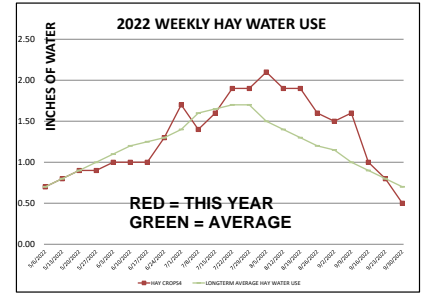




BLACKFOOT CHALLENGE IRRIGATION SCHEDULING PROGRAM ANNUAL REPORT 2022

Barry Dutton Soil Scientist



PROGRAM SUMMARY

This is our 13th 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 basin-wide 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 four years we also 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 that can provide both good crop production and adequate late-season stream flows during dry years.

2022 HIGHLIGHTS

- Snowpack started out average May 1 then increased to 400% of average in late June due to cool temperatures and more snowfall.
- April was dry and warm. May and June were both cool and moist while July through September were extremely hot and dry. We went 6 weeks with no rain in July/Aug.
- 5-8 inches of rain fell on Blackfoot croplands during the 2022 growing season depending on location, mostly early-season (the historic average is about 7 inches).
- Soil moisture was high at the start of March, dried throughout April then remained high during May and June. It plummeted in early July unless well-irrigated.
- 2022 potential crop water use in inches was way above average: hay = 30, pasture = 25, grains = 16-22. Crop water use in July, August and September was the highest ever. The Deer Lodge Agrimet weather station recorded the highest crop water use in its 18 years of record.
- Despite a cool/moist early season and hot/dry late season, most local irrigators managed to have another good year for crop production, some with the highest yields ever.
- Blackfoot River stream flows were average or better until early August when the 700 CFS drought trigger was reached and drought plans were implemented for the rest of the season. Drought plans appeared to be effective at reducing the downward trend in streamflows.
- More Blackfoot irrigators installed soil moisture monitoring equipment and expanded soil health practices.
- Biochar comes to Blackfoot ag lands with the start of a demonstration project to make and apply biochar.

BLACKFOOT CHALLENGE WEEKLY IRRIGATION REPORT
Friday August 5, 2022

HOTTEST WEATHER THIS YEAR
The heat wave continues to dominate the week with temperatures in the 100s and 110s. The heat wave is expected to continue through the weekend. The Blackfoot River stream flows are low and the water is very hot. The heat wave is a major concern for the crops and the soil. The heat wave is a major concern for the crops and the soil. The heat wave is a major concern for the crops and the soil.

CROP WATER USE - ABOVE AVERAGE WITH HOT WEATHER
Crop water use continues to be above average due to hot weather. Many crops will require water about 2 inches and some will require more. Some crops will require 3 inches of water.

Crop	Water Use (Inches)
Hay	30
Pasture	25
Grains	16-22

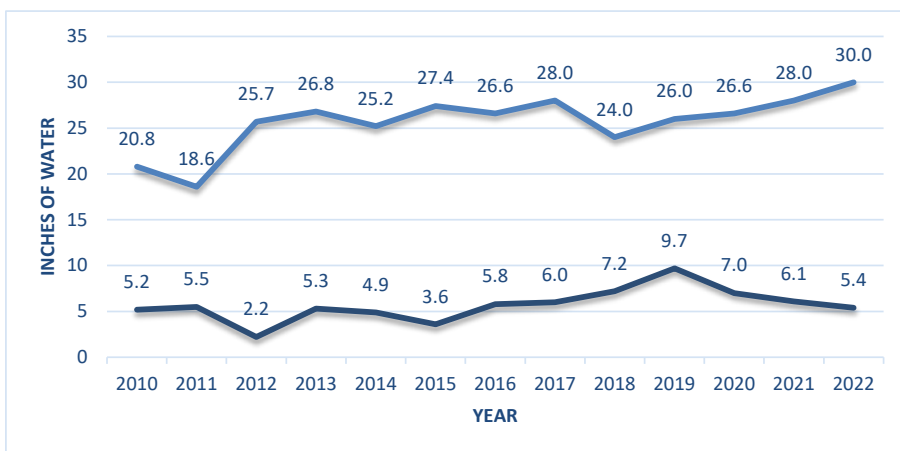
SOIL MOISTURE - AGAIN DROPS 2 INCHES UNLESS IRRIGATED OR OUT
Soil moisture has dropped 2 inches since the last report. The soil is very dry and the crops are stressed. The soil is very dry and the crops are stressed. The soil is very dry and the crops are stressed.

