BLACKFOOT CHALLENGE IRRIGATION SCHEDULING PROGRAM

ANNUAL REPORT

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SUMMARY

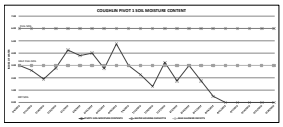
The Blackfoot Challenge Irrigation Scheduling Program provides information to help irrigators apply the right amount of water at the right time to meet crop goals. We work with individual irrigators to monitor weather, crops, irrigation and soil moisture across the drainage. Weekly reports give participants 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 and other information. This is the fifth year of the program and the first to focus on flood irrigation.

PROGRAM COMPONENTS

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

SOIL WATER HOLDING CAPACITY EVALUATION

The soil in each field is evaluated for how much water it will hold in the crop root zone and how it varies across the field. This is a major factor of irrigation and some local soils hold 2-3 times as much as others. This evaluation sets the upper limits for irrigation and soil storage.



SOIL MOISTURE MONITORING

Soil moisture is monitored throughout the growing season to evaluate the effects of rainfall, irrigation applications and crop water use. Crop stage, condition and other information is also recorded.

TRAINING

Interested irrigators can learn to evaluate soil texture, water holding capacity and water content during monitoring visits.

WEEKLY AND ANNUAL REPORTS

Weekly reports for participants are distributed each Friday by email and include:

- Past-week weather summary and prediction for next week, rain measured,
- Crop water use for each crop,
- Irrigation applied in each field,
- Soil moisture content in each field,
- Tips on irrigating, critical crop periods, drought strategies and other topics,
- Tables and charts of seasonal crop water use, rainfall and irrigations.

Weekly reports are emailed each week to approx. 100 irrigators and water managers throughout the drainage and are posted on the Challenge web site. These reports include information about weather, crop water use, irrigation and related subjects that all irrigators can use. They also provide irrigation tips, drought awareness and drought strategies based on current conditions and future predictions. Individual annual reports are provided each irrigator participant and a general report is compiled summarizing the overall program.

IRRIGATION GUIDE

An irrigation guide has been drafted and revised each year. This guide is adapted to the specific conditions of the Blackfoot Drainage for use by all irrigators and is a means of preserving current experience for the future. It summarizes information on irrigation system performance, crop water use, soils, critical growth periods, drought strategies and related topics. The guide is currently available on request and may appear on the Challenge web site soon and/or in print. In addition to the guide, a **one-page irrigation calendar** is distributed with weekly reports summarizing our most important seasonal suggestions (see page 7).

2014 PROGRAM HIGHLIGHTS

- Weekly reports distributed by email and posted on the Challenge web site
- 4 tests for application uniformity in flood irrigated fields
- 6 systems monitored for weekly soil moisture and crop water use totaling approximately 700 acres. These farms have a total of approximately 1500 acres of irrigation that this information will be applied on.
- Growing season rainfall on croplands: 5-7 inches (average = 6-8 inches)
- Potential crop water use in inches: hay=26, pasture=22, grains=16 (slightly higher than average)
- No over-irrigation among sprinkler irrigation participants – all applied less than crop water use
- Flood irrigation losses to deep percolation and tail-water were minimal. Tail-waters were used in downhill fields and seepage was returned to the shallow stream-side aquifer.
- The weather this year was relatively average for a change starting with temperatures slightly above average throughout the season.
- Additional information provided on flood irrigation, cattail control methods, fertilization, resource enhancement and other subjects
- River flows remained high enough that drought response plans were not needed this season.

2014 PROGRAM SUMMARY

This year's program included 4 irrigators with four flood systems and two pivot sprinkler systems covering approximately 700 acres. These four irrigators have a total of approximately 1500 irrigated acres on which this information will be applied. Each irrigator received weekly reports summarizing weather, crop water use and soil moisture conditions plus ideas for improving irrigation. Each irrigator was visited to evaluate soil moisture conditions and update the irrigation schedule. Interested irrigator participants from past years were visited once to determine soil moisture status at the start of the growing season.

Flood irrigation systems were evaluated and monitored for uniformity and soil moisture status and crop water use in a manner similar to sprinkler systems. Additional flood irrigation factors were also evaluated including:

- Water availability including streamflows and reservoir storage
- Diversion efficiency, measurement and fish friendliness
- Ditch system efficiency and leakage
- Return flow fate (tail water and seepage)
- Other issues identified by the irrigator
- Potential for water management projects

In addition, to working with individual irrigators, a general irrigation scheduling report covering the entire Blackfoot Drainage was compiled each week and emailed to approximately 100 interested parties. These parties included irrigators and other water users, drought managers, government agencies, conservation groups and individuals.

