



BLACKFOOT CHALLENGE IRRIGATION SCHEDULING PROGRAM ANNUAL REPORT 2021

Barry Dutton Soil Scientist



PROGRAM SUMMARY

This is our 12th 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 three years we also helped install, calibrate and use soil moisture sensors for instant readings by irrigators and 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. This year our snowpack started out on May 1 slightly below average and rainfall was also below average throughout the growing season. Drought conditions were widespread and severe across Montana and the western US during most of the year but the Blackfoot Drainage avoided drought until late in the season. Drought management planning and the cooperation of irrigators were successful in slowing the downward trend of stream flows in September.

2021 HIGHLIGHTS

- 6-8 inches of rain fell on Blackfoot croplands during the 2021 growing season depending on location (the historic average is about 7 inches).
- Early season soil moisture was not as good as last year with most soils having only 50-75% of their water holding capacity on May 1. Soil dried out considerable in April.
- April was dry and warm. May was cool and moist, then warm/dry conditions persisted throughout June and July. August and September had only a little rain and warm conditions which reduced stream flows to drought levels.
- 2021 potential crop water use in inches was above average:
hay = 28, pasture = 23, grains = 16-22
- Despite lower initial soil moisture levels, snowpack, and rainfall, local irrigators managed to have another good year for crop production, especially compared with the rest of the state.
- Blackfoot River stream flows dipped below average in mid-June and stayed that way for the remainder of the growing season. Drought Response Plans were triggered by low flows in mid-August with the Drought Committee meeting regularly and encouraging irrigators to reduce diversions. Call was made on junior irrigators throughout the drainage and many senior irrigators reduced diversions voluntarily.
- More Blackfoot irrigators installed soil moisture monitoring equipment and expanded soil health practices.

2021 WEATHER

2021 was not as good a year as the last three for great crop weather but conditions were considerably better than the rest of the state. The snowpack on May 1 was 102% of average (last year was 125% of average) and dropped to 92% May 7. There was significant rainfall throughout May but June and July had little rain and warm temperatures. Rainfall for the May 1 to September 30 period was about average overall (**Figure 1**). **Figure 3** lists weekly rainfall throughout the 2021 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.

BLACKFOOT CHALLENGE WEEKLY IRRIGATION REPORT

Friday May 28, 2021

Last week gave us snow, rain and cool temperatures but next week will be warm and sunny so send back as crop spring from the ground. Most Blackfoot croplands had about 2 inches of rain this week and some snowflakes. Surface soil moisture levels rose significantly and it proved a great time to irrigate soils to their full moisture holding capacities.

The snowpack jumped from good (96% of average) to great (140%). Streamflows surged above average and will increase further with warm weather this week. There appears to be plenty of water for early season irrigation and storage but predicted hot, dry weather could change that later on. The NOAA US Drought Monitor Map shows all Blackfoot croplands to be out of drought conditions!

WEATHER - MONSOON/SNOWSTORM TURNS TO SUN AND WARMTH

Cool, wet weather last week raised the 30-day rainfall to 170% of normal for the Blackfoot. This week will be mostly sunny with highs in the 70s and 80s. Lows will be in the 40s. The 30-day forecast says above average rainfall and average temperatures. The 90-day forecast says below average rainfall and above average temperatures.

