MISSISSIPPI
SOYBEAN IRRIGATION GUIDE

MSPB
MISSISSIPPI SOYBEAN PROMOTION BOARD

ABOUT MSPB

The Mississippi Soybean Promotion Board (MSPB) and the soy checkoff work to increase the profitability of soybean production in Mississippi. The volunteer farmer-leaders who serve on MSPB invest checkoff dollars in research to improve soybean production practices to make your farm more profitable and ensure the sustainability of Mississippi soybean production.

This guide contains results from irrigation research, scheduling guidelines, along with tips and tools to consider for irrigated soybean production in Mississippi. Use this information to help implement and manage irrigation on your farm. This guide is not meant to replace the expertise of an irrigation specialist or consultant and should only be used as a reference.

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IRRIGATION QUICK TIPS

PREPARATION

- Know the soil texture of your irrigated fields. This governs the amount of water available to your soybeans, especially before you start irrigating. Texture is also an important factor in determining the need to irrigate during vegetative development and determining how frequently to irrigate once you start. Coarse-textured soils have the least plant-available water, and medium-textured soils have the most.
- Put a rain gauge in every irrigated field.
- Plan on a water use rate of at least 0.25 in/day during soybean reproductive development.

TIMING

- Waiting too late to start irrigating during persistent drought may cause irreversible damage to soybeans and can be worse than not irrigating at all.
- Terminating irrigation too soon will result in lost yield because of the less-than-maximum weight of individual seeds. The lost revenue from the lost yield far exceeds the cost of a final irrigation that is skipped.
- If irrigation water is limited, postpone irrigation until R3 or R5 rather than watering earlier and quitting.

METHODS

- In hot and dry years that provide an extremely low yield potential, a single irrigation with a small amount of water, e.g. 1 in., at any reproductive growth stage is of no consequence toward improving yield to profitable levels.
- All methods of irrigation will produce equivalent yield gains if they are managed properly.

PEST MANAGEMENT

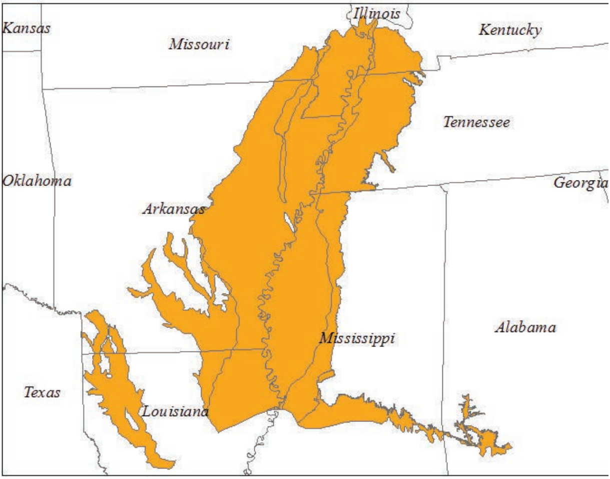
- Insects prefer irrigated over non-irrigated soybeans; therefore, scout closely for late-season insect infestations in irrigated plantings.
- Irrigated soybeans require the highest level of pest management to realize the full benefit from irrigation. Remember, with proper irrigation drought stress will not occur to limit or minimize the effect of yield-enhancing inputs. Irrigated beans are the ones to receive the highest level of management.

WHY IRRIGATE?

THE MISSISSIPPI RIVER VALLEY ALLUVIAL AQUIFER

Crops in the Lower Mississippi River Basin depend on irrigation to keep up with water requirements. Much of that water comes from the Mississippi River Valley Alluvial Aquifer (MRVAA), which is the upper aquifer of the Mississippi embayment aquifer system. Extensive use of irrigation is leading to a decline in available water in the aquifer at the rate of around 300,000-acre-feet annually, according to Dr. Jason Krutz, Director of the Mississippi Water Resources Institute.