2022 WEATHER

2022 was an odd and extreme year for weather. Things looked quite average until early May when it turned especially cool with abundant rain and snowfall. This lasted until early July when a switch flipped to unusually hot and dry conditions. We went 6 weeks with no rain and had temperatures that reached 100F in August. Rainfall for the entire season was below average at most sites and was concentrated in May and June (**Figure 1**). **Figure 3** lists weekly rainfall throughout the 2022 season. Remember that this rainfall figure is an average for croplands across the drainage and varies 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 way above average until mid-September. The snowpack on May 1 was 96% of average (last year was 102% of average). It increased dramatically with late snowfall throughout May and June, topping off at 400% of average in mid-June.

The NRCS water supply forecast seemed to choke in late June reporting Blackfoot watershed snowpack at 15,000% of average.

FIGURE 1. POTENTIAL CROP WATER USE FOR HAY AND GENERAL GROWING SEASON RAINFALL IN THE BLACKFOOT DRAINAGE 2010-2022



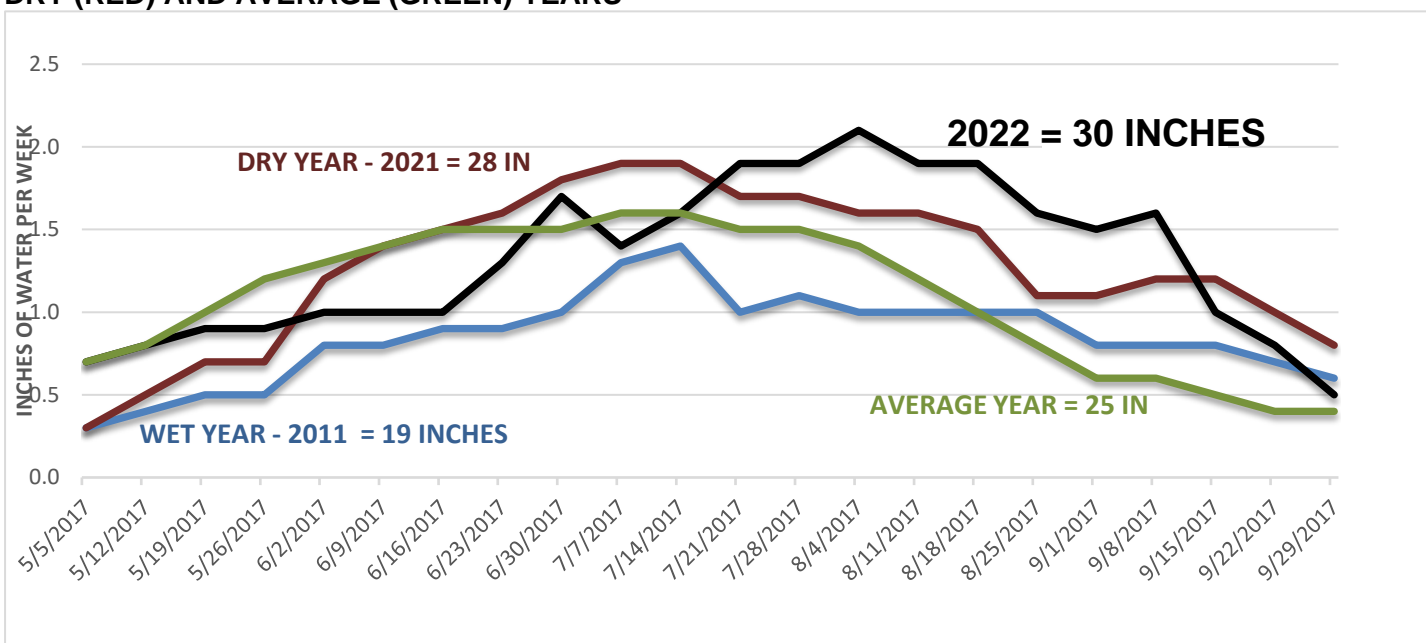
2022 POTENTIAL CROP WATER USE APRIL 1 TO OCTOBER 1 = 30 INCHES
 This is an average across the entire watershed and does not vary as much as rainfall at individual sites. It shows a steady increase over these 13 years.

