

9 – Water Management

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An abundant supply of good quality irrigation water is needed for optimum rice production. Knowledge of the quality and quantity of irrigation water is required for proper water management.

Determining Water Needs

A water supply is adequate for a given field if you can:

- Flush in two to four days;
- Flood in three to five days;
- Maintain flood for the entire season.

Recommended pumping rates are based on the different soil textures (Table 9-1). Since most fields may have more than one soil texture, use these pumping rates as a general guide for determining needed pumping capacities as shown in Table 9-2.

Table 9-3 shows the operating time required to pump 1 inch of water on different size fields at different pumping rates. This is useful for estimating the amount of pumping time required for a given situation.

Determining Pump Flow

A good method of determining pump discharge is to use an inline flow meter. Many irrigation equipment dealers handle flow meters and can provide cost and proper installation information. Proper installation is very important to assure accurate readings and good service from the flow meter. A portable flow meter can be used to monitor the flow of more than one pumping plant. Most flow meters can be equipped with a totalizing dial that records the total quantity of water pumped. This provides useful water management information that can also be used to document irrigation water requirements.

Table 9-1. Recommended Pumping Rates for Different Soil Textural Groups

Soil Textural Group	(GPM/AC)	
	Minimum	Desired
Silt Loam	10	15
Loam or Clay	15	20
Sandy	20	25

Table 9-2. General Guide for Maximum Irrigated Acreage for Different Soil Textural Groups at Various Pump Capacities

Pump Capacity (GPM)*	Irrigatable Acreage		
	Silt Loam	Loam or Clay	Sandy
400	40	27	20
600	60	40	30
800	80	53	40
1000	100	67	50
1200	120	80	60
1400	140	93	70
1600	160	107	80
1800	180	120	90
2000	200	133	100
2200	220	147	110
2400	240	160	120
2600	260	173	130
2800	280	187	140
3000	300	200	150

Example: A 1,000 gpm pump could be used to irrigate a 100-acre silt loam field but only 50 acres if the field is a sandy soil.

*GPM is abbreviation for gallons per minute.

Table 9-3. Pumping Hours for 1 Inch of Water on Different Acreages at Various Pump Capacities

Pump Capacity (GPM)	Surface Acres							
	20	40	60	80	120	160	200	240
	Time (Hours)							
200	45	91						
400	23	45	68	91				
600	15	30	45	60	91			
800	11	23	34	45	68	91		
1000		18	27	36	54	72	91	
1200		15	23	30	45	60	76	91
1400		13	19	26	39	52	65	78
1600		11	17	23	34	45	57	68
1800			15	20	30	40	50	60
2000			14	18	27	36	45	54
2200			12	17	25	33	41	49
2400			11	15	23	30	38	45
2600				14	21	28	35	42
2800				13	19	26	32	39
3000				12	18	24	30	36
3200				11	17	23	28	34
3400					16	21	27	32
3600					15	20	25	30
3800					14	19	24	29
4000					14	18	23	27
4200						17	22	26
4400						17	21	25
4600						16	20	24
4800							19	23
5000							18	22

Example: A well discharging 1,000 gpm will yield enough water to apply 1 inch to 80 acres in 36 hours or apply 1 inch to 120 acres in 54 hours.