The Alluvial Aquifer is composed of coarse sand and gravel at the bottom that grades to fine sand at the top. In some areas, the thickness of the sand has decreased to less than 15 meters and is considered to be in danger of being depleted for irrigation. Significant extraction of water from the Alluvial Aquifer began in the early 1900s (Griffis, 1972; Peralta et al., 1985). In areas near the Mississippi and Arkansas Rivers that are hydraulically connected, the level of the aquifer changes with water stage of the river. As the elevation of the rivers change water moves in and out of aquifer storage. In areas where the confining unit is thin, sandy or absent, recharge of the aquifer is significant. These areas generally correspond with the thickest parts of the aquifer. (Scott, H. et al., 1998). The Alluvial Aquifer has contributed to several decades of successful crop production in the Delta, but it is important for farmers to irrigate responsibly so water from the aquifer doesn't run out. MSPB supports the responsible use of water so that farmers remain profitable and successful for years to come.



All plants require water for growth and reproduction. Crop plants require water in an amount that will allow them to produce an economical yield of grain, forage, or fiber. Drought stress is an extended period of dryness that results in stress to crop plants, which is manifested in irreversible yield loss. In the Midsouthern United States, moderate to severe drought stress in soybeans is common during the summer growing season.

The water required to produce an economical yield is significantly greater than that for survival. Hence, the effect of drought stress on soybeans and their ability to cope with it has been, and always will be, a major hurdle for Midsouth agriculture. The following information can be used to successfully manage irrigation of soybeans to obtain the maximum yield.

Summer weather patterns (high temperatures and low rainfall) in the Midsouthern U.S. dictate that irrigation will be required

to attain maximum soybean yields. Properly timed and applied irrigation will increase soybean yield significantly in most years, which in turn will increase profits.

Irrigation is the single most important agronomic input for realizing maximum yield potential of an established soybean crop. It is especially important when both input and commodity prices are high. Producers cannot afford to grow poor soybeans with expensive inputs, nor can they afford to lose yield to improper irrigation when prices are high.

Properly managed irrigation of soybeans should result in a yield increase of 20 or more bushels per acre in years with normal Midsouth weather. Even in years with above-average rainfall, irrigated yields will increase profits because some degree of drought stress always occurs in the Midsouth.

STARTING POINTS

SOYBEAN REPRODUCTIVE GROWTH STAGES

VEGETATIVE STAGES

EMERGENCE TO COTYLEDON

VE

VC

MANAGEMENT PRACTICES:
Scout for adequate and uniform stand. If stand is poor, replanting may be necessary.

FIRST TRIFOLIATE TO SECOND TRIFOLIATE

V1

V2

MANAGEMENT PRACTICES:
Scout for early-season weeds, insects and diseases.

Apply post-emergence herbicides if needed to control small emerged weeds.

REPRODUCTIVE STAGES

BEGINNING FLOWERING TO FULL BLOOM

R1

R2

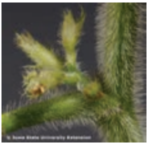
MANAGEMENT PRACTICES:
Scout for insects and diseases. Spray foliar insecticide or fungicide, if needed. See Insect Control Guide for Agronomic Crops in Mississippi. Check soil moisture status using soil moisture sensors. Start/complete irrigation setup.

REPRODUCTIVE STAGES

BEGINNING POD

R3

MANAGEMENT PRACTICES:
Scout for insects and diseases. Spray foliar insecticide or fungicide, if needed. Identify drought stress, which can affect pod formation. Beginning irrigation, if used, is critical at this stage.



FULL POD TO BEGINNING SEED

R4

R5

MANAGEMENT PRACTICES:
Scout for insects and diseases. Late-season diseases and defoliation by insects can severely impact yields. Spray foliar insecticide or fungicide, if needed.

FULL SEED

R6

MANAGEMENT PRACTICES:
Check soil moisture status for possible last irrigation.

BEGINNING MATURITY TO FULL MATURITY

R7

R8

MANAGEMENT PRACTICES:
Scout for issues before harvest, e.g. green stem syndrome. Utilization of desiccants is a viable option. If the plant is still green, the best option is to harvest slowly and make sure the harvesting equipment is sharp and in excellent condition.

SOIL-PLANT-WATER RELATIONS

The moisture status of plants is a function of soil water supply, the evaporative demand of the atmosphere, and the capacity of the soil to release water. In the field, significant water deficits develop on hot sunny days even in well-watered plants. As water evaporates from the leaves, the moisture tensions that develop increase the rate of water uptake from the soil. If roots cannot absorb water rapidly enough, plant water tension increases. These tensions become growth-limiting under these conditions.