2022 CROPLAND RAINFALL APRIL 1 TO OCTOBER 1 = 5.4 INCHES
 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.

2022 CROP WATER USE

Figure 1 shows that rainfall was below average in 2022 and weekly crop water was above average. Figure 2 shows weekly hay water use in 2022 (black line) started out below average (green line) in May through mid-June then rose above average and stayed above average until mid-September. Crop water use from late July through mid-September was the highest ever. Daily crop water use for alfalfa hay and small grains reached **1/4 to 1/3 inch per day** during this period. Irrigators struggled to boost soil moisture throughout 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 2022 (BLACK) COMPARED TO WET (BLUE), DRY (RED) AND AVERAGE (GREEN) YEARS



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 2022 IRRIGATION SEASON FOR ALL CROPS INCLUDING COMPARISONS TO AVERAGE, HOT AND COOL WEEKS

BLACKFOOT 2022 GROWING SEASON WEEKLY RAINFALL & CROP WATER USE (INCHES OF WATER)											
WEEK ENDING	RAIN ¹	2022 WEEKLY POTENTIAL CROP WATER USE ²						AVERAGE WEEKLY CROP WATER USE ³			
	RAIN	HAY CROPS ⁴	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	1.25	1.00	1.00	0.00	0.00	1.00	1.00				
5/6/2022	0.25	0.70	0.60	0.10	0.00	0.80	0.80	0.70	1.00	0.40	
5/13/2022	0.01	0.80	0.70	0.20	0.00	0.90	0.90	0.80	1.10	0.60	
5/20/2022	0.10	0.90	0.80	0.40	0.20	1.00	0.90	0.90	1.20	0.70	
5/27/2022	0.20	0.90	0.80	0.70	0.50	1.00	0.90	1.00	1.30	0.70	
6/3/2022	0.10	1.00	0.80	0.80	0.60	1.10	0.90	1.10	1.50	0.80	
6/10/2022	0.50	1.00	0.80	0.90	0.70	1.10	0.90	1.20	1.70	0.80	
6/17/2022	0.75	1.00	0.80	1.10	0.90	1.10	0.90	1.25	1.90	0.90	
6/24/2022	1.00	1.30	1.10	1.30	1.20	1.30	1.20	1.30	2.00	1.00	
7/1/2022	0.01	1.70	1.40	1.60	1.70	1.70	1.60	1.40	2.00	1.00	
7/8/2022	0.75	1.40	1.20	1.60	1.60	1.50	1.30	1.60	2.10	1.10	
7/15/2022	0.01	1.60	1.30	1.70	1.70	1.30	1.50	1.65	2.20	1.10	
7/22/2022	0.01	1.90	1.60	2.10	2.10	1.00	1.80	1.70	2.20	1.10	
7/29/2022	0.01	1.90	1.60	2.20	2.20	0.50	1.80	1.70	2.20	1.10	
8/5/2022	0.01	2.10	1.70	2.40	2.40	0.00	2.00	1.50	2.20	1.00	
8/12/2022	0.01	1.90	1.60	1.90	2.00	0.00	1.80	1.40	2.20	1.00	
8/19/2022	0.01	1.90	1.50	1.50	1.80	0.00	1.80	1.30	2.00	0.90	
8/26/2022	0.25	1.60	1.30	0.80	1.20	0.00	1.60	1.20	1.80	0.90	
9/2/2022	0.10	1.50	1.10	0.20	0.80	0.00	1.30	1.15	1.60	0.70	
9/9/2022	0.01	1.60	1.20	0.00	0.20	0.00	1.40	1.00	1.40	0.60	
9/16/2022	0.20	1.00	0.80	0.00	0.00	0.00	0.90	0.90	1.40	0.50	
9/23/2022	1.00	0.80	0.50	0.00	0.00	0.00	0.70	0.80	1.20	0.50	
9/30/2022	0.10	0.50	0.30	0.00	0.00	0.00	0.50	0.70	1.00	0.40	
TOTAL	5.39	30.00	24.50	21.50	21.80	15.30	28.40	26.25	37.20	17.80	

¹ 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) (This rainfall figure is an average across all Blackfoot croplands - use your own rain gauge for better accuracy)

