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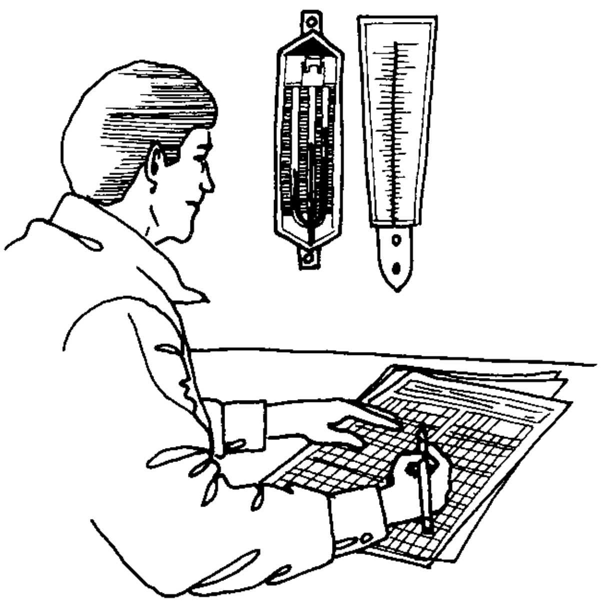
Irrigation Scheduling by the Checkbook Method



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Determining when to irrigate and how much water to apply is a critical decision for an irrigator. Crop stress results from too little water. Too much water may leach fertilizer from the root zone. Either way, crop yields suffer. Excess water also results in pumping cost waste.

A system for scheduling irrigation by the "checkbook" method is outlined in this circular. This method requires the irrigator to measure or obtain from local sources the maximum daily air temperatures. Crop water use can then be estimated from tables in this publication. Water use is tabulated on a soil moisture balance sheet to determine the soil moisture deficit. At some predetermined moisture deficit, irrigation must be started. Crop water use adds to the deficit while irrigation and rainfall reduces the deficit.

This system requires daily input by the irrigator, but if used properly is an excellent tool for irrigation scheduling.

Soil Moisture Holding Capacity

A soil's moisture-holding capacity is the available moisture a plant may extract from the soil. This is the difference in moisture content between a wet soil at field capacity and a dry soil at the permanent wilting point. The major factor affecting available moisture-holding capacity is soil texture. Texture refers to the relative amount of sand, silt and clay particles in soil. The available moisture-holding capacity of the soil must be determined prior to the start of irrigation scheduling.

If more than one soil type is present in the field, the limiting soil, the soil with the lowest moisture-holding capacity, should be used. If that soil covers a very small area, the predominant soil should be used. Your local Soil Conservation Service personnel or county extension agent can help determine the moisture-holding capacity from detailed county soil surveys. Soil moisture-holding capacities can be estimated from Table 1 if the soil textures and depths are known.

Crop Root Zone

Each crop has a typical root zone depth. The root zone determines to what depth the plant can extract water from the soil. The root zone of annual crops may not fully develop until 8 weeks after the crop emerges.

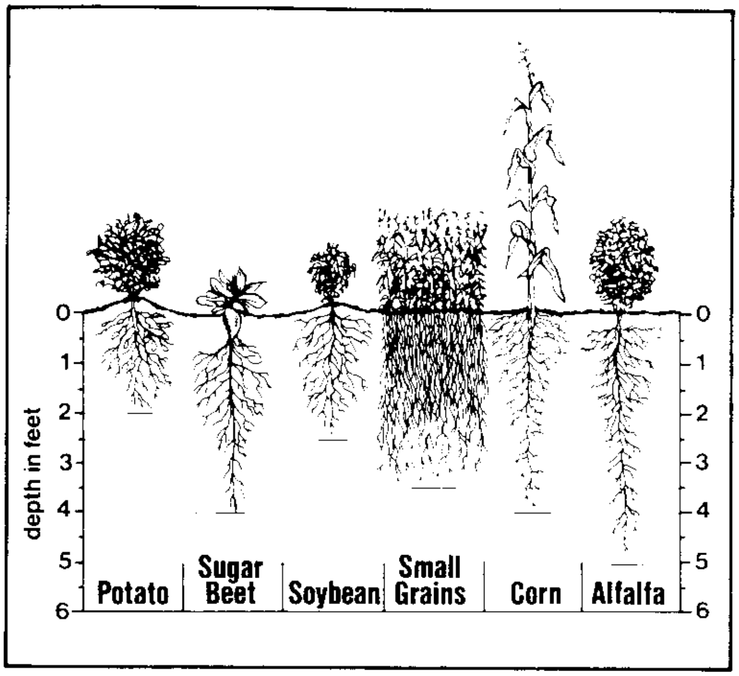


Figure 1. Typical fully developed root zone depths under North Dakota conditions.

