LIMITED IRRIGATION CHAPTER

As irrigation water supplies dwindle and pumping costs increase, more and more New Mexico farmers are turning toward limited irrigation as a means of stretching their existing irrigation water supply.

Limited irrigation is not new to New Mexico as it has been practiced in various areas of the state for over 200 years.

In an effort to provide SCS employees and farmers with the best available data on limited irrigation, this chapter will have the following objectives:

1. Delineate and define the different forms of limited irrigation existing in New Mexico.

2. Provide the best existing experimental data on use of limited irrigation water.

3. Provide guidelines for SCS assistance on planning and applying limited irrigation techniques.

DEFINITION OF LIMITED IRRIGATION

Limited irrigation is defined as the addition of available amounts of irrigation water to supplement rainfall and produce a crop. The combination of rainfall and irrigation water, will not, in normal years, meet the peak consumptive use rate of the crop being grown. The crop being irrigated is usually one which has been grown successfully under dryland conditions in the particular field office.

In New Mexico we have two distinct types of limited irrigation:

CONTROLLED LIMITED IRRIGATION

Controlled limited irrigation occurs when the farmer can control the rate of flow, volume, and timing of the irrigation water that he is applying to the crop.

UNCONTROLLED LIMITED IRRIGATION

Uncontrolled limited irrigation occurs when the farmer cannot control the rate of flow, total volume, or timing of irrigation water being applied to the crop.

Within these two distinct types of limited irrigation there are also 3 different classes which further define the problems encountered in each particular region of New Mexico:

CLASS A

This class of limited irrigation occurs when volume is not a limiting factor, but the rate of flow of irrigation water (GPM or CFS) is not adequate to meet the peak demand rate of the crop. This class of limited irrigation usually occurs in pump irrigated areas where the well output rate is the limiting factor.

CLASS B

This class of limited irrigation occurs when the rate of flow is sufficient, but the seasonal volume is not adequate to meet full crop needs. Class B limited irrigation is usually found on irrigation systems that depend on surface reservoirs for their irrigation water supplies, such as Elephant Butte, Conchas, etc.

CLASS C

Class C limited irrigation occurs when the rate of flow and volume of irrigation water available are inadequate to meet the complete crop needs. This class is especially applicable to community irrigation systems that have no storage reservoir, and rely entirely on stream flow for their irrigation water.

These 3 classes of limited irrigation, coupled with the 2 major types, give 6 categories of limited irrigation that can occur in New Mexico:

Category	Typical Example
Controlled-Class A	Pump irrigation on the High Plains
Controlled-Class B	Irrigation district with storage reservoir, operating under drought conditions.
Controlled-Class C	Farm with too great a planted acreage on an otherwise adequate delivery system.
Uncontrolled-Class A	Community irrigation system that has adequate storage, but has uncontrolled, inadequate delivery rates to individual farm users.
Uncontrolled-Class B	Irrigation district with storage reservoir, but operating under extreme drought conditions.
Uncontrolled-Class C	Community irrigation systems that rely entirely on stream flows and have no storage facilities.

Objectives of Assistance to Landowners on Limited Irrigation

Because the major objective of limited irrigation is to achieve the highest crop yield per acre inch of irrigation water applied, SCS assistance should be tailored to meet this objective.

ASSISTANCE ON UNCONTROLLED LIMITED IRRIGATION

Since the farmer cannot control the rate of flow, total volume, or timing of irrigation water with uncontrolled limited irrigation, the farmer merely tries to fill the root zone to the desired capacity with each irrigation, when water is available. SCS assistance should be aimed at assisting the farmer decide how much water needs to be applied to the root zone and how the existing irrigation system can be adjusted to make the most efficient use of the limited water available.