VEGETATIVE SOYBEAN-WATER RELATIONS

Leaf growth is very sensitive to water deficits. Daytime leaf growth in soybeans is greatly reduced even in well-watered soils. If plants are exposed to reasonably good soil water conditions, they will recover overnight and growth will resume during the nighttime hours. Nearly all vegetative growth occurs at night when water conditions in the plant are favorable. In general, water deficits in the vegetative phase slow the overall crop growth rate and result in shorter plants with less canopy leaf area resulting from fewer and/or smaller leaves. Results from various research activities in the Midsouth indicate that soybeans grown in the Early Soybean Production System (ESPS) will rarely suffer adverse effects from drought stress during the vegetative phase or between planting and R1; i.e., water use does not exceed rainfall in an average year.

REPRODUCTIVE SOYBEAN-WATER RELATIONS

The growth of pods and seeds, like that of leaves, is sensitive to plant water deficits. However, since these stages occur later in the season when soil moisture and rainfall are at their lowest seasonal levels, the potential for significant reductions in their growth and development caused by drought is great. The extent of this reduction depends on the longevity of drought.

DROUGHT STRESS AND YIELD REDUCTIONS

Each time drought stress occurs, yield reductions in some amount will occur. The intent of irrigation is to alleviate as many of these drought periods as possible, especially during reproductive development.

Irrigation is best used in conjunction with a knowledge of the following soil factors.

SOIL TEXTURE AND AVAILABLE WATER

COARSE-TEXTURED SOILS

(Sands) contain many large pores that lose water quickly due to gravity. Little plant-available water remains after gravitational water loss because of the relatively little surface area of the large sand particles.

MEDIUM-TEXTURED SOILS

(Loams) contain intermediate-sized particles and pores that are only moderately affected by gravitational water loss. These soils have the most water available to plants.

FINE-TEXTURED SOILS

(Clays) contain many small pores that lose water slowly due to gravity. The extensive surface area of the small clay particles holds water tightly against plant forces to extract water. Clay soils contain the most total water, but only an intermediate amount of plant-available water.

Data in the accompanying box provide a general categorization of plant-available water related to soil texture. Available soil water in coarse- and medium-textured soils is more readily extractable by plants than is water in fine-textured soils.

SOIL TEXTURAL CLASS	IN. AVAILABLE WATER/FT. (AVG.)
Coarse sand	0.6 — 0.8 (0.7)
Fine sand	0.8 — 1.0 (0.9)
Loamy sand	1.1 — 1.2 (1.15)
Sandy loam	1.3 — 1.4 (1.35)
Fine sandy loam	1.5 — 2.0 (1.75)
Very fine sandy loam, silt loam	2.0 — 2.5 (2.25)
Silty clay	1.5 — 1.7 (1.6)
Clay	1.3 — 1.5 (1.4)

SOYBEANS GROWING ON COARSE-TEXTURED SOILS GENERALLY WILL GROW FASTER THAN SOYBEANS GROWING ON CLAY SOILS.

However, without frequent rain to replenish depleted soil water, crops growing on coarse-textured soils will show visible drought stress quicker than will plants growing on finer-textured soils. Crops growing on sandy soils may die from unremedied drought stress, while those growing on clay soils may wilt progressively over a long period of time, but still recover with the addition of water.

IRRIGATION TECHNOLOGIES


WATERMARK
Soil Moisture Meter
(Centibars/kPa)
TEST
Press again

The timing of irrigation application is the most important consideration in irrigated soybean production. The method of irrigation, such as furrow or center-pivot, is not a factor in the response of the crop to water.

Soybeans grown on the flat alluvial flood plain of the lower Mississippi River Valley in the Midsouthern U.S. are irrigated primarily using surface methods. Furrow irrigation accounts for the major area of irrigated soybean, but flood irrigation is used to irrigate a large area, especially fields rotated with rice.

On clay soils, proper irrigation scheduling will ensure watering before large cracks develop in the soils. Watering alternate middles is an accepted practice and is widely used on the clay soils.

"47%: The decrease in the amount of water use by a combination of Pipe Planner, surge valves and soil-moisture sensors."

- Jason Krutz, Director of the Mississippi Water Resources Institute.