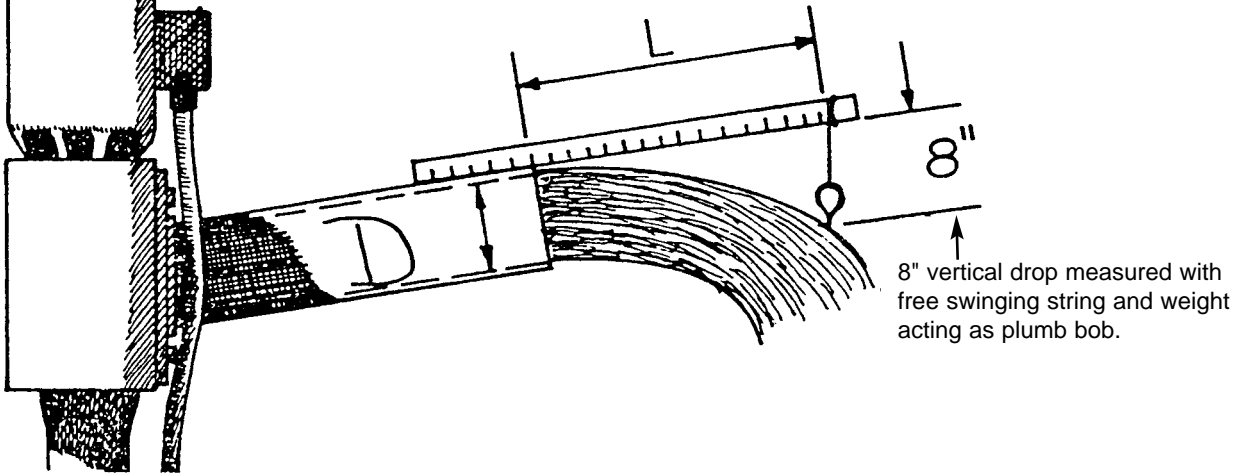
Flow meter and plumb bob measurement of water flow in a horizontal pipe from a riser.

If a flow meter is not available, the discharge rate can be estimated by the plumb bob method described in the following section (Figure 9-1 and Table 9-4).

When the water discharges from a vertical riser, the flow rate can be estimated with a vertical measurement. However, the accuracy is usually very poor because of the difficulty in obtaining a good measurement of the vertical height. A more accurate measurement is usually obtained if a hydrant is installed on the riser creating a horizontal discharge. A joint of pipe inserted in the hydrant stabilizes the flow and makes the plumb bob method possible.

Figure 9-1. Measuring Pump Flow

- Pipe can be horizontal or at slight angle.
- Pipe must be flowing full.
- Accuracy is ± 10 percent.



Measuring Procedure: Extend yardstick parallel with discharge pipe until 8" plumb bob barely touches the water stream. Measure length (L) and pipe inside diameter (D) which is less than the nominal pipe diameter.

Example: Discharge Pipe – 10 inches (D)
Discharge Length – 14 inches (L)

$$\text{GPM} = 10 \times 10 \times 14$$

$$\text{GPM} = 1400$$

Formula: Gallons per minute = the inside diameter squared x the length in inches.

Note: Discharge pipe must be full and plumb bob length must be 8" for this method to be accurate. See Table 9-4 for flow rates at various measurements.

$$\text{GPM} = D \times D \times L$$

Table 9-4. Pump Flows Calculated from Yardstick and 8-inch Plumb Bob Measurements

Length (L) Inches	Inside Diameter of Pipe (D) – Inches										
	4"	5"	6"	7"	8"	9"	10"	11"	12"	13"	14"
	Flow (GPM)										
4	64	100	144	196	256	324	400	484	476	676	784
6	96	150	216	294	384	486	600	726	864	1014	1176
8	128	200	288	392	512	648	800	968	1152	1352	1568
10	160	250	360	490	640	810	1000	1210	1440	1690	1960
12	192	300	432	588	768	972	1200	1452	1728	2028	2352
14	224	350	504	686	896	1134	1400	1694	2016	2366	2744
16	256	400	576	784	1024	1296	1600	1936	2304	2704	3136
18	288	450	648	882	1152	1458	1800	2178	2592	3042	3428
20	320	500	720	980	1280	1620	2000	2420	2880	3380	3920
22	352	550	792	1078	1408	1782	2200	2662	3168	3718	4312
24	384	600	864	1176	1536	1944	2400	2904	3456	4056	4704
26	416	650	936	1274	1664	2106	2600	3146	3744	4394	5096
28	448	700	1008	1372	1792	2268	2800	3388	4032	4732	5488
30	480	750	1080	1470	1920	2430	3000	3630	4320	5070	5880
32	512	800	1152	1568	2048	2592	3200	3872	4608	5408	6272
34	544	850	1224	1666	2176	2754	3400	4114	4896	5746	6664
36	576	900	1296	1764	2304	2916	3600	4356	5184	6084	7056

Pumping Cost

The total cost for pumping irrigation water is influenced by several factors. Taxes, insurance, interest, depreciation, maintenance and energy must all be considered as real costs. Energy is usually more than 50 percent of the total pumping cost over the life of an irrigation pumping plant.