CROP WATER USE - LOW LAST WEEK, JUMPING NEXT

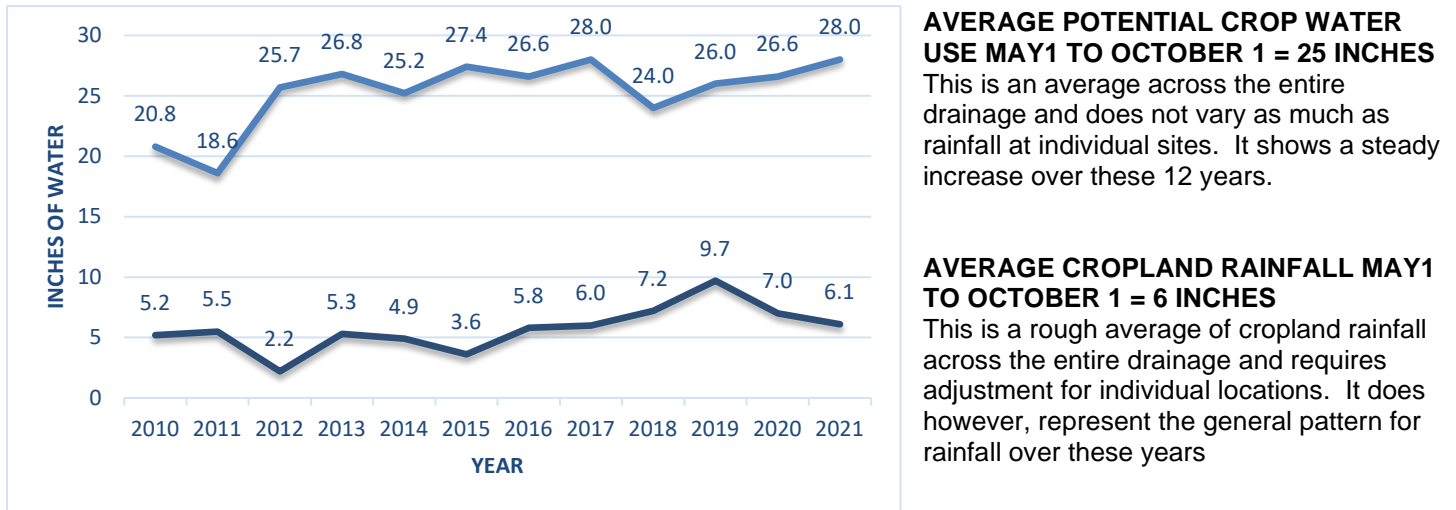
Last week, crop water use remained below average due to cool weather and slow crop development. This coming week that should change with warm sunny weather. Hay crops used less than 7% of an inch of water last week and will use about 1 inch next week. Note that in these early season reports, we list a range of crop water use for spring grains planted at different dates. Crop water use will even out as spring grains mature. The table below provides a quick summary of crop water use this last week and an estimate for next week.

WATER USE BY CROPS	LAST 7 DAYS	NEXT 7 DAYS	SEASON TOTAL
HAY CROPS	0.7	1.8	13
PASTURE	0.8	1.8	11
SPRING GRAINS	0.2-0.5	0.4-0.8	10-11
WINTER WHEAT	0.8	1.1	14
LAWN	0.7	1.8	13

*Seasonal water use and the next week's crop water use are estimates based on data that assumes irrigation and other water use. The data is based on the 2021 season and is not intended to be used for comparison with other years. The data is based on the 2021 season and is not intended to be used for comparison with other years.

Temperatures were above average in April, below average in May and then above average the remainder of the growing season, even in September.

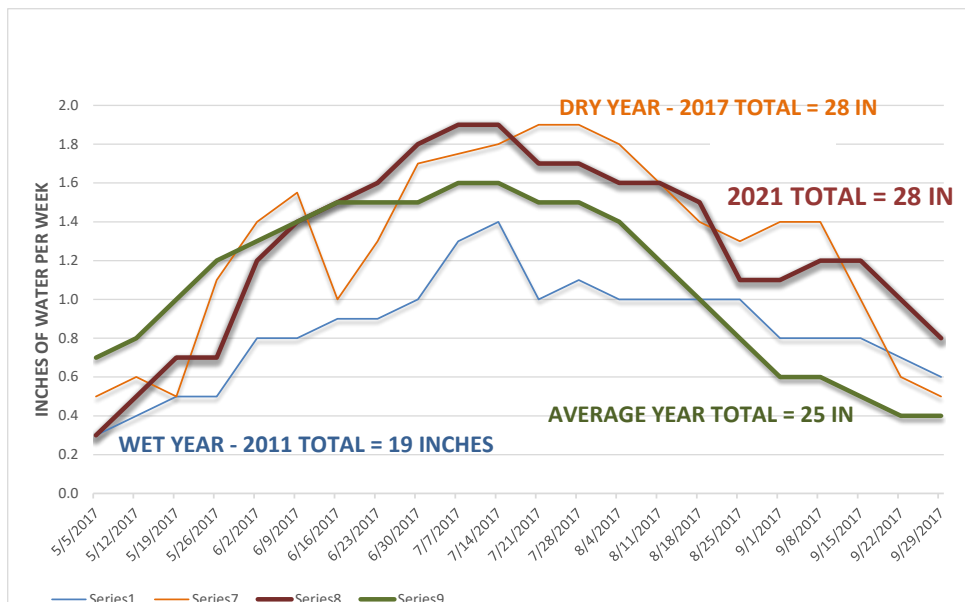
FIGURE 1. AVERAGE GROWING SEASON RAINFALL AND POTENTIAL CROP WATER USE FOR HAY IN THE BLACKFOOT DRAINAGE 2010-2021



2021 CROP WATER USE

Figure 1 shows that rainfall was average in 2021 and weekly crop water was above average. Figure 2 shows weekly hay water use started out below average in May then rose above average in early June and stayed above average the remainder of the season. Crop production was generally good although not as good as last year. Irrigators struggled to boost soil moisture following cutting and later in the season due to hot, dry weather.