PHAUCET/PIPE PLANNER

The PHAUCET software program was developed to improve distribution uniformity of irrigation water delivered from gated pipe. The software program helps growers determine the size of holes to punch along the length of a polypipe irrigation set. The formula is based on the following factors:

- Pressure change along the tubing
- Pipe diameter
- The different row lengths that will be encountered along an irrigation set
- The elevation changes that occur down the length of the pipe

The program is especially valuable for irregularly shaped fields. For fields set up using the output of the program, it may be possible to irrigate a greater number of rows in a set, allow irrigation water to reach the end of variable length rows more evenly, and help reduce runoff and irrigation pumping time. A wide range of experiences demonstrate at least a 25% reduction in pumping time and applied water and a reduction in irrigation costs.

PIPE PLANNER

Pipe Planner has displaced PHAUCET as an easy-to-use tool that can be used for the above purpose. Rollout vinyl pipe is most often used for surface water applications because of its ease of handling and its amenability to setups using Pipe Planner. Pipe Planner is an invaluable tool for ensuring even distribution of water down rows of unequal length in a field. At $3 per acre-inch, farmers can expect a cost saving of $12 to $14 per acre with Pipe Planner (Krutz).

HOW TO IMPLEMENT:

Before using Pipe Planner, producers must know the following for each field:

- Output or discharge rate in gallons per minute from the well or riser
- Furrow spacing and direction
- Elevation change along the polypipe set.

Once the required information is entered, Pipe Planner calculates the optimum polytube size, the sizes and number of holes to punch in each section of tubing, and the approximate time required for proper irrigation. The resulting irrigation designs can be used in paper or electronic form and can be remotely accessed.

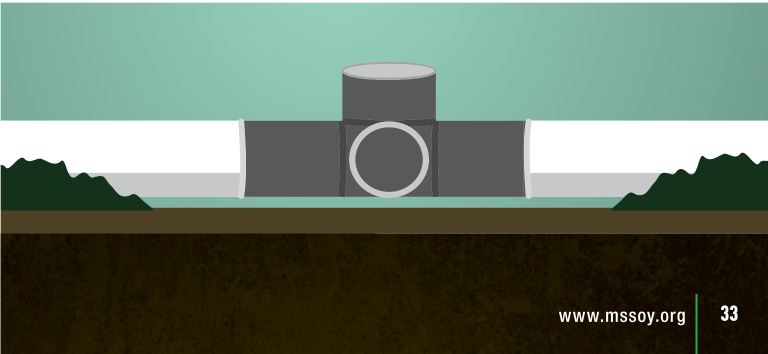
A video series on the topic of Pipe Planner implementation, called Pipe Planner: All You Need to Know, is available on the MSPB website, www.mssoy.org.

SURGE VALVES

With furrow irrigation, continuous flow from the entire line of irrigation pipe is the norm for applying water. However, applying water sporadically to an irrigation furrow results in water moving to the end of irrigated furrows quicker than when applied by continuous flow. This can be accomplished by using a surge valve with an automatic controller, which automatically cycles irrigation water between the two sides of the valve.

The net result is less water applied with each irrigation and less total irrigation water applied during the season, resulting in equal yield and higher net return. Net return is higher due to less fuel being used to irrigate.

Surge valves are a good investment for farmers who find that their conventional systems lose water when the flow down the furrow slows down and allows applied water to infiltrate below the root zone.



Surge valves skip this problem entirely by pulsing water across the field, where it can shoot over the area that's already been wetted and reach the spots that need more attention.

Research funded by MSPB with Krutz indicates that water use with surge valves is 22-24% less compared to continuous-flow furrow irrigation. In addition, 25% of the agricultural overdraft from MRVAA can be eliminated if surge valves are implemented on continuous-flow furrow irrigated soybeans grown on clay-textured soils.

HOW TO IMPLEMENT:

- Start by ordering either an 8, 10 or 12-inch surge valve. All surge valves come with a control panel with an electric motor that is solar powered.
    - o Set a time for it to irrigate the field based on the number of hours it takes to get to the end of the field.
- Use the soak setting: The valve will oscillate water from one side of the valve to the other every hour or so to make sure the water soaks in, but not more than is needed.