Table 9-5 presents typical energy use values for various energy sources and different pumping depths. Since energy prices can vary from season to season, current energy prices should be applied to the energy use values to calculate actual cost. Energy use values vary due to motor or power unit design, wear and matching to load. The values are presented as a guide for comparison.

Table 9-5. Energy Use Comparison

Energy Unit ²	Typical Energy Use Per Ac-In of Water Pumped from Different Pumping Depths ¹				
	50'	100'	150'	200'	250'
Electric – KWH (Conventional)	8.2	16.4	24.6	32.8	41.0
Electric – KWH (Submersible)	9.0	18.0	27.0	36.0	45.0
Diesel – GAL	0.5	1.1	1.6	2.2	2.7
LP Gas – GAL	1.0	2.0	3.0	4.0	5.0
Gasoline – GAL	0.8	1.6	2.4	3.2	4.0
Natural Gas – CCF	1.0	2.0	3.0	4.0	5.0

NOTE: Typical energy use can vary ±20 percent due to motor or power unit design, wear and matching to load.

¹The pumping plant performance values used in the calculations are based on Nebraska Standards and Arkansas pumping plant tests. The values for gasoline, LP and natural gas include a 5 percent drive loss, while no drive loss is considered for electric. All values assume a 75 percent pump efficiency. Typical fuel consumption is based on the system performing at 80 percent of the best performance possible. Pumping depth is depth to water when pumping.

²KWH = kilowatt hour; GAL = gallon; CCF = 100 cubic feet

Typical values for the amount of water pumped in a season have been determined for different soil textures (Table 9-6). The values may vary but can be used as a guide for determining seasonal water use.

Table 9-6. Typical Water Use

Soil Textural Group	Seasonal Water Use	
	(Ac-In/Ac)	(Ac-Ft/Ac)
Silt Loam - with pan	24	2.0
Silt Loam - no pan	30	2.5
Loam or Clay	36	3.0
Sandy	48	4.0

Tables 9-5 and 9-6 can be used to estimate energy cost as well as to compare actual energy costs to what is presented as typical. This information can be useful for evaluation of water management practices.

Example:

- Rice field is predominantly clay
- Pumping depth is 100 feet
- Diesel power unit with diesel at \$0.90 per gallon
- Typical energy use from Table 9-5 is 1.08 gal/ac-in
- Typical water use from Table 9-6 is 36 ac-in/ac

Estimated energy cost is:

$$1.1 \text{ gal/ac-in} \times 36 \text{ ac-in/ac} \times \$0.90/\text{gal} = \$35/\text{ac}$$

For more information on pumping irrigation water, request publication MP 279, *Pumping Irrigation Water*, from the local county Extension office.

Irrigation Water Quality

While ample irrigation water is necessary for a productive rice crop, poor quality water can cause soil-related problems that negatively impact rice. Some of the predominant soil-related problems that affect rice include salinity (high soluble salts), zinc deficiency, phosphorus deficiency and excessive sodium, which causes poor physical soil conditions.

Salinity is most often associated with arid or semi-arid regions of the world, such as in the southwestern USA. However, salinity problems are common in the rice producing regions of Arkansas in some circumstances. The poor drainage characteristics of the soils in Arkansas that allow them to be efficient for rice production also contribute to the problems associated with salinity.

Salinity results from adding salt to soils, usually in irrigation water, faster than it is

removed by natural processes, such as surface runoff and downward percolation. Irrigation water is the major contributor of soluble salts in Arkansas but excessive nutrient additions from fertilizers, manures or waste materials may also contribute to the accumulation of salts. The types of soluble salts that usually contribute to salinity problems include calcium, magnesium, sodium, chloride, sulfate and nitrate.

In addition to the effect on rice production, irrigation water that contains excessive levels of chloride can lead to chloride toxicity in soybeans. Rice is most sensitive to chloride and nitrate salts at the seedling growth stage. Sodium problems are usually native to particular soils such as the Foley, Lefe, Hillemann and Stuttgart soil mapping units. However, isolated cases of water containing excess sodium have been observed. Excessive sodium may cause poor physical conditions of the soils which can interfere with crop stand establishment.