FIGURE 2. WEEKLY POTENTIAL HAY WATER USE IN 2021 (RED) COMPARED TO WET (BLUE), DRY (ORANGE) AND AVERAGE (GREEN) YEARS



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 due to water availability, fertilizer, stand quality, micro-climate, management style, and many other factors.

FIGURE 3. POTENTIAL WEEKLY CROP WATER USE THROUGHOUT THE 2021 IRRIGATION SEASON FOR ALL CROPS INCLUDING COMPARISONS TO AVERAGE, HOT AND COOL WEEKS

BLACKFOOT 2021 GROWING SEASON WEEKLY RAINFALL & CROP WATER USE (INCHES OF WATER)										
WEEK ENDING	RAIN ¹	2021 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
5/7/2021	0.40	0.30	0.40	0.00	0.00	0.50	0.50	0.60	1.00	0.30
5/14/2021	0.20	0.50	0.50	0.10	0.00	0.70	0.70	0.70	1.10	0.40
5/21/2021	0.50	0.70	0.60	0.30	0.10	0.80	0.80	0.90	1.20	0.50
5/28/2021	2.00	0.70	0.60	0.60	0.20	0.80	0.70	1.00	1.30	0.50
6/4/2021	0.10	1.20	1.00	0.90	0.60	1.30	1.20	1.10	1.50	0.60
6/11/2021	0.10	1.40	1.20	1.10	0.80	1.50	1.30	1.20	1.70	0.70
6/18/2021	0.20	1.50	1.30	1.40	1.10	1.60	1.40	1.25	1.90	0.70
6/25/2021	0.20	1.60	1.40	1.60	1.40	1.70	1.50	1.30	2.00	0.80
7/2/2021	0.10	1.80	1.50	1.90	1.70	1.90	1.70	1.40	2.00	0.90
7/9/2021	0.01	1.90	1.60	2.00	2.00	2.00	1.90	1.60	2.10	1.00
7/16/2021	0.01	1.90	1.60	2.00	2.00	1.50	1.90	1.65	2.20	1.00
7/23/2021	0.25	1.70	1.40	1.80	1.80	1.00	1.60	1.70	2.20	1.00
7/30/2021	0.01	1.70	1.40	1.90	1.90	0.50	1.60	1.70	2.00	1.00
8/6/2021	0.25	1.60	1.30	1.80	1.80	0.20	1.50	1.50	1.80	0.90
8/13/2021	0.25	1.60	1.30	1.80	1.80	0.00	1.50	1.40	1.70	0.80
8/20/2021	0.25	1.50	1.20	1.50	1.70	0.00	1.40	1.30	1.60	0.80
8/27/2021	0.50	1.10	0.90	0.90	1.20	0.00	1.00	1.20	1.40	0.70
9/3/2021	0.25	1.10	0.80	0.40	0.60	0.00	1.00	1.15	1.40	0.70
9/10/2021	0.01	1.20	0.90	0.00	0.20	0.00	1.10	1.00	1.30	0.60
9/17/2021	0.01	1.20	0.90	0.00	0.00	0.00	1.10	0.90	1.20	0.50
9/24/2021	0.25	1.00	0.70	0.00	0.00	0.00	0.90	0.80	1.10	0.50
9/30/2021	0.20	0.80	0.50	0.00	0.00	0.00	0.70	0.70	1.00	0.40
TOTAL	6.05	28.00	23.00	22.00	20.90	16.00	27.00	26.05	34.70	15.30

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.