Plant roots extract the greater portion of the water used from the upper root zone. Therefore less than the fully developed root zone may be used for irrigation water management purposes. Table 2 gives some fully developed root zone depths and some suggested root zone depths for water management purposes.

Always make sure the total root zone is moist at or near the beginning of crop emergence and growth. If

Table 1. Approximate Available Soil Moisture Holding Capacities for Various Soil Textures.

Soil Texture	Available Moisture In/In	Available Moisture In/Ft
Coarse sand and gravel	.04	0.5
Sand	.07	0.8
Loamy sand	.09	1.1
Sandy loam	.13	1.5
Fine sandy loam	.16	1.9
Loam and silt loam	.20	2.4
Clay loam and silty clay loam	.18	2.1
Silty clay and clay	.16	1.9

Table 2. Typical Crop Root Zone.

Crop	Depth of Fully Developed Root Zone (Feet)	Depth of Root Zone for Irrigation Water Management (Feet)
Potatoes	2.0	2.0
Soybeans, Edible Beans	2.5	2.0
Small Grains	3.5	3.0
Corn, Sugarbeets, Sunflower	4.0	3.0
Established Alfalfa	5.0	4.0

necessary, irrigate to wet the root zone. Moist soil is necessary for proper root zone development to take place. If a dry layer of soil exists in the root zone, plant roots cannot grow through this dry layer and a reduced rooting depth will result.

Crop Water Use

A crop's water use depends on the type of crop, stage of growth, temperature, sunshine, wind speed, relative humidity and soil moisture content. This publication includes tables for estimating crop water use based on maximum daily temperatures and the crop's growth stage.

Tables 6 through 14 give estimated water use values for commonly irrigated crops in North Dakota. The daily crop water use may be estimated from the tables by observing the maximum daily temperature and knowing the average date of emergence. Critical crop growth stages are also indicated on the tables and should be used instead of week after emergence if the growth stage is different.

Maximum daily temperatures may be taken from weather bureau reports if a reporting station is close. Otherwise a minimum-maximum thermometer should be purchased.

Pumping Capacity

A system's pumping capacity determines the rate at which the soil profile can be refilled with moisture. Pumping capacity is often referred to in units of gallons per minute (GPM) per acre irrigated. For example, a 500 GPM pumping rate used to irrigate 100 acres gives a 5 GPM/acre pumping capacity. A 780 GPM pumping rate for a 130 acre center pivot gives a 6 GPM/acre pumping capacity (see Table 3).

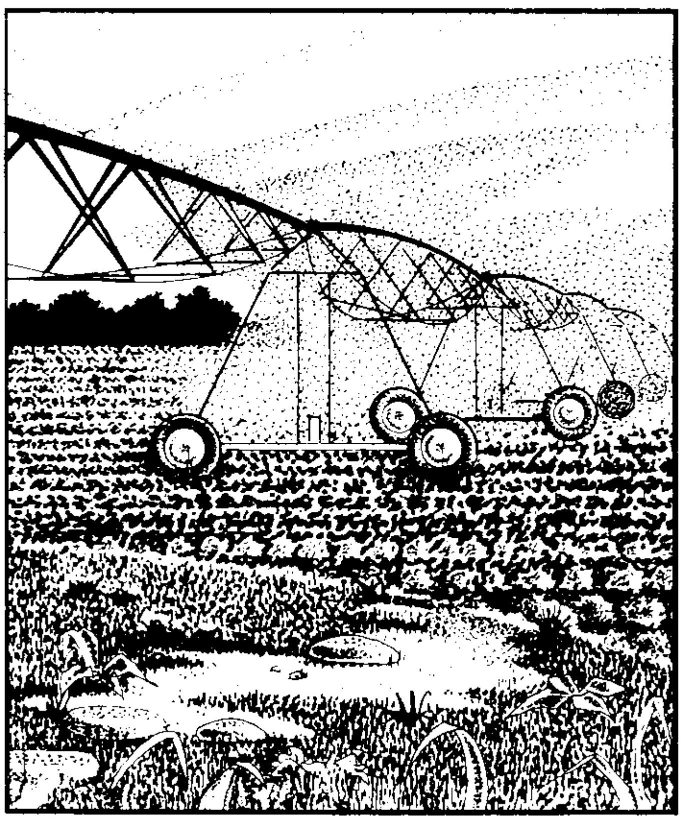


Table 3. Pumping Capacity (GPM/Acre) for Different Sized Irrigated Areas and Pumping Rates.