Examples of assistance or information needed are:

1. Estimates of the rate of water use by the crops since last irrigation.

2. Measurement of soil moisture needs.

3. Estimate of volume of water applied per irrigation.

4. Assistance on installation of borders, furrows, or installation of headgates to control limited flows.

5. Information on crop rotation and selection of drought resistant and low water use crops.

6. Assistance to irrigation system managers who wish to convert from uncontrolled to controlled limited irrigation.

ASSISTANCE ON CONTROLLED LIMITED IRRIGATION

Since the farmer can control the rate, volume, and timing of irrigation water applied under controlled limited irrigation, SCS assistance can be of a much greater intensity.

Examples of SCS assistance on controlled limited irrigation are:

1. Explanation of research data showing crop response to various irrigation techniques.

2. Information on pumping cost economics as related to crop yields.

3. Assistance on scheduling limited irrigations, incorporating the farmer's objectives.

4. The same assistance as on uncontrolled limited irrigation.

The major crops grown under controlled limited irrigation on the High Plains are grain sorghum, cotton, and wheat. There has been an enormous amount of data compiled over the years on these crops by various state, federal, and private organizations. The following data is a summary of these results for grain sorghum, cotton, and wheat.

GRAIN SORGHUM

Research on grain sorghum under limited irrigation has been conducted on the High Plains of Texas and New Mexico since 1937.

The following are the combined results of currently available data on limited irrigation of grain sorghum:

1. Plants once in severe stress from moisture never produce as much grain as plants not in stress, even though rainfall and later irrigation provided enough moisture to grow a plant of normal size. A theory had existed that if grain sorghum is put in stress for water, a deeper root system is produced. Another similiar idea had been that "it doesn't hurt sorghum to wait for water." Both of these theories have been found to be without basis. There has been no evidence that sorghum in stress for moisture produces a better or deeper root system.

2. The critical stages of growth that require adequate soil moisture for maximum yield potential are the boot, bloom, and soft dough stages.

3. If only one summer irrigation is applied, maximum yield and efficiency is obtained when a three or four inch net application (depending on soil texture) is applied so that adequate moisture is available at the boot stage of growth, which is usually 45 to 50 days following planting.

4. When two summer irrigations are planned, the first should be timed so that moisture is available at the boot stage and the second at the bloom stage of growth for maximum yield and efficiency. See attached table for the timing of three or four irrigations per season.

5. The planting date should be as late as possible to produce a crop with the miminum amount of water. Late planting places the period of maximum water use late in the summer when the temperature and consumptive use rates are less. Exceptions to this late planting are on extermely sandy soils where May and June rainfall might be lost to deep percolation. Staggered plantings also increase efficient use of water by staggering the peak use period for the entire crop.

6. Preplant irrigations to fill the root zone and for emergence is a common practice for grain sorghum on the High Plains. The need to have a full soil moisture profile by the time the plant is at critical growth stages cannot be overemphasized.

   However, if the crop is going to receive more than two limited irrigations during the growing season, the need to have the soil profile full at planting time is now being questioned for limited irrigation.