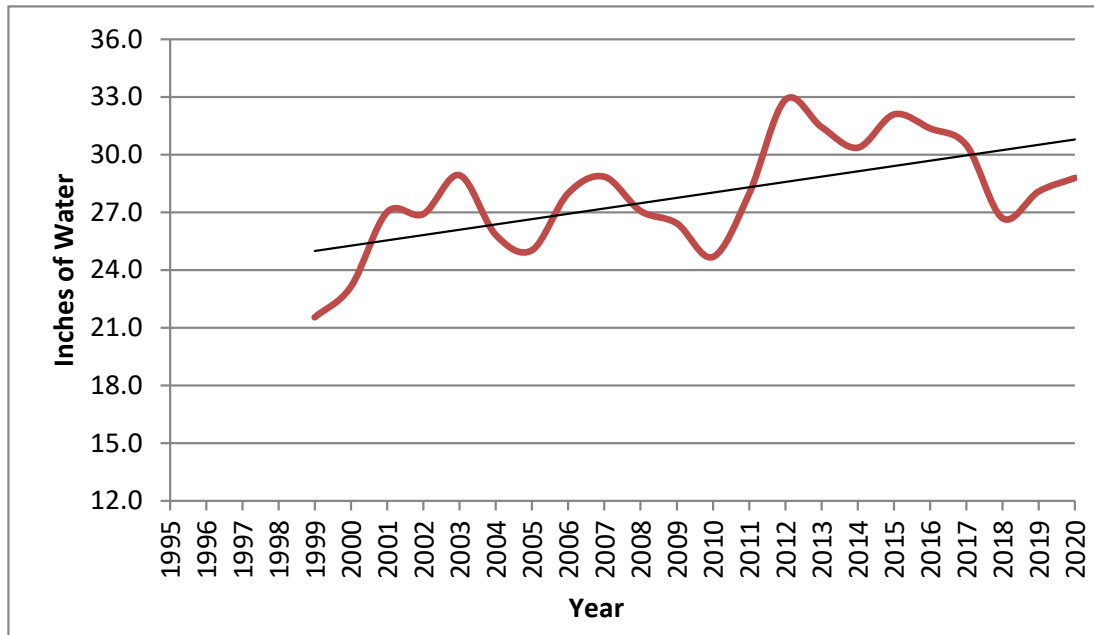
CROP WATER USE TRENDS

Crop water use for hay in 2021 was about 28 inches, above the 25 inch average over the past 12 years of this program. Nine of the last 12 years have had above average crop water use (**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 average crop water use for hay is now 25-28 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 drainage it will

be increasingly important for irrigators 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 20 YEARS. Data from Deer Lodge Agrimet Weather Station

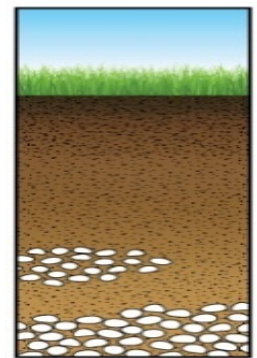
<https://www.usbr.gov/pn/agrimet/agrimetmap/drlmda.html>



2021	28.0
2020	28.8
2019	28.1
2018	26.7
2017	30.5
2016	31.4
2015	32.1
2014	30.4
2013	31.4
2012	32.9
2011	28.0
2010	24.7
2009	26.4
2008	27.1
2007	28.9
2006	28.0
2005	25.0
2004	25.8
2003	28.9
2002	26.9
2001	27.0
2000	23.1
1999	21.6
AVERAGE	27.9

2021 SOIL MOISTURE

Early season soil moisture in 2021 was lower than the last three years due to lower snowpack (102% on May 1) and warmer conditions in March and April which dried out the surface soil. At the beginning of May most local hay root zones held 50 to 75% of their water holding capacity versus over 75% last year. Rains, cool temperatures and below-average crop water use made it easier for irrigators to boost soil moisture in May. A lack of rain in June and July combined with higher temperatures and crop water use made it harder for irrigators to keep soil moisture up but those who made an effort saw good results in crop yields. Despite a little rain in August (about ¼ inch per week) high temperatures kept crop water use high and presented challenges for recharging soil moisture after cutting hay crops. Throughout late August and September, drought concerns reduced irrigation in many fields and soil moisture fell to lower levels across the drainage. Irrigators with good water rights and who had water available were able to boost soil moisture where needed for fall grazing, new plantings and to help plants recover from hot, dry conditions.