System Pumping Capacity (GPM/Acre) Assuming No Evaporation or Wind Drift Losses

Pump Rate (GPM)	Irrigated Area (Acres) 80	100	120	140	160
400	5.00	4.00	3.33	2.85	2.50
500	6.25	5.00	4.17	3.57	3.12
600	7.50	6.00	5.00	4.29	3.75
700	8.75	7.00	5.83	5.00	4.38
800	10.00	8.00	6.67	5.71	5.00
900	11.25	9.00	7.50	6.43	5.63
1000	12.50	10.00	8.33	7.14	6.25
1200	15.00	12.00	10.00	8.57	7.50

Application Efficiency

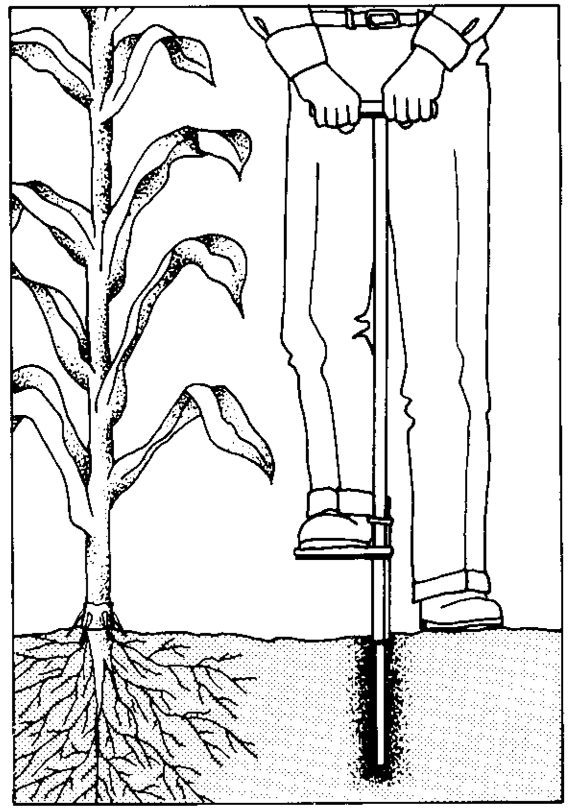
Sprinkler irrigation is not 100 percent efficient and losses from evaporation and wind drift must be considered. Average application efficiencies in North Dakota are approximately 85 percent for applications of about 1 inch of water or more and drop to 80 percent for applications of ½ to ¾ inch. Table 4 shows pumping capacity represented as an equivalent daily application amount over the irrigated area in inches/-day at 80 percent and 85 percent efficiency.

Table 4. Pumping Capacity Represented as an Equivalent Daily Application Amount Over the Entire Irrigated Area.

Pumping Capacity (GPM/AC)	Application Rate (inch/day) 80% Efficiency	85% Efficiency
4	.17	.18
5	.21	.23
6	.25	.27
7	.30	.32
8	.34	.36

For example, if a center pivot having a pumping capacity of 6 GPM/acre has an application efficiency of 80 percent it will have a net application rate of .25 in/day. If the system makes a revolution in three days it will apply .75 in/revolution (3 days × .25 in/day = .75 in/revolution).

Pumping capacities may be estimated from Table 3 using the pumping rate and acres irrigated. Remember that Table 3 gives system pumping capacities assuming 100 percent efficiency with no evaporation or wind drift losses. The effective application rate needs to be determined from Table 4 using either 80 percent or 85 percent application efficiency.



Determining Moisture Deficit

To start using the checkbook method of scheduling, the initial soil moisture content needs to be determined. In this publication soil moisture content is expressed as a soil moisture deficit. Soil moisture deficit is the difference in moisture content between a full profile, the soil at field capacity, and the existing field soil moisture content. It is most convenient to describe this deficit as **inches** of water deficit in the plant root zone. Think of this deficit as being equal to the amount of water which would be required to refill the soil root zone to field capacity or the point of zero deficit.

To determine the existing soil moisture content, take samples with a soil probe at several places in the field. Pay particular attention to the areas which have the coarsest soil textures. Determine the soil moisture deficits by feeling the soil and consulting Table 5, "Guide for Judging How Much Moisture Has Been Removed from the Soil." Soil samples should be taken in 6 inch or 1-foot increments to the depth used for water management purposes (see Table 2).