SOIL MOISTURE SENSORS

Soil moisture sensors can be used to determine the need to irrigate soybeans during both vegetative and reproductive development. Soil moisture sensors allow growers to better time irrigation to crop demand and available soil moisture content rather than setting a schedule and maintaining it throughout the growing season. Farmers can save $10 per acre with soil moisture sensors, according to Krutz.

When using soil moisture sensors to schedule irrigation the most critical factor is to ensure they are placed in the most representative area or areas of each field to be irrigated. If only one sensor site is used, it should represent the majority soil texture in the field. However, multiple sensor sites may be needed or preferred in fields with variable soil textures. Soil moisture sensors help farmers determine moisture by depth in the active rooting zone and infiltration depth of applied water.

WHY SOIL MOISTURE SENSORS?

USES
25-50% LESS
IRRIGATION WATER

SAVES MONEY
ABOUT $10/ACRE

MEASURES EFFECTIVENESS
OF IRRIGATION SYSTEM

BETTER
PREPARES FARMERS
FOR WEATHER EVENTS

MATCHES THE
IRRIGATION FREQUENCY
WITH THE DEMAND OF THE CROP

MSSOY.ORG

Technical editing provided by Jason Krutz, Ph.D., Mississippi State University.

HOW TO IMPLEMENT:

Quantity: Use a minimum of one sensor set per 40-80 acres if a field contains the same soil type.

Where: A soil moisture sensor set includes three sensors placed 6, 12 and 24 inches deep in the soil for soybeans.

When: Place soil moisture sensors in the field during the growing season to schedule initiation and termination of irrigation according to growth stage and soil moisture level.

How: Think about the whole field, and consider the soil type variation to decide sensor placement.

Here are some more tips for the installation and use of Soil Moisture Sensors from the University of Mississippi extension office.

- Watermark sensors have a useful life of about 5 years. Sensors older than this should be discarded and replaced with new sensors.
- Watermark sensors should be pre-conditioned before installation to ensure the quickest response to changes in soil moisture after installation.
- Sensors must be installed when the soil is moist.

For detailed information about the above tools for increasing irrigation efficiency, go to www.mssoy.org and search the following phrases: Pipe Planner, Surge Valves, Soil Moisture Sensors.

In addition to the use of the PHAUCET/Pipe Planner program, surge valves and soil moisture sensors, the following tactics may also be considered for increasing irrigation efficiency:

ZERO GRADE

ZERO GRADE IS FREQUENTLY USED FOR FLOOD IRRIGATION.

The flood method is the inundation of a field or paddy with water from one or a few sources. This irrigation method results in irrigation water running to the low end of a field or paddy before filling the area contained within levees that separate individual paddies. This then results in more water on the lower than on the upper end of a paddy at the end of an irrigation cycle.

Zero grade is the term used to describe the process of making a field completely flat. This tool is used to remove slope within a field so that irrigation water is distributed at an even depth over the entire field during flood irrigation. Levees are not

required within the irrigated area. The net result will be that less water is required to flood an individual paddy at each irrigation event.

TAIL-WATER RECOVERY

TAIL-WATER RECOVERY IS GENERALLY USED FOR SURFACE-IRRIGATED CROPS.

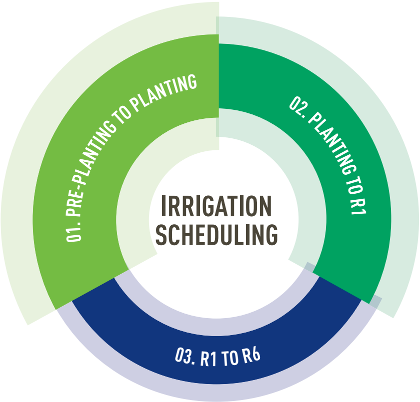
Tailwater recovery is a planned system to collect, contain, and transport water runoff from irrigated areas for reuse. The benefits from this process are:

1) Conservation of irrigation water by capturing and reusing the irrigation runoff water from a field, and

2) Improvement of off-site water quality by preventing the downstream movement of sediments, nutrients, and chemicals that are suspended in the runoff water.

Collection facilities may include ditches and on-farm water storage structures that are built for this purpose.