2014 WEATHER

Compared with past years of extremely wet/cold (2011) and dry/hot (2013) conditions, 2014 was somewhat average. Rainfall was an inch or so below average and temperatures were higher than average throughout most of the season. Most cropland soils started with about half of their water holding capacity this season. This means that a hay field on a clay soil which holds 6 inches in the 3 foot root zone had about 3 inches of stored moisture on May 1.

	2014	**AVERAGE**
Total (gross) growing season rainfall (May1-Sept30):	5-7 inches	6-8 inches
Effective (net) growing season rainfall:	3-5 inches	3-4 inches

An important lesson from this program is the dramatic difference between one year and the next. It seems increasingly important for irrigators to pay attention to spring conditions and weather predictions. Whether this is the same old story or a product of climate change is unknown but we seem to be getting warmer and more variable conditions. In the past few years the active part of the growing season has started anywhere from late-April to mid-June. This is when there is enough sun and warm temperatures to stimulate the crops full growing potential. This variation in the peak growing season can hurt production unless growers can be equally flexible. In 2011 when cool, cloudy, rainy conditions persisted into June, those who cut on their regular schedule had a smaller crop. Those who waited an extra week or two saw dramatic increases in production due to that wait. By comparison, in 2013 when warm, dry weather began in late April and persisted through June, those who irrigated early and took advantage of this warm period had much better crops than those who waited until their normal irrigation startup in late May or early June. The lesson is to look ahead and be more flexible.

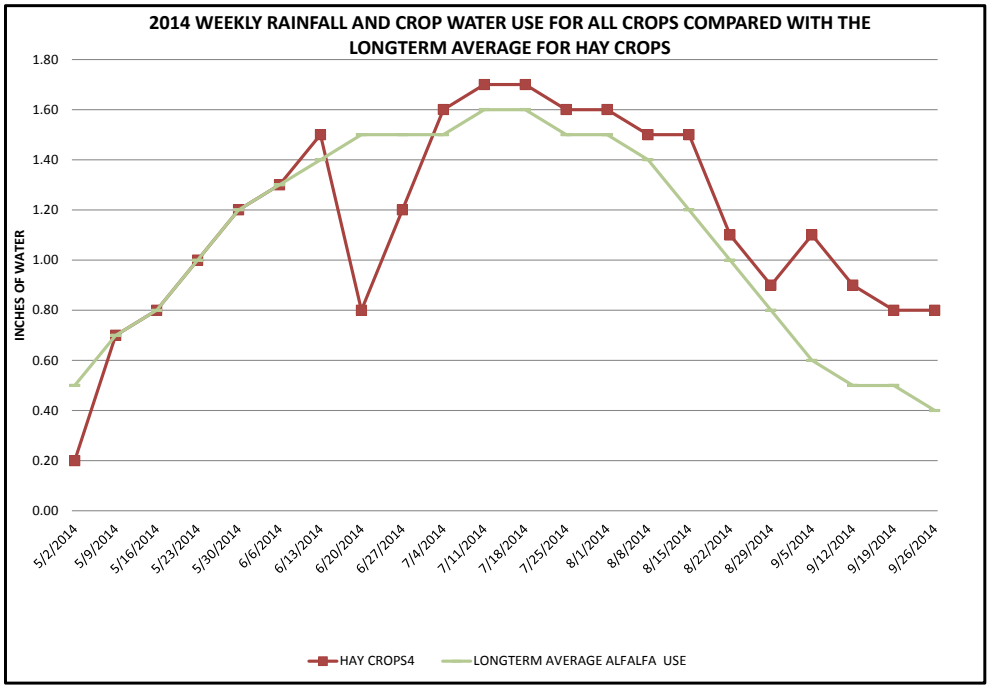
2014 UNIFORMITY TESTS

Uniformity is an important factor in irrigation and the goal is to apply water evenly with no dry spots or excessively wet areas. While uniformity can be easily measured under sprinkler

systems using rain gauges or other catchments, it is more difficult to evaluate in flood irrigation. Uniformity was evaluated on four flood-irrigated fields this year by observing water distribution during irrigation events and by determining soil moisture content following irrigation. These tests revealed good uniformity in all four fields with few excessively wet or dry areas. The best uniformity was observed in a nearly level field which had been leveled in the past to promote uniform irrigation. However, uniformity was almost as good in adjacent unleveled fields. We also followed-up with one of our past sprinkler irrigators who has serious uniformity problems caused by debris/moss. We confirmed that the screening system he installed solved the uniformity issue identified by our past uniformity tests.