Table 5. Guide for Judging How Much Moisture Has Been Removed From the Soil. (Numbers indicate inches of water deficit per one foot of soil)

Soil Moisture Deficiency	Coarse Texture	Moderately Coarse Texture	Medium Texture	Fine and Very Fine Texture
0% (Field capacity)	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand. 0.0	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand. 0.0	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand. 0.0	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand. 0.0
0-25%	Tends to stick together slightly, sometimes forms a very weak ball under pressure. 0.0 to 0.2	Forms weak ball, breaks easily, will not slick. 0.0 to 0.4	Forms a ball, is very pliable, slicks readily if relatively high in clay. 0.0 to 0.5	Easily ribbons out between fingers, has slick feeling. 0.0 to 0.6
25-50%	Appears to be dry, will not form a ball with pressure. 0.2 to 0.5	Tends to ball under pressure but seldom holds together 0.4 to 0.8	Forms a ball somewhat plastic, will sometimes slick slightly with pressure. 0.5 to 1.0	Forms a ball, ribbons out between thumb and forefinger. 0.6 to 1.2
50-75%	Appears to be dry, will not form a ball with pressure. 0.5 to 0.8	Appears to be dry, will not form a ball. 0.8 to 1.2	Somewhat crumbly but holds together from pressure. 1.0 to 1.5	Somewhat pliable, will ball under pressure. 1.2 to 1.9
75-100% (100% is permanent wilting)	Dry, loose, single-grained, flows through fingers. 0.8 to 1.0	Dry, loose, flows through fingers. 1.2 to 1.5	Powdery, dry, sometimes slightly crusted but easily broken down into powdery condition 1.5 to 2.0	Hard, baked, cracked, sometimes has loose crumbs on surface. 1.9 to 2.5

From Israelsen and Hansen, Irrigation Principals and Practices. Third Edition.

NOTE: A Ball is formed by squeezing a handful of soil very firmly.

The total root zone deficit is computed by adding the deficits for each foot. If you feel uncomfortable making this soil moisture deficit determination, contact either your local Soil Conservation Service Office or your county extension agent for help.

The following example shows how the deficit in a 3-foot root zone may be estimated. Do this at the start of scheduling and about every two weeks during the irrigation season. Correct the soil moisture deficit column if it is different than that determined by probing the soil.

In this example the estimated deficit is the percent of water removed from the soil compared to that soil at field capacity. This percent deficit is multiplied by the moisture-holding capacity of each segment of depth to determine the total deficit in the 3-foot root zone.

Soil Moisture Balance

The soil moisture balance uses a checkbook-like procedure, to show the moisture deficit or amount of moisture which has been withdrawn from the soil profile. Crop water use removes water from the soil **increasing** the deficit. Irrigations or rainfall add water to the soil **decreasing** the soil moisture deficit. The purpose of irrigation scheduling is to prevent the soil moisture deficit from becoming excessive causing plant stress and to prevent over-irrigation when a very small or no soil moisture deficit exists. The amount of irrigation water applied should not be larger than the soil moisture deficit. Excess water will run off or leach through the soil profile.

When scheduling irrigations, a projection of crop water use must be made several days ahead to avoid stressing the last part of the field before it is irrigated. For example, when using a center pivot system that takes three days to cover the field, project what the moisture deficit will be after three days. Use this to determine when to start irrigating.

Irrigation Scheduling Techniques

In general, high-yielding crops are most sensitive to moisture stress in the reproductive (flowering and early seed fill) stages of growth. Crops are somewhat less sensitive early in the growing season and again later in the growing season as they near physiological maturity.

A common irrigation scheduling guideline is to prevent the soil moisture deficit from exceeding 50 percent of the available soil moisture holding capacity in the root zone. This is a general guideline and applies to corn and small grains. However, irriga-

3 Foot root zone (table 2)

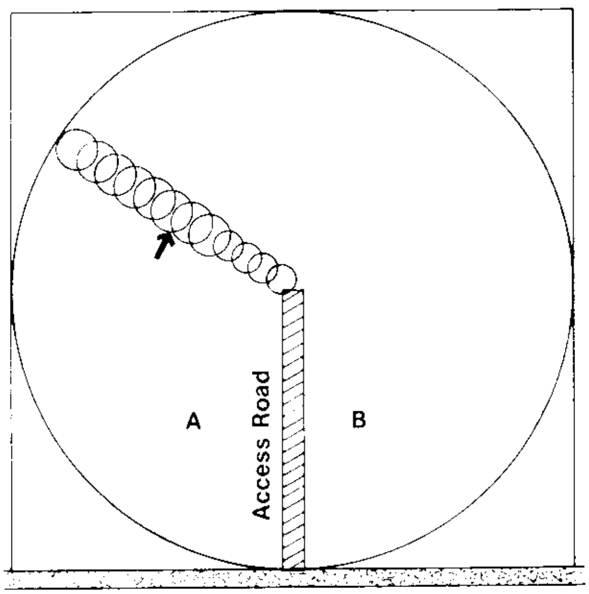
MOISTURE HOLDING CAPACITY

soil depth	soil texture	(table 1) moisture holding capacity
0-12"	sandy loam	.13 IN/IN
12"-36"	loamy sand	.09 IN/IN