IRRIGATION SCHEDULING THROUGH SOYBEAN GROWTH STAGES



01 PRE-PLANTING TO PLANTING

MAKE IRRIGATION PLANS.

March is the ideal time to plan the irrigation setup for the season.

IRRIGATION FOR EMERGENCY.

A dilemma sometimes faced when planting into dry soil is whether or not to water before or after planting to effect germination and emergence.

- Crusting soils should be watered before planting to prevent the crusting and subsequent emergence problems that occur if irrigation follows planting. This can be accomplished efficiently with overhead irrigation.
- Shrink-swell soils (clays) should be watered after planting for the following reasons:
    - Planting is not delayed by waiting for the soil to dry.
    - Rows planted in dry soil can be pre-plant-cultivated or bedded for furrow formation to effect rapid down-slope movement and drainage of post-plant irrigation water.
    - Preemergence herbicides will be activated, and this has become increasingly important since they are now being used to introduce more modes of action into soybean weed control programs.
    - Seeds can be planted shallow to effect quick emergence.
    - Irrigation water is not wasted because of watering unplanted acres that may receive rain before planting can occur.
    - The earlier planting option offered by after-planting irrigation is maintained.

02 PLANTING TO R1

Irrigation of soybeans during vegetative phases is rarely necessary in the Midsouth. In fact, in three years of MSPB-funded research (2015-2017) conducted at Stoneville, Miss., vegetative soybeans never needed irrigating when using the recommended season-long threshold of -85 kPa to schedule irrigation.

03 R1 TO R6

IRRIGATION WITH LIMITED WATER.

- If irrigation water is limited, postpone irrigation until R3-R5 stages rather than watering earlier and quitting. Since rain is often more likely to occur during the early reproductive period (R1-R3) than during later reproductive development, irrigation that is delayed until the R3-R5 period because of limited irrigation water can ensure maximum number of pods if more likely rains are received during the early stages (R1-R3) of reproductive development.

- The largest seeds for a variety are often found when non-irrigated soybeans were severely stressed through R5, and then received water (irrigation and/or rain) afterward.

IRRIGATION WITH LIMITED WATER.

- MSPB-funded research indicates that soybean producers in the Midsouth who irrigate using lay-flat polyethylene tubing can maintain a season-long, static soil moisture sensor threshold of -85 kPa for ESPS soybean grown on silt loam to clay soils without adversely affecting yield or profitability, while concurrently optimizing irrigation water use efficiency.

TERMINATING IRRIGATION

TIMING OF TERMINATION

When beans have reached stage R6.5, or the stage at which seeds in pods from one of the four uppermost nodes easily separate from the pod membrane, the seeds are no longer taking in additional moisture or nutrients. Thus, irrigation can be terminated about 10 days before this point. Having wet soil or applying a last irrigation to dry soil at or just before R6 will ensure that enough soil moisture is available to completely fill the seeds to R6.5. This will ensure maximum yield.

Stopping irrigation too soon will not result in fewer seed but will result in smaller seed. A properly irrigated crop with a 70 bu/acre yield potential will have 12.5 million (3000 seed/lb) to 14.5 million (3500 seed/lb) seeds/acre. Thus, even very small reductions in seed size can translate to large reductions in yield.

SOIL TEXTURE AND TERMINATION

The coarser the soil texture, the later the last irrigation should be. The shortest and longest times between the last irrigation and maturity should be in the order of coarse- to medium- to fine-textured soils, respectively.

Soybeans growing on clay soil should receive a last surface irrigation (in the absence of rain) about 15 days before R7, which coincides with R6. Assuming a water use rate of 0.12 to 0.15 inch per day from R6 to R7, this last irrigation will provide enough available water in an 18-inch rooting zone to carry the soybean crop to R7 or beginning maturity.

Soybeans growing on soils with a low infiltration capacity or on coarse-textured soils with a low available water holding capacity may need a last irrigation after R6. This decision about a last irrigation is more critical for early plantings because they are in the R6 to R7 period during the hottest and driest part of the growing season.

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Technical editing for this guide was led by researchers from Mississippi State University and personnel from the Mississippi Soybean Promotion Board. MSPB/soy checkoff neither recommends nor discourages the implementation of any advice contained herein, and is not liable for the use or misuse of the information provided.