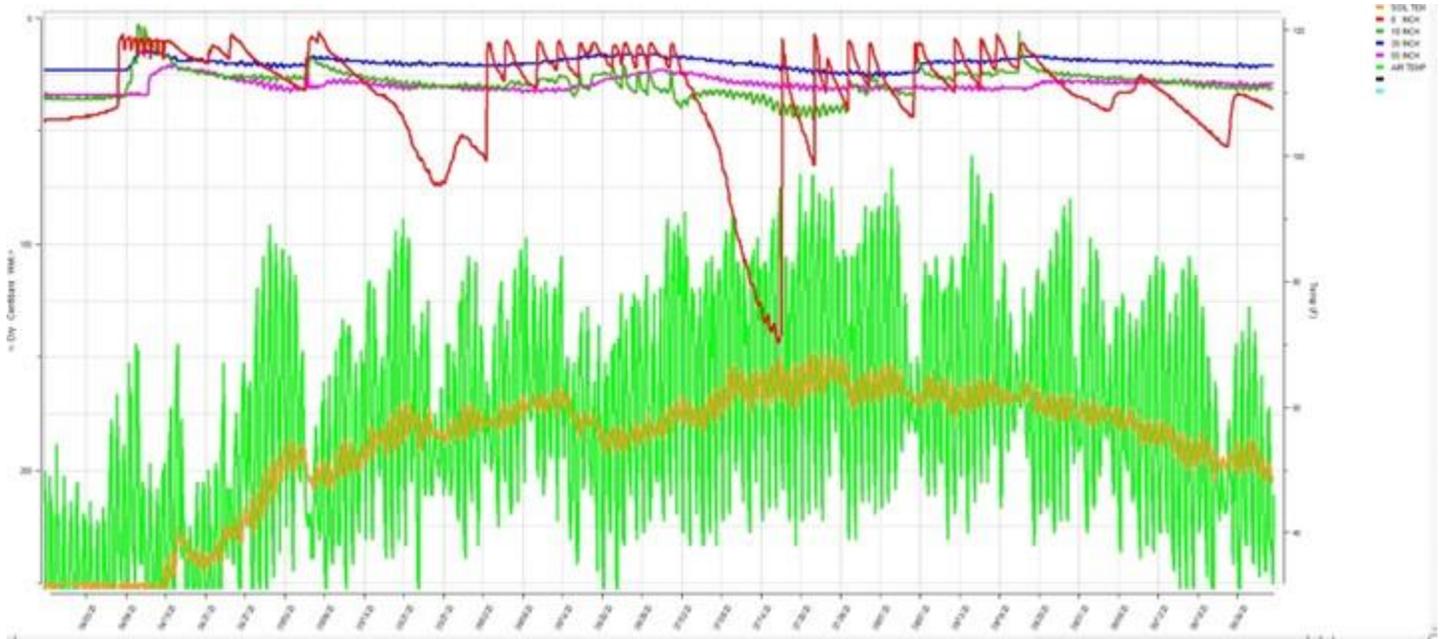
The chart below shows a slight drying of the surface foot (red line) and second foot (green) of soil through mid-May when it was boosted by a rainstorm. In late May soil moisture dropped in all layers (smaller dip) before being boosted by irrigation which kept it high until hay cutting in mid-July when it dropped considerably (large dip). Irrigation then kept soil moisture high in all levels until the end of the season. The fact that all three sensors fluctuate shows that the crop has deep roots and is using moisture to at least 3 feet. We continue to encourage deep irrigation to promote deep root growth.

*Example Soil Moisture and Temperature Graph from April 1 to September 30*



The chart below shows an example where the crop is mostly shallow-rooted and is only using soil moisture in the first foot of soil (red). The second foot (green), third foot (blue) and fifth foot (purple) soil moisture sensors show much less variation. This irrigator is now trying to “train” his roots to go deeper by letting the surface dry out at times during the season.