ESTIMATED DEFICIT

soil depth	(table 1) moisture holding capacity	(table 5) estimated deficit
0-6"	6" x .13 IN/IN = .78"	x 40% = .31"
7"-12"	6" x .13 IN/IN = .78"	x 25% = .20"
13"-24"	12" x .09 IN/IN = 1.08"	x 50% = .54"
25"-36"	12" x .09 IN/IN = 1.08"	x 30% = .32"
	Total 3.72"	Total deficit 1.37"

tion management techniques will vary with crops. Potatoes, for example, may need to be scheduled using a smaller allowable deficit, commonly 35 to 40 percent. Sunflower and some forage crops can may withstand a slightly higher deficit then the general 50 percent guideline. Soybeans are generally irrigated to maintain a drier soil or higher deficit early in the season so vegetative growth is restricted. At the onset of blossoming, soybeans should be irrigated to maintain a minimum 50 percent water deficit.



Schedule irrigations on the basis of one spot in the field near the starting point of the center pivot (A) but remember to plan ahead so the last part of the field to be irrigated (B) does not become overly dry.

Balance Sheet

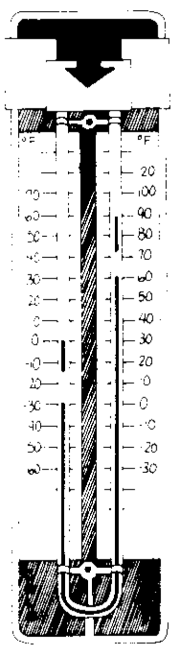
The balance sheet allows the irrigator to keep a "checkbook" balance of the soil moisture content. Crop water use adds to the deficit. Rainfall and irrigations subtract from the deficit.

Keeping the balance between a zero deficit and the allowable depletion level is the goal of good irrigation scheduling.

Record the maximum temperature daily and determine the estimated water use from the appropriate crop table. Add this to the previous day's soil moisture deficit. Subtract any rainfall and/or irrigation for the day. Record the new soil moisture deficit. Determine whether irrigation should start or not.

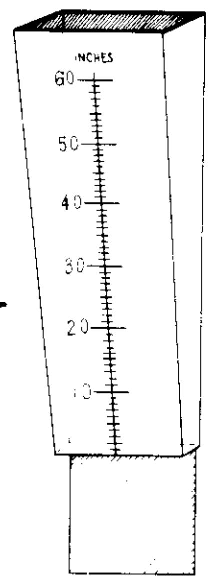
Remember, the soil moisture deficit can never be less than zero. A zero deficit indicates the soil moisture is at field capacity. Likewise, the deficit can never be greater than the total available soil moisture capacity for the soil being irrigated.

Periodically, at least every two weeks, probe at several locations in the field and determine whether the soil moisture deficit on the balance sheet is correct. If it is not, scratch the old value and enter the new value you determined. The following example illustrates how a balance sheet is kept.



Use maximum-minimum thermometers to record the daily high temperature for use with the average water use tables.

Use rain gauges to record both the rainfall and the water applied by the irrigation system. Place a rain gauge outside the irrigated area for rainfall. Place at least two raingauges under the irrigation system to get the average water applied. Pouring a shallow layer of diesel fuel in the gauge prevents evaporation until the gauge can be read.



Record crop and field number

Record emergence date

SOIL MOISTURE BALANCE SHEET

CROP: Corn FIELD: # 1 EMERGENCE DATE: May 20

PUMPING CAPACITY: 6 GPM/ACRE .27 NET INCHES/DAY

ROOT ZONE DEPTH: 3 FEET | MOISTURE HOLDING CAPACITY IN ROOT ZONE: 3.75 INCHES | 50% OF MOISTURE HOLDING CAPACITY IN ROOT ZONE: 1.88 INCHES

MAINTAIN DEFICIT LESS THAN 1.88 (INCHES)