Zinc and phosphorus deficiencies are usually associated with alkaline (high pH) soils, particularly on silt loam soils. Alkaline soils are created by irrigating with water that contains high concentrations of calcium and magnesium bicarbonate. When the water enters the field, the bicarbonates are converted to calcium and magnesium carbonate (lime) which are then deposited in the field. The soil pH increases in the field where the carbonates (lime) are deposited. A soil pH gradient is usually created such that the

soil pH is high near the inlet and decreases down the slope. It is possible to develop both salinity and alkalinity problems in the same field.

Correct diagnosis of problems concerning irrigation water quality are critical for effective management. Water quality testing is an important step in diagnosing existing problems and identifying potential problems. Several values are helpful in evaluating the quality of a particular water source. These include calcium concentration, bicarbonate concentration, chloride concentration, electrical conductivity (EC) and sodium absorption ratio (SAR) (Table 9-7).

Table 9-7 provides a brief guide for evaluating water quality. The calcium and bicarbonate concentrations provide an estimate of the amount of lime that will be deposited and predictions can be made concerning the change in soil pH with long-term use. Electrical conductivity is a measure of the total salts that are dissolved in the water, which allows an estimate of the potential for salinity injury to rice with use of the water. Chloride concentration is important because of the potential for chloride toxicity to soybeans and because it often is the major contributor to high electrical conductivity. The SAR is a ratio of sodium to calcium and magnesium. This number provides an estimate of how much sodium is in the water relative to calcium and magnesium. The SAR allows the prediction of whether sodic (high sodium) soils are likely to develop with long-term use of the water.

Table 9-7. General Rice Irrigation Water Quality Guide

Water Quality Variable	Level Considered to Cause Concern [†]	Concern
Calcium (Ca) Bicarbonate (HCO ₃)	> 60 ppm (> 3 meq/L) > 305 ppm (> 5 meq/L)	Together can cause soil pH increases near water inlet and inflow areas, causing zinc or phosphorus deficiency in silt loam soils.
Electrical Conductivity (EC) (after lime deposition)	>770 ppm (> 1200 mhos/cm; 1.2 dS/m)	Causes high soil salinity which can injure and/or kill seedling rice.
Chloride (Cl)	> 100 ppm (> 3 meq/L)	Contributes to measured EC level (see above). High Cl alone may pose a problem for soybeans in rotation.
Sodium Adsorption Ratio (SAR [‡])	> 10	Causes sodic soil which has poor physical condition.

[†] Lower levels can cause injury in some cases.

[‡] SAR = $\text{Na} / \sqrt{[(\text{Ca} + \text{Mg})/2]}$, where Na, Ca and Mg are in meq/L.

The University of Arkansas conducts water quality testing for a small fee that includes a computer prediction of any long-term effects that may result from using the irrigation water. This analysis includes effects of various crop rotations, soil texture, and water management alternatives. Once a water source has been tested, retesting is usually not necessary for at least five years. However, earlier retesting may be necessary when crop problems develop that may be related to water quality or when the pumping rate or depth changes significantly.

For more information on management of saline or alkaline soils, refer to Section 8, "Efficient Use of Fertilizer," or to University of Arkansas Soil Test Note No. ST003, *Management of Soils with High Soluble Salts*.

Sprinkler Irrigated Rice

Sprinkler irrigation of rice is very limited at this writing. Research and experience show that the best potential is either on clay or sandy loam soils that are relatively free of johnsongrass. Many silt loam soils tend to crust which causes excessive runoff and inadequate infiltration in the soil. This can lead to drought stress or excessive irrigation which generally results in decreased yields and increased pumping costs. Rutting and sticking of the center pivot is also a potential problem. There is also a possibility that certain disease problems could be increased when the foliage is wetted at the frequency associated with sprinkler irrigation. Sprinkler irrigation should be used on an experimental basis only, and the following recommendations should be considered:

- Don't attempt on silt loam soils that tend to crust or seal.
- Use residual herbicide program.
- Be certain sufficient water is available during reproductive growth (after joint movement).
- Be prepared to use phenoxy herbicides at midseason.
- Plant rice varieties with blast resistance.