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

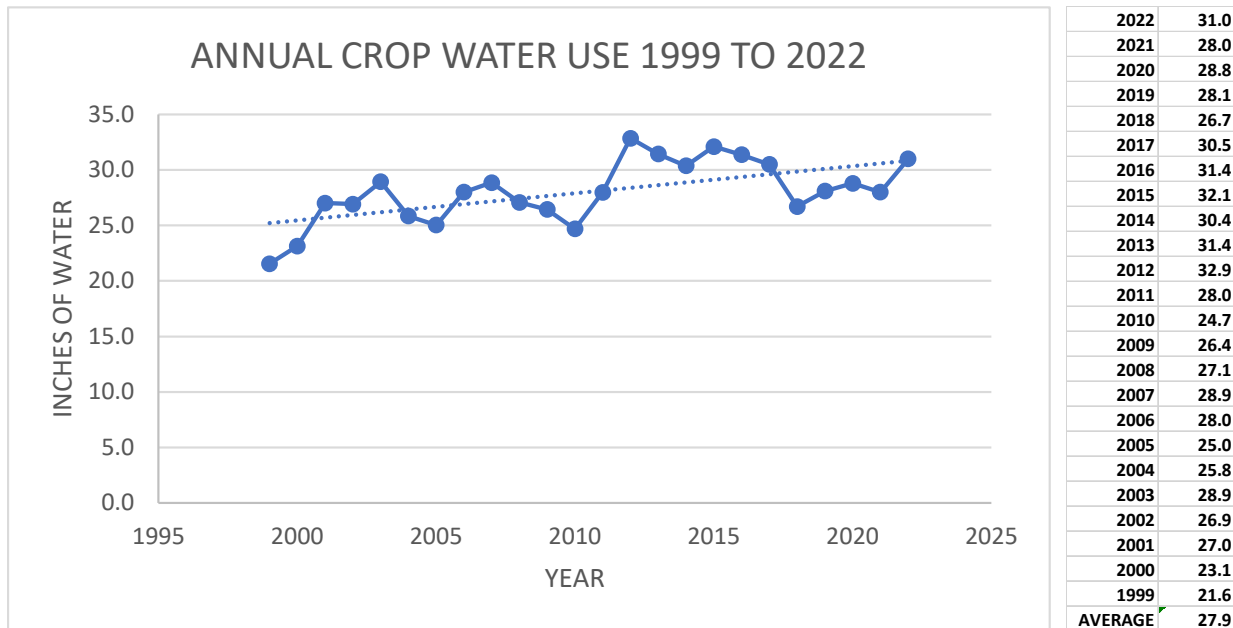
³ **Longterm average** water use for each crop each week based on long-term historic data.

⁴ Hay Crop water use drops approximately 2/3 the first week after cutting, 1/2 the second and 1/3 the third.

CROP WATER USE TRENDS

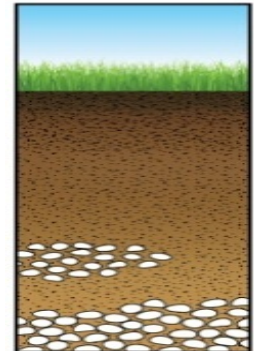
Potential crop water use for hay in 2022 was about 30 inches, which is above the 28 inch average over the past 13 years of this program (**Figure 1**). There is a **general increase in crop water use across all years** with 2018 the most recent dip. This trend of increasing crop water use is also reflected 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.

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>



2022 SOIL MOISTURE

Early season soil moisture in 2022 was similar to last year, starting out near field capacity (full) in early March. A relatively dry March and April saw soil moisture drop slightly by May 1 but then it was boosted in most fields by cool, rainy conditions until late-June. Rain, cool temperatures and below-average crop water use made it easier for irrigators keep soil moisture high during this period. A dramatic change to hot/dry conditions in late-June caused soil moisture to drop quickly in fields not irrigated. These conditions presented a challenge to irrigators trying to keep soil moisture levels high but those who did saw a great response in production. Hot conditions presented a special challenge for increasing soil moisture after cutting, especially when drought response measures were implemented.



2022 DROUGHT

The potential for drought this year was NOT evident early because of a strong snowpack, abundant rainfall and cool conditions. In May and June the snowpack ranged from 96% to 400%. However, by early August, hot and dry conditions caused the Blackfoot Challenge Drought Response Plan to be implemented. Notices were sent out to participating irrigators that they should initiate their individual drought plans. Blackfoot streamflows at Bonner dropped below the 700 CFS trigger level in early August and the 600 CFS level in mid-August. Scattered rain in late August provided a temporary boost to streamflows but they then dropped again toward the 500 CFS level. This drop then stabilized about the 500 CFS level despite no additional rain. This suggests that drought response measures and not rainfall were responsible for preventing further streamflow declines. Our 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!