Week After Emergence	Date	Maximum Temperature	Add: Crop Water Use	Subtract: Rainfall	Subtract: Net Irrigation	Total: Soil Moisture Deficit
4	6/12					.18
	13	71	.09			.27
	14	64	.11	.19		.19
	15	64	.11	.89		0
	[illegible]	72	.09			.09
5	6/17	74	.12			.21
	18	[illegible]	.12			.33
	19	[illegible]	.12			.45
	20	[illegible]	.15			.60
	[illegible]	77	.12	.24		.48
	22	74	.12	1.39		0
	23	85	.15			.15
6	6/24	82	.19			[illegible]
	25	85	[illegible]			.53
	26	77	.14			.67
	[illegible]	81	.19			.86
	28	80	.19			1.05
	29	80	.19			1.24
	30	83	.19		.75	.68
7	7/1	78	.17		X	.85
	2	75	.17		X	1.02
	3	84	[illegible]			[illegible]
	4	[illegible]	.22		.75	.71
	[illegible]	87	.22		X	.93
	6	85	.22		X	1.15
	7	86	.22		.75	.62
8	7/8	77	.19		X	.81
	9	77	.19		X	1.00
	10	74	.19	.56		.63
	11	78	.19	.12		.70
	12	83	.24			.94
	13	86	.24			1.18
	14	93	.30		.75	.73
9	7/15	97	.30		X	[illegible]
	[illegible]	88	.25		X	1.28
	[illegible]	92	.30		1.08	.50
	18	[illegible]	[illegible]	.56	X	.19
	19	76	.19		X	.38
	20	80	.25		X	.63
	21	91	.30			.93
10	7/22	77	.19	.20		.92
	23	78	.19	.23		.88
	24	80	.24			1.12
	25	82	.24		1.08	.28
	26	88	.24		[illegible]	.52
	27	90	.29		X	.81
	28	92	.29		X	1.59 ~~1.10~~
11	7/29	94	.29		1.08	[illegible]
	30	94	.29		X	1.00
	31	84	.23		X	1.23
	8/1	76	.18	.20	X	1.21
	2	79	.18	.84		.55
	3	82	.23			.78
	4	80	.23			1.01
12	8/5	73	[illegible]	.62		.56
	6	82	.22			.78
	7	86	.22			1.00
	8	78	.17		1.08	.09
	9	76	.17		X	[illegible]
	10	82	.22		X	.48
	11	98	[illegible]		[illegible]	.70
13	8/12	74	.17			.87
	13	76	.17			1.04
	14	65	.12	.22		.94
	15	74	.17	.28		.83
	16	70	.17	.16		.84
	17	69	.12			.96
	18	62	.12			1.08

Pumping rate and net application rate per day, see Table 3

Depth of root zone for irrigation management, see Table 2

Soil probe and feel method, Table 5, used to determine starting soil deficit.

Week after emergence and date

Rainfall exceeds previous days deficit plus todays water use, deficit becomes zero

Irrigation is started so deficit as irrigation is being completed does not exceed 50% of soil moisture holding capacity. Here the system is applying .75 inches in 3 days. Assuming 80% application efficiency.

Moisture holding capacity in root zone and maximum allowable deficit; obtain from SCS or Table 1.

Maximum daily temperature is recorded and estimated crop use taken from water use tables. Water use is added to previous days deficit.

Soil moisture deficit is corrected by probing the field and feeling the soil, see Table 5.

Rainfall and irrigation are subtracted from previous days deficit. Here the system is applying 1.08 inches in 4 days. 4 × .27" = 1.08" An 85% application efficiency is assumed.

Table 6. Average Corn Water Use (inches/day)

Week After Emergence	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Date																	
Maximum Temperature 50-59 °F	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.06	0.04	0.03
60-69	0.02	0.03	0.05	0.06	0.08	0.10	0.12	0.14	0.14	0.13	0.13	0.13	0.12	0.11	0.09	0.07	0.06
70-79	0.03	0.04	0.06	0.09	0.12	0.14	0.17	0.19	0.19	0.19	0.18	0.17	0.17	0.16	0.13	0.10	0.08
80-89	0.04	0.06	0.08	0.11	0.15	0.19	0.22	0.24	0.25	0.24	0.23	0.22	0.21	0.20	0.17	0.13	0.10
90-99	0.05	0.07	0.10	0.14	0.18	0.23	0.27	0.30	0.30	0.29	0.29	0.27	0.26	0.25	0.20	0.16	0.12

3 Leaf

12 Leaf

Tassel

Silk

Pollinate

Blister Kernel

Early Dent

Dent

Black Layer

Table 7. Average Wheat Water Use (inches/day)