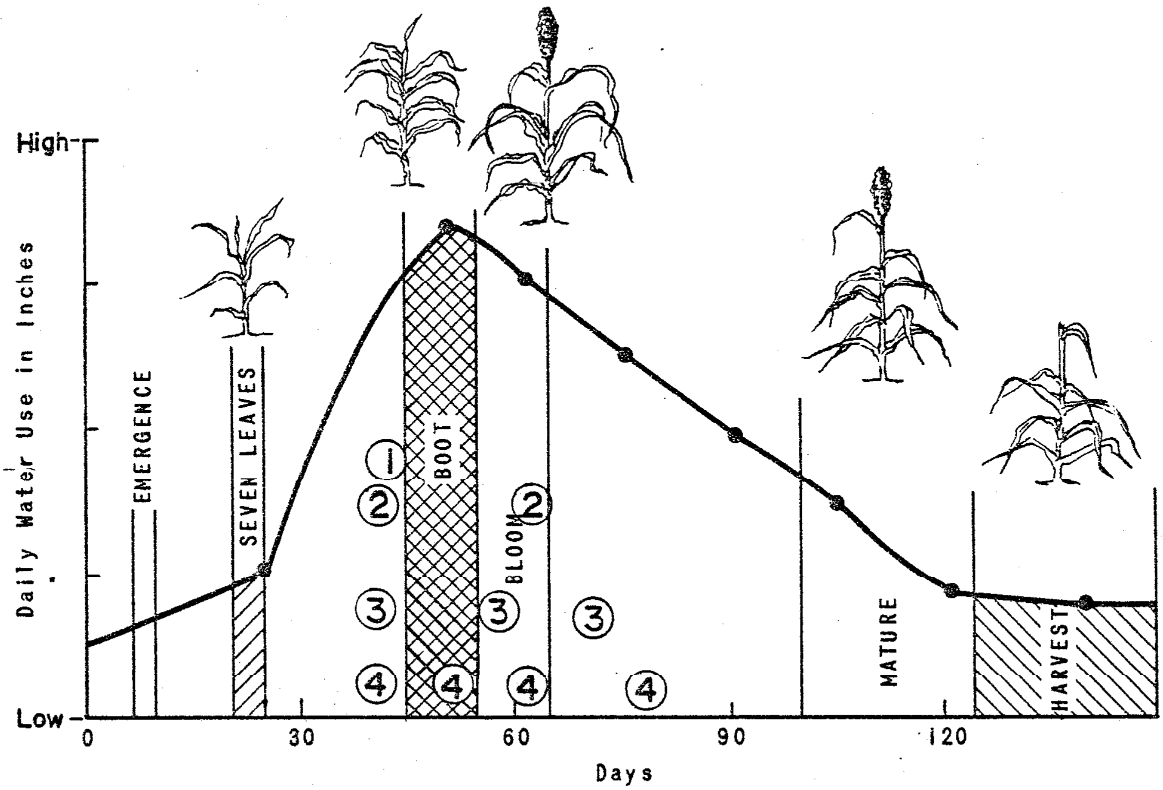
If we try to fill the entire soil profile at planting time, the conditions of the soil at planting are such that the intake rate is usually very high, and irrigation water losses due to deep percolation are great. Depending on the location and rainfall patterns, the need for a preplant irrigation to obtain emergence is also questionable.

If the entire soil profile is not filled at planting time, irrigations following emergence may be large enough to not only satisfy current crop needs, but also to fill the vacant soil profile. This line of reasoning is used to leave room in the soil profile for rainfall that occurs during May-July.

The decision as to which method to use depends on the field office location, soils, and rainfall patterns.

7. The most efficient water use, by surface irrigation methods, as measured by the average yield per acre inch of water applied, has been obtained from planting single rows on 40 inch beds and irrigating every other row.

8. If grain sorghum is to be grown with only limited irrigation water supplies, a hybird with 15-20 fewer days of maturity time than a full season hybird should be chosen. Careful selection of a hybird within a given maturity range can further increase the drought resistance when irrigation water stress is anticipated.



TIMING OF IRRIGATIONS FOR MAXIMUM WATER USE EFFICIENCY OF GRAIN SORGHUM

①= Time of irrigation if only 1 seasonal irrigation is available.

②= Times of irrigation if 2 irrigations are available.

③= Times of irrigation if 3 irrigations are available.

④= Times of irrigation if 4 irrigations are available.

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COTTON

The majority of research done in the West, on growing cotton under limited irrigation, has been done on the High Plains of Texas.