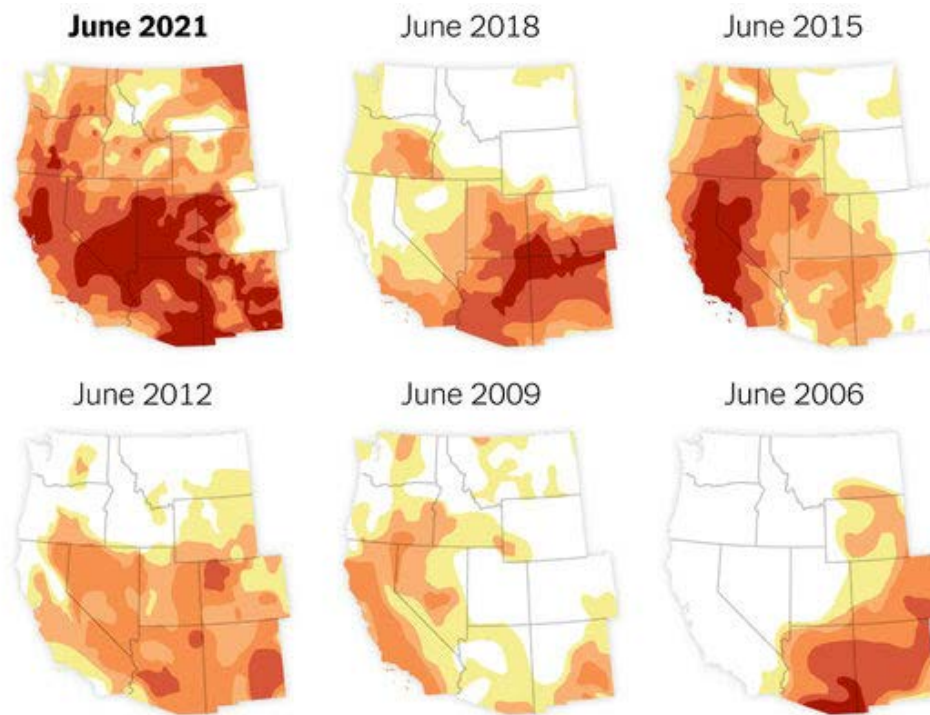


2021 DROUGHT

The potential for drought this year was evident early because of a rapidly diminishing snowpack. May 1 the snowpack was at 102% compared with 125% last year. In one week, it dropped to 92% on May 7. Rainfall in May was encouraging at over 3 inches but hot dry weather and high crop water use prevailed throughout most of the remaining irrigation season. Over an inch of rain fell in August but stream flows continued a downward trend. In late July, weekly irrigation reports began talking about drought planning and practices to help maintain stream flows. The drought committee began meeting

in late July and implemented the Blackfoot Challenge Drought Response Plan during the week ending August 20. Notices were sent out to participating irrigators that they should initiate their individual drought plans. Junior water right holders without a Blackfoot Challenge Drought Response Plan were notified by FWP that they should cease water diversions if their rights were junior to the departments Murphy Rights. Other senior water right holders throughout the drainage made call on junior rights as they usually do in most years. Our weekly irrigation reports illustrated stream flow conditions and continued to discuss irrigation options to reduce water diversions. The drought committee met regularly and Challenge staff encouraged irrigators to follow their drought plans.

Drought-related activities increased as stream flows dropped towards 500 CFS at Bonner. Although stream flows did not rebound significantly, it appeared that efforts were successful at halting the downward trend at about 500 CFS despite little rainfall in late August and throughout September. It is worth noting that the Blackfoot drainage had much less severe drought conditions in 2021 than the rest of the state and most of the western US. Drought conditions across the west were more widespread and severe than ever. Thanks to all those irrigators who cut back using water they are legally entitled to under our concept of “**shared sacrifice**” - it’s working!



2021 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 along with potential sources of drought financial assistance. We explained how the Blackfoot Challenge and others are keeping water in streams including a variety of programs. Other tips this year discussed soil health concerns, soil moisture monitoring equipment and fun topics like where did our water come from (Ringwoodite and Meteors?) and how is water and carbon distributed on earth.

Soil Moisture Sensor Program for Irrigators

In 2021 the Challenge helped install and calibrate soil moisture sensors at 2 more locations bringing our total to 14. These sensors provide instant soil moisture and temperature readouts at each field. In addition to instant readings, data recorders collect moisture data 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 Jennifer Schoonen if you are interested.

Example Soil Moisture and Temperature Graph from June to September



Soil Health

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 our soil health tour included representatives from local NRCS offices and Conservation Districts as well as a cross-section of local ranchers. Jim Stone gave an overview of Challenge efforts and practices throughout the drainage to improve soil health. Soil pits at the Iverson ranch revealed high-organic matter topsoil with excellent soil structure (dirt



clods). Kyle Kelley explained his sequence of practices employed to convert an extremely sod-bound field into a more productive and diverse crop. He also provided some entertaining anecdotes about the challenges of applying compost from the carcass collection program. It seems the current composting operation has produced more intact bones and skulls than expected which present a challenge when put into a manure spreader. Luckily his compost applications have not been an attractant to bears as initially feared. 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).

Biochar Comes to the Blackfoot Drainage?

Currently there are only limited options in the Blackfoot drainage 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 have is a robust local forest industry that produces large amounts of wood waste that is usually burned in slash piles. The Challenge is considering participation this year in a Biochar project with the potential to give local landowners a new soil amendment option. Biochar looks like granulated charcoal and is made by heating organic matter without oxygen. It's used as a soil amendment to increase water and nutrient holding capacity as well as having other benefits. Biochar may 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.



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 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, 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 drainage, 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.