Land Grading

Precision land grading is desirable, but not absolutely necessary. If you are considering precision grading, make certain that cut areas won't expose a subsoil with undesirable characteristics. The Natural Resource Conservation

Service has county soil descriptions that can be helpful. Also, taking several deep (> 6 inch depth) soil cores or samples may be beneficial if a problem soil is suspected. The application of poultry litter has also shown good results for improving rice yields on cut soil areas. Additional information on management of precision graded soils is given in Section 8, "Efficient Use of Fertilizer."

When a field is precision graded, it is recommended that a slope of no less than 0.05 percent (0.05 foot per 100 feet) should be provided in at least one direction. A slope of 0.1 percent (0.1 foot per 100 feet) is the general recommendation because it provides good drainage and is often easier to construct and maintain than flatter slopes. It is also recommended to consider putting a field to grade in only one direction (i.e., zero cross slope) if it doesn't require a significant amount of extra dirt work. Building a permanent pad or elevated road on one or more sides of a field should also be considered in the grading plan. Settling often occurs in the deeper fill areas following a grading job. If possible, touch up these areas before planting or provide field drain furrows for improved drainage. The land grading design should consider the type of drain outlets and the number required for the field. If possible, it is best to provide an outlet point for every 20 acres.

It is not usually desirable to precision grade a field to zero slope (zero-grade) in all directions unless continuous rice production is planned. Rotation crops will usually perform better on zero-grade fields that are not over 50 acres in size. It is also critical that the perimeter ditch around the field have unrestricted drainage at its outlet(s). Another consideration for the rotation crop would be to plant on a slightly raised bed but still install a network of drain furrows in the field.

Yearly preplant field leveling or smoothing is essential for seedbed preparation, surface drainage and maintaining optimum flood depths. A landplane or float should be used to remove reverse grades, fill "potholes" and smooth out old levees, rows or ruts in a field. **Rice can germinate under either soil or water, but not both.** Therefore, maintaining a field surface that provides good drainage is important for stand establishment; controlling weeds, diseases and insects; maintaining desired flood depths; and providing a dry field for harvesting.



Operation of a laser controlled dirt pan on a field that is being precision graded.



Operation of a land-plane to smooth the field surface and prepare the seedbed.

Establishing Levees

An accurate levee survey is important to assure proper control of water. All surveying instruments should be properly adjusted and checked for accuracy. Be careful not to exceed the operating range or distance of the equipment. A levee elevation difference of no more than 0.2 foot is generally recommended. This difference is increased on steeper fields when narrow distances between levees present a problem for combine operation. Premarking levees on clay soils and establishing levees as soon as conditions allow can reduce water loss from levee seepage. Levee gates should be installed early in case flushing is necessary and also to provide outlets to avoid levee washouts in case of a heavy rain. One gate per levee is usually adequate. Two gates may be necessary in small loop levees near the water source and in larger bays (> 10 acres) to assure adequate water control.

Water Delivery to Fields

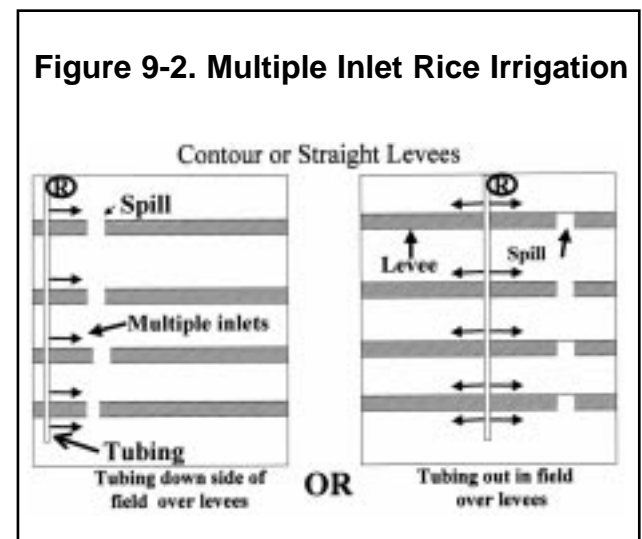
Ditches and canals are sometimes used for water delivery to fields. There is a certain amount of water loss associated with seepage and evaporation from ditches. In addition, canals and ditches require continuous maintenance. Replacing

ditches and canals with either surface or underground pipe when possible is desirable. Installing pipe not only eliminates seepage and evaporation losses but provides more accurate water control and may return land back to production.