The following are the results of currently available data on limited irrigation of cotton:

1. Timely applications of small amounts of irrigation water have been found to be more efficient than larger applications delivered before or after critical stages of growth. The attached chart shows the rate of water use during the growing stages of the plant with the most critical period for water being at the peak bloom stage of growth. Timing of a single irrigation should be given special consideration for maximum water use efficieny. Early maturing varieties have a higher percent of bolls to set early. Therefore, their effective irrigation season is shorter than for later maturing varieties. The most effective irrigation season may last only 30 days for early maturing varieties and as long as 50 to 60 days for late maturing varieties. The choice of variety maturity can have a significant influence on yield under limited irrigation where more than 30 days are required to irrigate an entire cotton acreage.

2. Tests show that if water is so limited that producers can apply only one summer irrigation, highest yields and water use efficiency were obtained when cotton had adequate water 20 to 30 days following bloom initiation. The proper timing for one watering is also shown on the attached chart. Soils should be wetted to a depth of two feet by this one summer irrigation as this will be the only irrigation water received.

3. Cotton to be irrigated twice during the summer has been found to produce more efficiently when the first summer irrigation was applied at bloom initiation and the second irrigation 16 to 30 days later. The second irrigation should be timed to prevent the development of damaging water stress conditions. Intervals will be closer for sandy or shallow soils than for loam or clay soils. Rainfall in excess of one inch can delay the application of either irrigation up to one week.

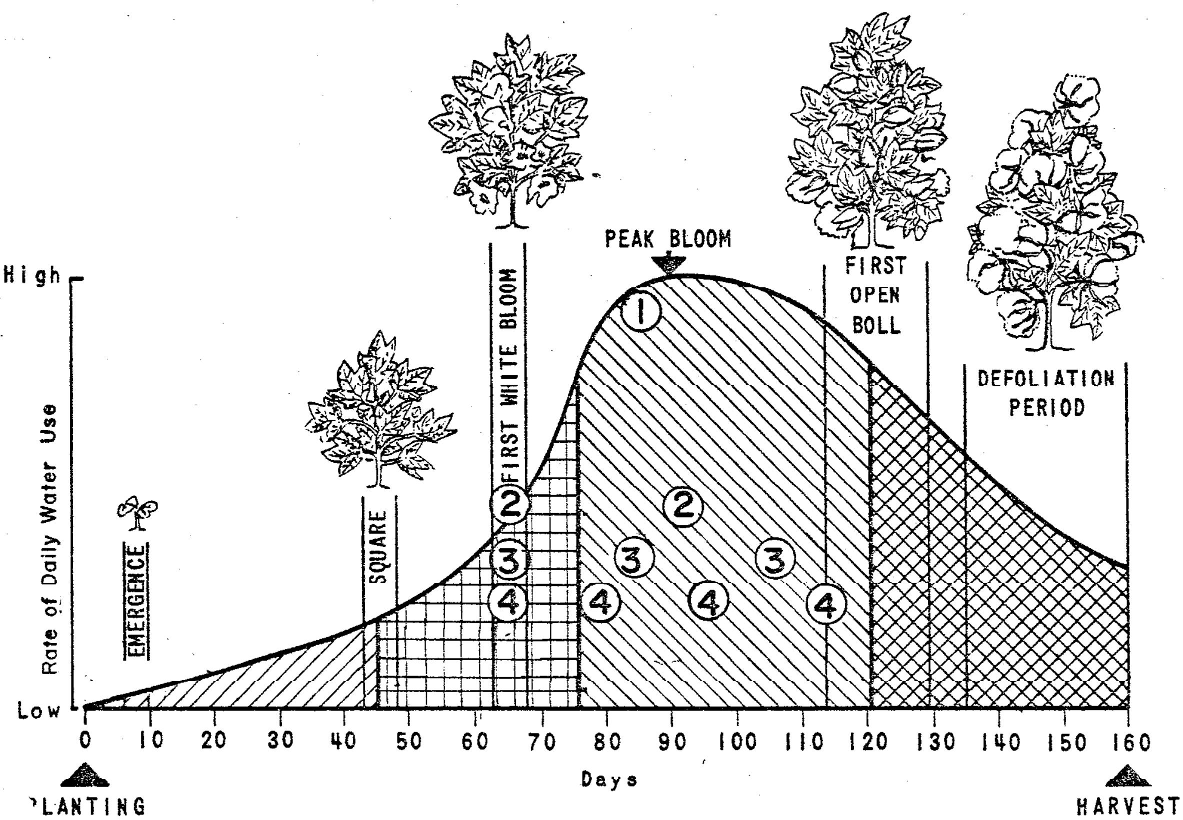
4. The timing of three or four irrigations is also represented on the attached graph.