2014 CROP WATER USE

Crop water use in 2014 is summarized on Page 7. This table was updated weekly and distributed to irrigators throughout the drainage. 2014 hay *potential* crop water use was approximately 26 inches compared with a long-term average of 23 inches. Pasture potential crop water use was approximately 22 inches and small grains 16 inches depending on planting date. *Potential* crop water use in 2014 was higher than average for all crops due to higher temperatures throughout the growing season. The chart below compares *2014 weekly hay water use* (red line) with the long-term average (green line). All crops in 2014 had similar higher-than-average water use.



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 limitations in water, 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, streamflows or other reasons (fishing?).

2014 SOIL MOISTURE

An average local irrigated soil holds about **4 inches of water in a 3-foot hay root zone** (1.5 inches in the first foot and 1.25 inches in the second and third feet). A rocky and sandy soil may hold less than three inches and a silty or clayey one as much as 6 inches in this same 3-foot root zone.

Early season soil moisture in 2014 was about average. Most local fields checked in early May (the start of the active growing season) revealed soil moisture contents of about ½ their full water holding capacity. Many irrigators had difficulty keeping soil moisture high due to higher than average crop water use throughout the season. 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 first 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.

2014 IRRIGATION TIPS

Irrigation tips were provided each week according to the 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 periods. Tips were expanded to include more flood irrigation concerns and to respond to irrigator questions. This year all participants received a summary report, a soil probe and a t-shirt with important points about local irrigation (see logo top of page 1). Participants also received a quick reference guide (pages 9-10) customized for each individual field. The next generation of our local irrigation guide is available on request and summarizes irrigation tips from over the years of this program.

2014 DROUGHT INFORMATION AND STRATEGIES

Dour weekly reports included streamflow information for the Blackfoot Rive. This year we did not reach critical streamflow levels and drought response efforts were not implemented.

WATER USE OPTIONS AND POTENTIAL FUTURE PROJECTS

Flood irrigators this season included individuals who wished to take a broader view of their potential water use options. We were asked to evaluate both the effectiveness of their irrigation and potential options for their future water use. These evaluations included water leasing, riparian vegetation improvement, wetland development, stream restoration, instream flow enhancement and other options.

Potential future water conservation projects were also identified including canal lining, piping and source substitution where water is lost in long leaky irrigation canals. Leakage is of most concern where it does not effectively recharge ground and surface waters. Potential stream restoration, instream flow enhancement, wetland mitigation, riparian restoration and water leasing projects were identified.

BLACKFOOT 2014 GROWING SEASON WEEKLY RAINFALL & CROP WATER USE (INCHES OF WATER)

	RAIN[1]	2013 WEEKLY POTENTIAL CROP WATER USE[2]						AVERAGE POTENTIAL CROP WATER USE[3]		
	RAIN	HAY CROPS[4]	PASTURE	SPRING GRAINS 5-15 START	SPRING GRAINS 5-30 START	WINTER WHEAT	LAWNS	LONGTERM AVERAGE ALFALFA USE	HOT WEEK ALFALFA HAY WATER USE	COOL WEEK ALFALFA HAY WATER USE
5/2/2014	0.10	0.20	0.20	0.00	0.00	0.20	0.20	0.50	0.80	0.20
5/9/2014	0.50	0.70	0.60	0.00	0.00	0.80	0.70	0.70	0.90	0.30
5/16/2014	0.30	0.80	0.70	0.00	0.00	0.90	0.80	0.80	1.00	0.50
5/23/2014	0.30	1.00	0.80	0.25	0.00	1.10	0.90	1.00	1.10	0.70
5/30/2014	0.10	1.20	1.10	0.75	0.00	1.30	1.10	1.20	1.20	0.80
6/6/2014	0.10	1.30	1.20	0.90	0.30	1.40	1.20	1.30	1.30	0.90
6/13/2014	0.10	1.50	1.25	1.25	0.75	1.75	1.40	1.40	1.50	1.00
6/20/2014	1.25	0.80	0.70	0.80	0.60	0.80	0.80	1.50	1.70	1.10
6/27/2014	0.50	1.20	1.00	1.40	1.00	1.40	1.10	1.50	1.90	1.10
7/4/2014	0.10	1.60	1.40	1.75	1.50	1.50	1.50	1.50	2.00	1.20
7/11/2014	0.00	1.70	1.50	1.80	1.80	1.40	1.60	1.60	2.10	1.30
7/18/2014	0.00	1.70	1.50	2.00	2.00	0.80	1.60	1.60	2.00	1.20
7/25/2014	0.20	1.60	1.30	1.70	1.70	0.50	1.50	1.50	1.90	1.10
8/1/2014	0.10	1.60	1.40	1.50	1.50	0.25	1.50	1.50	2.20	1.10
8/8/2014	0.10	1.50	1.30	1.50	1.50	0.00	1.50	1.40	1.70	1.00
8/15/2014	0.10	1.50	1.20	0.50	0.50	0.00	1.40	1.20	1.50	0.90
8/22/2014	0.20	1.10	0.80	0.10	0.10	0.00	1.00	1.00	1.30	0.70
8/29/2014	0.50	0.90	0.70	0.00	0.00	0.00	0.80	0.80	1.00	0.50
9/5/2014	0.10	1.10	0.90	0.00	0.00	0.00	1.00	0.60	0.80	0.40
9/12/2014	0.00	0.90	0.80	0.00	0.00	0.00	0.90	0.50	0.70	0.30
9/19/2014	0.10	0.80	0.70	0.00	0.00	0.00	0.80	0.50	0.70	0.30
9/26/2014	0.10	0.80	0.70	0.00	0.00	0.00	0.80	0.40	0.60	0.20
9/30/2014	0.01	0.48	0.24	0.00	0.00	0.00	0.40	0.40	0.60	0.20
TOTAL	**4.86**	**25.50**	**21.75**	**16.20**	**13.25**	**14.10**	**24.10**	**24.40**	**30.50**	**17.00**