Flexible irrigation tubing may be used to replace ditches and canals. The tubing is designed for low pressure and comes in various thicknesses that have different pressure capacities. If water will flow in the ditch or irrigation canal, then the tubing should be applicable to the situation. The minimum thickness recommended for this application is 9 mL. This can be an alternative when installing underground pipe is not affordable.

Multiple Inlet Irrigation

The basic concept of multiple inlets is to proportion the irrigation water evenly over the whole field at one time. The proportioning is accomplished by placing irrigation tubing across each paddy (area between levees) and releasing water into each paddy at the same time through holes or gates in the tubing. Tubing can be placed along the side of the field or through the field depending on the location of the irrigation source. This can be done on fields with straight levees and also on fields that have crooked levees (see Figure 9-2).



Multiple inlets provide the potential for improved water management in the following areas:

1. Can flood field quicker – increased fertilizer and herbicide efficiency;
2. Reduces pumping time during season;
3. Reduces pumping cost;

4. Reduces amount of water pumped;
5. Reduces runoff from field;
6. Reduces irrigation labor;
7. Reduction in cold water effect;
8. Avoids risk of washing out levees from over-pumping top levees;
9. Reduces problems associated with scum and algae buildup in levee spills (gates).

A quicker flood time is usually achieved when it is possible to put the water in at different points down the field. Once a flood is established with multiple inlets, the levee gates can be set above the desired flood depth so that more rainfall can be held on the field. Inlets to individual levees can provide more precise water control for situations such as when there are one or more levees that seem to dry out faster. The flow to these levees can be increased independently of the other levees to avoid excessive pumping on the rest of the field. Multiple inlet irrigation is possibly more easily managed on precision graded fields that have uniform acreage between the levees, but it can still offer improved water management on ungraded fields.

Information from field demonstrations and producer experiences indicates that the average reduction in labor is 30 percent and the average reduction in pumping is 25 percent. Some producers that are using multiple inlets on sandier fields feel that it has reduced pumping by 50 percent. This is very possible under certain conditions, but most producers will experience about a 25 percent savings and in some situations there may be a minimal reduction in pumping savings. Producers who aren't experiencing a significant reduction in pumping still use it for the other benefits it offers, especially the irrigation labor savings.

A few potential disadvantages or problems that can occur with multiple inlets are:

1. Cost of riser bonnets (universal hydrants) and irrigation tubing;
2. Initial installation of irrigation tubing and initial adjustment of the inlets (holes or gates);
3. Floating, moving and twisting of irrigation tubing early in the season;
4. Working around or over irrigation tubing with field equipment (i.e., spraying levees);
5. Animal damage to tubing – especially coyote;
6. Removal and disposal of tubing

Discussions about these problems/disadvantages with producers using multiple inlets indicate that most are willing to deal with these problems because of the advantages offered.

To lay out multiple inlets for a field, a grower needs a good estimate or measurement of the pumping capacity at the field and the field acreage. The pumping capacity in gpm (gallons per minute) is divided by the field acreage to get the ratio of gpm per acre. The estimated or measured acreage in each paddy is then multiplied by this ratio to determine the amount of water to proportion into each paddy. Following is an example of this process:

Pumping capacity – 1,500 gpm
 Field Acreage – 100 acres
 $1,500 \text{ gpm} \div 100 \text{ acres} = 15 \text{ gpm/acre}$
 4 acre paddy: $15 \text{ gpm per acre} \times 4 \text{ acres} = 60 \text{ gpm}$
 7 acre paddy: $15 \text{ gpm per acre} \times 7 \text{ acres} = 105 \text{ gpm}$

The required flow to each paddy is provided either through several punched holes or a few adjustable gates. Either will work, but the adjustable gate seems to be easier to manage. The most common adjustable gate has a 2.5 inch opening that can be shut completely off or left open to flow approximately 75 gpm.

The 9 to 10 mL tubing is recommended for multiple inlet irrigation and the suggested sizes for different flow rates are as follows:

- 12 inch – less than 1,200 gpm;
- 15 inch – 1,200 to 2,200 gpm; and
- 18 inch – greater than 2,200 gpm.