Week After Emergence	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Date														
Maximum Temperature 50-59 °F	0.01	0.03	0.04	0.06	0.07	0.08	0.08	0.08	0.08	0.08	0.07	0.06	0.04	0.03
60-69	0.02	0.04	0.07	0.10	0.12	0.13	0.14	0.14	0.14	0.14	0.12	0.10	0.07	0.04
70-79	0.03	0.06	0.10	0.13	0.17	0.19	0.19	0.19	0.19	0.19	0.17	0.14	0.10	0.06
80-89	0.04	0.08	0.12	0.17	0.22	0.24	0.24	0.25	0.25	0.25	0.22	0.17	0.12	0.08
90-99	0.05	0.10	0.15	0.21	0.26	0.29	0.30	0.30	0.30	0.30	0.27	0.21	0.15	0.09

2 Tiller

Joint

Boot

Heading

Flower

Early Milk

Early Dough

Hard Dough

Table 8. Average Barley Water Use (inches/day)

Week After Emergence	1	2	3	4	5	6	7	8	9	10	11	12	13
Date													
Maximum Temperature 50-59 °F	0.02	0.03	0.05	0.06	0.08	0.08	0.08	0.08	0.08	0.07	0.06	0.04	0.02
60-69	0.03	0.05	0.08	0.10	0.13	0.13	0.13	0.14	0.14	0.12	0.09	0.06	0.03
70-79	0.04	0.07	0.11	0.14	0.18	0.18	0.19	0.19	0.19	0.17	0.13	0.08	0.04
80-89	0.05	0.09	0.13	0.19	0.23	0.23	0.24	0.24	0.25	0.22	0.17	0.11	0.05
90-99	0.06	0.10	0.16	0.23	0.28	0.29	0.29	0.30	0.30	0.27	0.20	0.13	0.06

4-5 Leaf

Heading

Milk

Table 9. Average Soybean Water Use (inches/day)

Week After Emergence	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Date																
Maximum Temperature 50-59 °F	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.08	0.08	0.08	0.07	0.07	0.06	0.05	0.04
60-69	0.02	0.03	0.05	0.07	0.09	0.11	0.12	0.13	0.13	0.13	0.13	0.12	0.11	0.10	0.08	0.06
70-79	0.03	0.05	0.07	0.09	0.12	0.15	0.17	0.19	0.19	0.18	0.17	0.17	0.16	0.14	0.11	0.08
80-89	0.04	0.06	0.09	0.12	0.15	0.19	0.22	0.24	0.24	0.23	0.22	0.21	0.20	0.18	0.14	0.10
90-99	0.05	0.07	0.11	0.15	0.19	0.23	0.27	0.29	0.29	0.29	0.27	0.26	0.25	0.22	0.17	0.13
				3rd Trifoliate				Flower				Upper Pod Fill			Leaf Drop	

Table 10. Average Sunflower Water Use (inches/day)

Week After Emergence	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Date															
Maximum Temperature 50-59 °F	0.01	0.03	0.05	0.06	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.06	0.04	0.03
60-69	0.02	0.05	0.08	0.10	0.12	0.14	0.14	0.14	0.13	0.13	0.13	0.12	0.10	0.07	0.04
70-79	0.03	0.07	0.11	0.15	0.17	0.19	0.19	0.19	0.19	0.18	0.17	0.16	0.13	0.10	0.06
80-89	0.03	0.09	0.14	0.19	0.22	0.25	0.25	0.25	0.24	0.23	0.22	0.21	0.17	0.13	0.07
90-99	0.04	0.11	0.17	0.23	0.27	0.30	0.30	0.30	0.29	0.29	0.27	0.26	0.21	0.15	0.09
					Bud		Ray Flower			100% Anther		Ray Petal Drop			Maturity

Table 11. Average Potato Water Use (inches/day)

Week After Emergence	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Date															
Maximum Temperature 50-59 °F	0.02	0.03	0.04	0.05	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.06	0.05	0.04
60-69	0.03	0.04	0.07	0.09	0.11	0.13	0.14	0.14	0.14	0.13	0.13	0.12	0.10	0.09	0.07
70-79	0.04	0.06	0.09	0.12	0.15	0.17	0.19	0.19	0.19	0.19	0.18	0.17	0.14	0.12	0.10
80-89	0.05	0.08	0.12	0.16	0.19	0.22	0.25	0.25	0.25	0.24	0.23	0.21	0.18	0.16	0.13
90-99	0.06	0.10	0.14	0.19	0.24	0.27	0.30	0.30	0.30	0.29	0.29	0.26	0.23	0.19	0.16
		7 inch		Budding		Full Cover									

Table 12. Average Pinto Bean Water Use (inches/day)