[1] Rainfall should be reduced to account for immediate evaporation from crop and soil surfaces (0.1-May and Sept, 0.15-June and August, 0.2-July)

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

[3] Average water use for each crop each week based on historic data.

[4] Hay Crop water use should be reduced by approximately 2/3 the first week after cutting, 1/2 the second and 1/3 the third.

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 – perform maintenance and test system.
- Evaluate weather conditions and 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.

BLACKFOOT AREA IRRIGATION QUICK REFERENCE GUIDE

This guide was produced by Barry Dutton for the Blackfoot Challenge Irrigation Scheduling Program 2012.

The three tables below list crop water use for common crops in the Blackfoot drainage. You can use the season and monthly values to get a general idea of how much water to apply. You can use the daily values to determine how long your irrigation water will last. For example: If you apply 1 inch to alfalfa in June and the weather is average your daily use is about 0.20 inches per day so 1 divided by 0.20 is 5 days. If you have hot weather your 1 inch may only last about 3 days (1 divided by 0.3 = 3.3 days). Remember that to build up soil moisture you must apply more than the crop water use.

AVERAGE CROP WATER USE IN INCHES - ALFALFA, MIXED GRASS HAY, LAWN

	May	June	July	Aug	Sept	Season Total
Monthly Average	3.00	5.00	6.00	5.00	3.00	22.00
Weekly Average	0.75	1.25	1.50	1.25	0.75	
Hot, Windy Week	1.25	2.25	2.50	2.25	1.25	
Cool Week	0.30	0.75	0.90	0.75	0.30	
Daily Average	0.10	0.20	0.20	0.20	0.10	
Hot, Windy Day	0.20	0.30	0.35	0.30	0.20	
Cool Day	0.05	0.10	0.13	0.10	0.05	
Average Rainfall	2.00	2.00	1.50	1.00	1.00	7.50
Average Effective Rainfall	1.25	1.25	0.50	0	0	3.00

AVERAGE CROP WATER USE IN INCHES – PASTURE

	May	June	July	Aug	Sept	Season Total
Monthly Average	2.25	4.25	5.00	4.25	2.25	18.00
Weekly Average	0.50	1.10	1.30	1.10	0.50	
Hot, Windy Week	1.10	1.90	2.20	2.00	1.10	
Cool Week	0.20	0.50	0.80	0.50	0.20	
Daily Average	0.07	0.16	0.19	0.16	0.07	
Hot, Windy Day	0.15	0.25	0.30	0.25	0.15	
Cool Day	0.04	0.08	0.11	0.08	0.04	
Average Rainfall	2.00	2.00	1.50	1.00	1.00	7.50
Average Effective Rainfall	1.25	1.25	0.50	0	0	3.00

AVERAGE CROP WATER USE IN INCHES – SMALL GRAINS[1]