*Example Soil Moisture and Temperature Graph from April 1 to September 30*



## Soil Health and Biochar

The Challenge is providing technical and logistical assistance to a Biochar project sponsored by the Nature Conservancy, Forest Service, BLM and University of Montana. Biochar is a potential soil amendment that can increase soil water and nutrient holding capacities. It also promotes microbial activity which increases nutrient availability and productivity. But its greatest potential may be to sequester carbon in a form that lasts for thousands of years.

Biochar was delivered to five fields in the watershed, mixed with compost donated by Missoula Compost and applied to 100 foot square plots. Some sites also applied compost without biochar to adjacent plots for comparison. We invite everyone interested in Soil Health to join the Soil Health listserv and receive announcements about this important topic. Anyone who wants to sign up can email Brad (brad@ [blackfootchallenge.org](mailto:brad@blackfootchallenge.org)).



## **Climate Change Has Potential Benefits and Challenges for The Blackfoot Watershed**

Climate change is one of man's biggest challenges. The Blackfoot watershed continues to see a significant increase in the amount of water it takes to irrigate a crop (Figures 1 & 4). As temperatures continue to climb, irrigation systems and practices will need adjustments to apply more water, more quickly or more frequently with less loss. However, these increased temperatures will also mean a **longer growing season and more crop choices** for irrigators that have sufficient water. Some scientists believe that our area will become hotter but also wetter. This would be great for the Blackfoot watershed and would allow increased crop production and crop choices.

Some challenges will include more frequent drought conditions and maintaining late-season streamflows for the fish and recreationists. Water rights are now fully adjudicated in the watershed but that adjudication was based on crop water needs that are increasing. Future irrigators will need to adopt additional water conservation measures, irrigate less acres, change crop types or varieties that use less water or other options. Junior water rights may receive less water less often and may not get water in all years.

As population grows, it's likely we will see downstream water users interested in leasing/purchasing water from Blackfoot irrigators. Similar efforts in other states have pumped huge sums of money into increasing irrigation efficiency to continue crop production while freeing up water for downstream leasing. I expect this may become a significant income source for local irrigators.

### **Cool+Wet Early Season Conditions Seems to Produce the Best Crops?**

Based on our experience over the past 14 years, it seems that the best years for crop production are those that start out cool and wet, especially into June. ***It seems that local crops do better when they have abundant soil moisture through a combination of lower crop water use due to cool/wet conditions and regular contributions from rain and irrigation.*** When conditions are cool and wet in April – June, it's easier for irrigators to keep up with crop water use since it is low. Rain and irrigation is also more effective (more actually goes into the soil+crop and less evaporates). This reduces or eliminates any stress periods and encourages crops to grow to their full potential.

### **Best Management Strategy for Blackfoot Irrigators**

We continue to refine an over-all Best Management Strategy for both individual irrigators and water management across the entire drainage. We combine experience from the best local irrigators with irrigation science to fine-tune recommendations. 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 strategy is condensed into our irrigation calendar (page 8) and its main points are:

- early evaluation of the coming irrigation season in April – pay attention early,
- heavy irrigation early in the season to fill up the soil water holding capacity,
- heavy irrigation throughout May and June up to first cutting in early-mid July
- reduced irrigation or no irrigation during low water flows in late July and September
- taking advantage of available water in wet years for 2<sup>nd</sup> cuttings, new plantings, cover crops and to help fields recover from extremely dry conditions

In dry years, irrigators who applied water early and kept pouring it on up until haying in mid-July had excellent crops. In moist years like 2020, irrigators who took advantage of the abundant moisture and longer growing season had great production, great second cuttings and abundant fall pasture. There is little doubt that the future will only get more challenging for Blackfoot irrigators. However, there 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 so enjoy it!

## THE BLACKFOOT WATERSHED 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, start irrigating if dry.



### 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- BE DROUGHT AWARE!

- Stop irrigating if you can during drought periods or irrigate less often.
- 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 watershed, especially in drought years.
- Reduce river withdrawals by rotating systems and reducing the amount of irrigation at one time. This is the least efficient time to irrigate (lots of water lost to evaporation) so don't irrigate unless you need to.



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

- Stop irrigating if you can during drought periods.
- 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.