2022 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 drought concerns, irrigation during cooler periods (May) and during hotter weather (June – 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

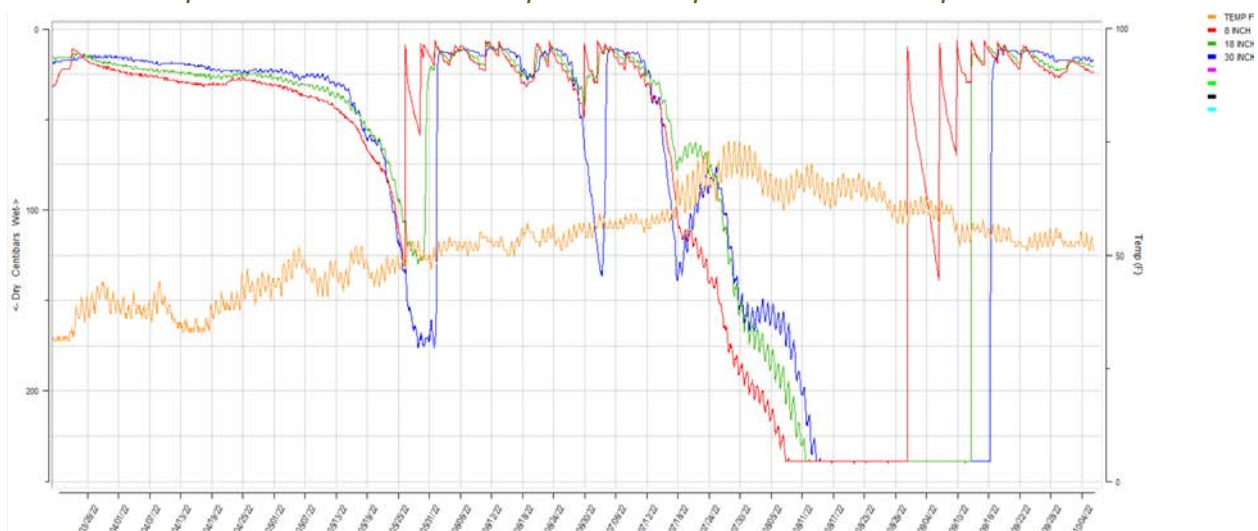
In 2022 the Challenge helped install and calibrate soil moisture sensors at 3 more locations bringing our total to 17. These sensors provide instant soil moisture and temperature readouts at each field. Data recorders collect moisture readings from several depths and provide a permanent record. These charts show the effects of individual irrigations including the depth of water penetration and how long before its depleted by crop use.



Soil moisture sensors are installed at 8, 18 and 30 inches to represent the 1st, 2nd and 3rd foot of soil. We also added soil moisture sensors at 54 inches (the middle of the 5th foot of soil) to evaluate how deeply irrigation is penetrating local soils. One goal of soil health is encouraging deep root penetration to grow your crop in a larger volume of soil. This provides more water and nutrient storage and a larger population of worms, nematodes, fungi and microbes to work for you making nutrients available. The Blackfoot Challenge assists with equipment costs, installation and calibration of sensors as well as training in how to interpret and use the results. Contact Clancy Jandreau if you are interested.

The example chart below shows a gradual drying of all soil layers from March through late May when irrigation began. Irrigation boosted soil moisture in all levels until haying in July. Soil moisture was then allowed to be exhausted until irrigation resumed the end of August. You can see that moisture is used first from the surface foot (red) then the second foot (green) and then the third foot (blue). The reverse occurs when irrigation water is applied with the red increasing first and then the lower layers.

Example Soil Moisture and Temperature Graph from June to September



Soil Health and Biochar

Soil Health continues to be a popular local topic, not just the worms and nematodes but the practices that encourage them. Blackfoot farmers and ranchers continue to try different grazing, harvesting, tilling, irrigating and other techniques. This year the Challenge began a cooperative Biochar project with the Nature Conservancy, Forest Service, BLM and University of Montana. Currently there are limited options in the Blackfoot watershed for adding organic matter and active biological products to ag fields. The carcass removal and small composting program is the only local source. We simply don't have the large-scale dairy and food processing operations that provide large quantities of soil amendments in other areas. However, one thing we do have is a local forest landscape that produces large amounts of wood waste that is usually burned in slash piles.



Biochar has the potential to give local landowners a new soil amendment option. Biochar looks like granulated charcoal and is made by heating organic matter with limited oxygen. It's used as a soil amendment to increase water and nutrient holding capacity as well as biological activity. Biochar is likely to become an important method to sequester carbon in soils and fight climate change. It lasts in soils for hundreds to thousands of years, unlike regular organic matter which is quickly decomposed by soil organisms. Slash from timber harvests is an obvious potential local source of biochar. This could improve soil health while reducing air pollution and greenhouse gas emissions from slash burning. There are many studies and field trials being conducted around the world to examine the potential for biochar.



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 (jennifer@blackfootchallenge.org) or Brad (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 we now see 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.

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 June and up to first cutting in early-mid July
- reduced irrigation or no irrigation during low water flows in late July to September
- taking advantage of available water in wet years for 2nd 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.