The tubing is usually placed over the levees or along the side of the field on the permanent pad. In both cases it is recommended that the tubing be placed in a shallow trench when it is installed. In some fields where an outside levee is pulled, it is possible to place the tubing in the borrow ditch on the inside of this levee.



Irrigation tubing placed in a rice field for multiple inlet irrigation using adjustable gates.

When crossing the levees, the tubing should go as straight over as possible without any angle in order to avoid twisting of the tubing. On firm levees, some of the levee top should be knocked off into the borrow ditch to provide a smooth ramp across the ditch so the tubing won't tend to kink. The tops of fresh or sandy levees should not be knocked off. They will usually settle enough from the weight of the water and tubing, so, some soil should be shoveled from the field into the borrow ditch. On sandier levees it may be necessary to put a plastic spill under the tubing at the levee crossing to better avoid levee wash out.

If the tubing is laid further out in the field, a short pipe might need to be placed under the tubing at the low side of each levee pad, as a culvert, to assure water can flow under the tubing. When placed out in the field there is more tendency for the tubing to float and move and this can cause the tubing to twist at the levee. Some type of stake can be placed on both sides of the tubing to keep it from moving. Once the rice has some size it will help keep the tubing from moving.

When the tubing is laid on the permanent pad it is critical that it be placed on the flat area in a shallow ditch to avoid rolling or twisting. In this application, the water will tend to flow to the low end of the tubing. It may be necessary to make some humps under the tubing with mounded soil, pipe, buckets, barrels, etc., as it goes down the slope to help hold the water back to the high side of the field. This can also be accomplished by using some type of rope or strap around the tubing to squeeze or choke down on the tubing in order to restrict the water flow in the tubing. It is also recommended that small holes be punched in the air pockets that form in the tubing once it is laid. These holes can be punched with pencil or ink pen points, wire flags, toothpicks, etc. The idea is to punch a small hole rather than cut the tubing, so caution has to be taken if a pocket knife is used.

Well Operation

The basic approach to rice irrigation is to flush if necessary to obtain an acceptable rice stand and establish the initial flood at beginning tillering (6 to 10 inches tall). A shallow flood depth of 2 to 4 inches should be maintained until about two weeks prior to harvest unless there is a reason for draining such as for straighthead control. If blast develops, the flood depth may be increased to help suppress the disease.

Research indicates that it may be possible to stop pumping as early as 14 days after heading if the field will retain a flood for 7 to 10 days after pumping is ceased. If the weather forecast at 10 to 14 days after heading predicts temperatures above 95°F and no rain, then the flood should be maintained.

If the well continues operating until the last levee is flooded, a significant amount of water can be wasted as runoff. Determining when to stop a well so that the water in transit will fill the remaining levee area requires experience. This depends on field size, soil type and well capacity. Table 9-1 can be used as a guide. If the pumping rate is near the recommended minimum, the water should be 90 percent down the field before the well is turned off. When the pumping rate is near the desired value, you can typically turn the well off when the water is 70 to 80 percent down the field. Some growers find that they can better establish the initial flood by filling up the bottom levee pad first and then stair-stepping the flood back up the field by raising the levee spills (gates).

Electric companies offer a variety of rate structures that are suited to particular situations. Visiting with your electric company representative to determine the best rate structure is worthwhile. Significant energy savings (20 to 30 percent) are usually possible when the electric company is allowed to turn off an electric well for two to four hours during the daily peak load periods. Table 9-1 can be used as a guide to determine if enough pumping capacity exists to take advantage of this option. If the pumping rate is closer to the desired value than the minimum value, a two- to four-hour shutdown should be allowable.



A portable tachometer being used to check turning speed of gear-head and pump.

Power units operate over a wide range of speeds (1,500 to 2,400 RPM). The best fuel consumption performance is usually obtained over a much narrower range of speeds (1,600 to 1,900 RPM). It is best to determine the most economical operating speed and run the unit at this setting whenever possible. Other factors, such as desired pump speed and load on the power unit, must be considered. This information can be determined from pump and power unit performance specifications available through irrigation equipment dealers. Reviewing this information with a dealer can be helpful, particularly when operating a new well installation or a power unit that you are not familiar with. It is also important to make sure the gear-head ratio is correct to assure that the pump is turning the desired speed. A portable tachometer is a good tool for verifying both engine and pump speed.