Week After Emergence	1	2	3	4	5	6	7	8	9	10	11	12	13
Date													
Maximum Temperature 50-59 °F	0.02	0.03	0.04	0.05	0.06	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.05
60-69	0.04	0.05	0.06	0.08	0.11	0.13	0.14	0.14	0.13	0.13	0.13	0.11	0.08
70-79	0.05	0.06	0.09	0.12	0.15	0.18	0.19	0.19	0.19	0.18	0.17	0.15	0.11
80-89	0.06	0.08	0.11	0.15	0.19	0.23	0.25	0.25	0.24	0.23	0.22	0.19	0.14
90-99	0.08	0.10	0.14	0.18	0.23	0.28	0.30	0.30	0.29	0.29	0.27	0.24	0.17
				4 Leaf	Auxillary Bud	Flower		Podding		Initial Stripe	Leaf Yellow		Maturity

Table 13. Average Sugarbeet Water Use (inches/day)

Week After Emergence	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Date																				
Maximum Temperature 50-59 °F	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.06	0.06	0.05	0.05	0.05
60-69	0.02	0.04	0.05	0.06	0.08	0.10	0.11	0.13	0.14	0.14	0.13	0.13	0.13	0.12	0.11	0.10	0.10	0.09	0.08	0.08
70-79	0.03	0.05	0.07	0.09	0.11	0.14	0.16	0.18	0.19	0.19	0.19	0.18	0.17	0.17	0.16	0.15	0.14	0.13	0.12	0.11
80-89	0.04	0.06	0.09	0.12	0.15	0.17	0.20	0.23	0.24	0.25	0.24	0.23	0.22	0.21	0.20	0.19	0.17	0.16	0.15	0.14
90-99	0.05	0.08	0.11	0.14	0.18	0.21	0.25	0.28	0.30	0.30	0.29	0.29	0.27	0.26	0.25	0.23	0.21	0.20	0.18	0.17
					4-6 Leaf		10-12 Leaf			Full Cover										

Table 14. Average Alfalfa Water Use (inches/day). Use this table except for the first three weeks after cutting.

Week After May 1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Date																						
Maximum Temperature 50-59 °F	0.04	0.05	0.06	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.06	0.06	0.05	0.05	0.05
60-69	0.07	0.09	0.11	0.12	0.13	0.13	0.13	0.14	0.14	0.14	0.14	0.14	0.13	0.13	0.13	0.12	0.11	0.10	0.10	0.09	0.08	0.08
70-79	0.09	0.12	0.15	0.17	0.18	0.18	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.18	0.17	0.17	0.16	0.15	0.14	0.13	0.12	0.11
80-89	0.12	0.16	0.19	0.22	0.23	0.23	0.24	0.24	0.25	0.25	0.25	0.25	0.24	0.23	0.22	0.21	0.20	0.19	0.17	0.16	0.15	0.14
90-99	0.15	0.19	0.23	0.27	0.28	0.29	0.29	0.30	0.30	0.30	0.30	0.30	0.29	0.29	0.27	0.26	0.25	0.23	0.21	0.20	0.18	0.17

Use these tables for the first three weeks after cutting.

Week After 1st and 2nd Cut	1	2	3
Maximum Temperature 50-59 °F	0.05	0.06	0.08
60-69	0.08	0.11	0.13
70-79	0.11	0.15	0.18
80-89	0.15	0.19	0.23
90-99	0.18	0.23	0.28

Week After 3rd Cut	1	2	3
Maximum Temperature 50-59 °F	0.04	0.05	0.07
60-69	0.07	0.09	0.11
70-79	0.10	0.13	0.15
80-89	0.13	0.16	0.20
90-99	0.15	0.20	0.24

SOIL MOISTURE BALANCE SHEET

CROP ____________ FIELD ____________ EMERGENCE DATE ____________ ____________

PUMPING CAPACITY ____________ GPM/ACRE ____________ NET INCHES/DAY

ROOT ZONE DEPTH	MOISTURE HOLDING CAPACITY IN ROOT ZONE	50% OF MOISTURE HOLDING CAPACITY IN ROOT ZONE
____________ FEET	____________ INCHES	____________ INCHES

MAINTAIN DEFICIT LESS THAN ________ (INCHES)

			Add	Subtract		Total
Week After Emergence	Date	Maximum Temperature	Crop Water Use	Rainfall	Net Irrigation	Soil Moisture Deficit

			Add	Subtract		Total
Week After Emergence	Date	Maximum Temperature	Crop Water Use	Rainfall	Net Irrigation	Soil Moisture Deficit

Continue on Additional Sheets as Required