5. Cotton fiber and seed quality is significantly affected by soil moisture availability during the critical stage of growth. Adequate soil moisture is necessary for cotton to produce its maximum fiber and seed characteristics. Timely applications of irrigation water normally prevents severe soil moisture stress during critical

stages of growth. However, under a limited irrigation system, moisture stress can be expected during part of the critical routine stage of growth. Generally, an irrigation applied during the middle of the fruiting stage of growth will support fruit forms set early. This fruit will develop in a more favorable part of the growing season and will be of a higher quality than late set fruit resulting from late irrigation water.

6. Cotton grown under a preplant plus two summer irrigations or cotton grown under a preplant plus one summer irrigation during favorable rainfall conditions can be expected to produce maximum fiber length. On the other hand, cotton grown under a preplant plus one summer irrigation during unusually dry years can be expected to produce short fibers. Tests show that under low soil moisture conditions, cotton planted in a skip-row manner will produce significantly longer fibers than cotton planted in a solid manner. This difference in length was found to be the result of additional soil moisture stored in adjacent fallow areas made available by cotton redevelopment during the fruiting stage of growth.

7. Low Micronaire and fiber strength should not be a problem under limited irrigation. However, severe soil moisture stress has been responsible for excessively high Micronaire readings. Seed quality has been found to be higher for cotton grown under limited moisture conditions than under optimum irrigation conditions on the South Plains of Texas.



TIMING OF IRRIGATION FOR MAXIMUM WATER USE EFFICIENCY OF COTTON

(1) = Time of irrigation if only 1 seasonal irrigation is available.

(2) = Times of irrigation if 2 irrigations are available.

(3) = Times of irrigation if 3 irrigations are available.

(4) = Times of irrigation if 4 irrigations are available.

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WINTER WHEAT

As with the preceeding data on grain sorghum and cotton, the majority of research data on limited irrigation of winter wheat, adaptable to New Mexico, has been done on the High Plains of Texas.

The following results are a summation of currently available data on limited irrigation of winter wheat:

1. The critical stages of growth that require adequate soil moisture are:

   (a) jointing

   (b) boot

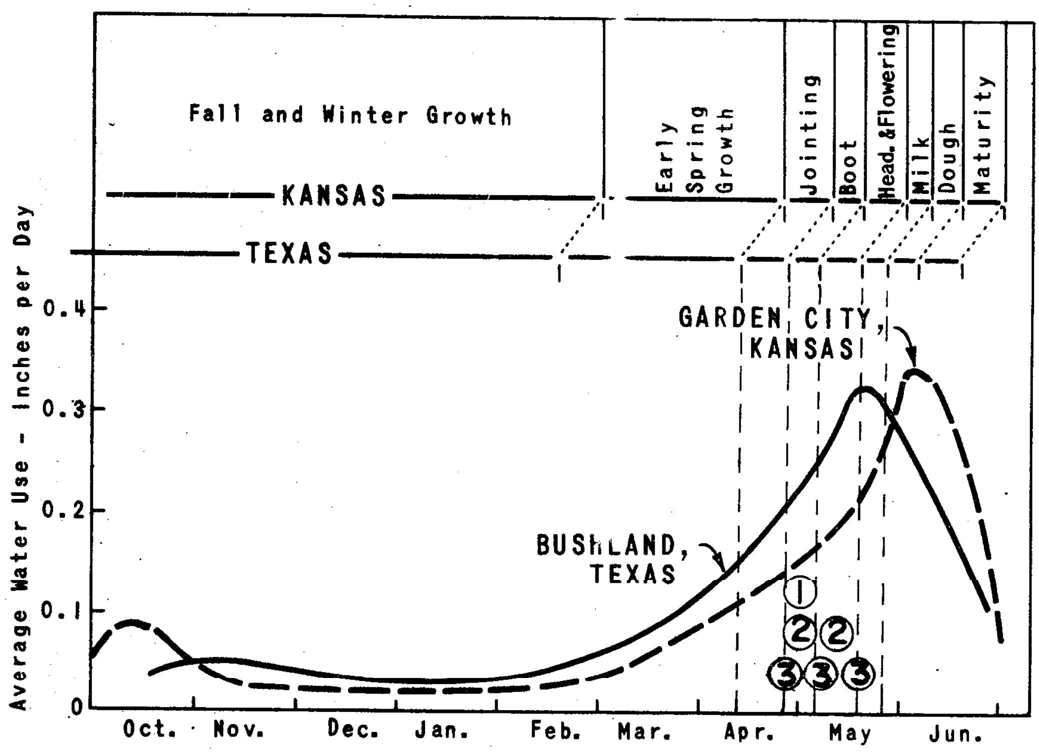
   (c) heading

   (d) milk and soft dough stages

   A preplant irrigation, sufficient to wet the entire soil profile, is generally applied 4 to 6 weeks before planting or immediately after planting.

2. Under limited irrigation, fall and winter grazing of winter wheat should be kept to a minimum.

3. Assuming that the entire soil profile is full at the time of fall planting, and that non-growing season rainfall is sufficient to replace water lost to drainage and evapotranspiration during the non-growing season, the following table shows when spring irrigations are needed for winter wheat grown under limited irrigation conditions:



TIMING OF IRRIGATIONS FOR MAXIMUM WATER USE EFFICIENCY OF WINTER WHEAT

(1) = Time of irrigation if only 1 summer irrigation is available.

(2) = Times of irrigation if only 2 summer irrigations are available.

(3) = Times of irrigation if only 3 summer irrigations are available.

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CORN

Research on limited irrigation of corn has been conducted in Colorado, Nebraska, North and South Dakota, and on the High Plains of Texas.

The following are the recommendations of this research adapted to an 18" or less rainfall area:

1. Critical stages of growth that require adequate soil moisture are:

   a. Late stage of vegetative growth period
   b. Tasseling-silking
   c. Grain filling

2. Greatest yield reductions are encountered when plant-water stress occurs near tasseling and continues through pollination. The tasseling-silking stage is the most critical for plant-water stress because of delayed silking relative to pollen shedding and reduced seed set. The vegetative growth period is least sensitive to stress related yield reductions; however, yield data indicates that the latter phase of vegetative growth can permanently limit yield potential by reducing ear size and grain numbers.

Research data from the Bushland, Texas Experiment Station emphasizes the following items:

1. Seasonal water use by corn will average about 31" net water per year.

2. The zero yield value of corn can be expected if only 16" of moisture is available.

3. Peak consumptive use rates for corn approached .31"/day.

4. Corn does not reflect the same drought-resistant characteristics of sorghum and cotton and is much more sensitive to plant water stress.

5. Where water supplies are limited, a suggested management alternative is to reduce corn acreage to the area that can be adequately irrigated and to plant the remaining area to sorghum. Although potential yields are lower for grain sorghum, it can be irrigated for near maximum yields with about 3/4 the irrigation water needed for corn, primarily because of a shorter growing season and less sensitivity to water deficits.

Irrigated corn does not have the flexibility to limit water application well below CU needs and still maintain efficient water use for grain production in New Mexico.

Limited irrigation of corn involves unacceptable high risks and should not be practiced.

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