Keys to Water Management Success

- Keep acreage within the limits of pumping capacity.
- Select fields that hold water adequately.
- Establish a smooth field surface that provides a good seedbed, drainage and water control.
- Contact county Extension office for water quality testing if there is no recent history.
- Consider using multiple inlets on fields where it might help improve the water management.
- Be certain of accurate levee survey, proper levee construction and correct gate installation.
- Survey levees on 0.2 foot intervals when possible.
- Establish a levee base as early as possible (before seeding) on clay soils.
- Where choices exist, seed long season varieties on fields with good water-holding capacity or low pumping cost.
- Service and check out the pumping plant before the pumping season to prevent costly pumping delays.
- Carefully analyze differences in energy costs. Select and use another energy source where economically justified.
- Choose the electric rate structure best suited for specific pumping situations and allow the electric company to control the well if water supply is adequate.
- Work with equipment dealers on proper selection, matching and operation of pumping plants.
- Replace ditch and canal water delivery systems with pipe or tubing when possible.
- Flush if necessary for stand establishment or weed control.
- Maintain a continuous, shallow flood of 2 to 4 inches from beginning tillering until two weeks prior to harvest. Consider ceasing pumping on field in preparation for harvest 10 to 14 days after heading if there is an adequate flood on the field to prevent drought stress during grain fill.
- Drain only if necessary for straighthead, scum or possible rice water weevil control.
- Operate the well in a manner that minimizes runoff or tailwater loss.
- Consider the use of available surface water for irrigation when pumping cost can be decreased.

Critical Water Management Situations

Situation	Rice Stage	Recommended Practices or Precautions
After dry-seeding, no moisture for germination.	Rice not germinated.	Flush as quickly as possible, being sure surface water does not stand for more than two days. Use multiple water inlets, if possible, to reduce flush time.
Soil surface is crusted.	Rice germinated but not emerged.	Flush to soften crust before spikes braid or lose their penetrating power.
Residual herbicides have been applied, soil surface has become dry, weeds are germinating.	Rice has germinated and may be emerged.	Flush to activate herbicides.
Barnyardgrass has become drought stressed and is less than 4-leaf.	Rice may or may not be emerged.	Flush and apply herbicide before grass gets too large.
Barnyardgrass has become too large, drought stressed or was not controlled	Rice is 6" to 8" tall.	Flood, treat with Ordram, and maintain flood.
Seedling rice has tipburn and dying before flooding (salinity injury).	Rice has emerged but may be less than 8" tall.	Have water tested for quality. Dilute the salts by flushing and don't let soil surface dry.
Rice has turned chlorotic (yellow) within two to four days after flooding (high pH, Zn deficiency).	Rice is 6" to 10" tall.	Drain immediately and, after recovery, apply zinc, add N; reflood to shallow depth.
History of straighthead.	Rice is about two to three weeks prior to internode movement. (Consider DD50 drying time frame.)	Plant tolerant variety. Drain before DD50 first drying date to allow the soil to dry thoroughly until rice plants are drought stressed; then reflood, preferably before 1/2-inch internode elongation.
Not enough water; severe drought stress.	Rice can be in various stages.	Flush over quickly, then close gates and raise flood to desired depth as water becomes available.

Critical Water Management Situations (cont.)

Situation	Rice Stage	Recommended Practices or Precautions
Nitrogen applied on dry soil.	Rice is three weeks old.	Flood immediately after application to move N down into the soil.
Nitrogen applied into flood.	Rice is at internode elongation.	Prefer stable flood with little water movement. Delay pumping for 24 hours after N application.
Sprangletop or large barnyardgrass.	Rice is tillering to internode elongation (IE) stage.	Apply granular Ordram into floodwater. Flood should cover two-thirds of weed height and must be maintained for suppression.
Drought, pumping flow rate is low.	Rice near heading.	Use multiple inlets; clean out algae in flow pattern to ensure sufficient water as heads emerge.
Preparation for harvest.	Rice is about 10 to 14 days after heading; heads beginning to drop and some heads beginning to ripen	Consider ceasing pumping on field in preparation for harvest 10 to 14 days after heading if there is an adequate flood on the field that would prevent drought stress during grain fill. However, if temperatures are hot, then maintain flood five to ten more days.