	May	June	July	Aug	Sept	Season Total
Monthly Average	2.00	5.00	6.00	2.00	0.00	15.00
Weekly Average	0.50	1.25	1.50	0.50	0.00	
Hot, Windy Week	0.90	2.25	2.75	0.90	0.00	
Cool Week	0.20	0.70	0.90	0.20	0.00	
Daily Average	0.06	0.18	0.21	0.06	0.00	
Hot, Windy Day	0.13	0.32	0.36	0.13	0.00	
Cool Day	0.03	0.10	0.13	0.03	0.00	
Average Rainfall	2.00	2.00	1.50	1.00	1.00	7.50
Average Effective Rainfall	1.25	1.25	0.50	0	0	3.00

[1]Assumes a May 1 planting date and a mid-August harvest, adjust for other dates.

EFFECTIVE RAINFALL AND IRRIGATION

Most summer rainstorms (less than ¼ inch) do not add to soil moisture but just evaporate off crop and soil surfaces. A greater effect of summer rainstorms is to lower crop water use. Likewise, when you apply irrigation you lose part to immediate evaporation (0.1 in May and Sept, 0.15 in June and August, 0.2 in July).

CRITICAL CROP PERIODS – WHEN TO MAKE THE GREATEST EFFORT TO IRRIGATE

Alfalfa – stand establishment and after cutting. Moisture stress is indicated by blue-green color and wilting. The month of June is the main irrigation period for maintaining soil moisture (up until cutting).

Grass Hay – stand establishment, cutting (not as important as with alfalfa since grasses are better adapted to water stress). Moisture stress is indicated wilting and browning of leaves although this is not always obvious since grasses are more adapted to water stress. The month of June is the main irrigation period for maintaining soil moisture (up until cutting).

Small Grains – stand establishment, boot, bloom and early heading stages. Stop irrigating at the milk to soft dough stage. Critical periods are not as "critical" if growing small grains for hay. The months of June and July are the main period for maintaining soil moisture (up until the soft dough stage).

SOIL TEXTURES AND AVAILABLE WATER HOLDING CAPACITIES – KNOW HOW MUCH YOUR SOIL HOLDS IN THE ROOT ZONE – FILL IT UP AND DON'T OVER-IRRIGATE

SOIL TYPE	**COARSE SOILS** (Rocky, Sandy, Loamy sand)	**MEDIUM SOILS** (Sandy loam, Silt loam, Loam, Sandy clay loam)	**FINE SOILS** (Clay, clay loam, silty clay loam)
SOIL LAYER	**TEXTURE** ***AWHC[1]***	**TEXTURE** ***AWHC[1]***	**TEXTURE** ***AWHC[1]***
1 foot	Gravelly Sandy Loam ***1.0***	Loam **1.5**	Silty Clay loam ***2.0***
2 foot	Very Gravelly Sandy Loam ***0.75***	Sandy Loam ***1.25***	Clay Loam ***2.0***
3 foot	Very Gravelly Sandy Loam ***0.5***	Sandy loam ***1.25***	Clay Loam and Clay ***2.0***
4 foot	Very Gravelly Sandy Loam ***0.5***	Sandy loam & Loamy Sand ***0.75***	Clay Loam and Clay ***2.0***
5 foot	Very Gravelly Sandy Loam ***0.25***	Sandy loam & Loamy Sand ***0.75***	Clay Loam and Clay ***2.0***
ROOT ZONE STORAGE			
2 ft root zone total	***1.75***	***2.75***	***4***
3 ft root zone total	***2.25***	***4.0***	***6.0***
5 ft root zone total	***3.00***	***5.5***	***10.0***

[1] ***AWHC – Available Water Holding Capacity in inches of water***

DROUGHT STRATEGIES – HOW TO GET THE MOST FROM LIMITED WATER

- Fill up your soil to its water holding capacity at the beginning of the season and keep it near full;
- Save water for critical growth periods;
- Plan to concentrate your efforts on the first cutting;
- Concentrate efforts during the cooler periods of May-June and and reduce or stop irrigation during the hottest part of the summer which coincides with the lowest stream flow period;
- Rotate systems during low river flows to reduce the amount withdrawn;
- Reduce your irrigated acreage and do a good job on a smaller area;
- Plant crops that use less water (annual crops);
- Improve irrigation system performance;
- Plan for a Lower Yield – don't fertilize for 100 bushel if you only have water for 80;
- Monitor irrigation system performance so you put on the right amount uniformly.

Some strategies can be used immediately and others require planning ahead and can be used in future years. Each of these ideas can have negative consequences for irrigators (usually lower yield or loss of alfalfa plants).