Drought Preparedness

Water Conservation

Water conservation is defined as the efficient use of water so that unnecessary or wasteful uses are eliminated. In many areas, more groundwater is drawn out of the aquifers each year than is recharged through rainfall and stream flow. As a result, groundwater levels have dropped dramatically. Demand for water from a state's streams and reservoirs may rapidly approach the available long-term supply. Across many states, many communities are regularly required to limit water use at some time during the year.

While some additional water supplies can be developed by constructing new reservoirs, in many locations the demand for water will still equal or exceed the available long-term supply. For these towns and cities, water conservation can make the difference between adequate supplies and shortages. Importantly, the way water is used and, in some instances, wasted must be rethought.

This section explains easy ways that water can be conserved and money can be saved at the same time. Useful information is also provided on how to measure home water use, how simple repairs can be made, and how water-saving devices are installed. In addition to the measures found in this section, also refer to the General Family Preparedness section found at the beginning of this handbook.

Water Conservation at Home

There are dozens of ways to conserve water and save money around the home. As a starting point, seven of the easiest ways to reduce water use at home are listed below. These should be part of your everyday routine, not just precautionary measures in times of drought.

1. Install a water-saving showerhead.

- An effective water-saving showerhead should have a flow rate of 3 gallons or less a minute. The standard showerhead uses 5 to 10 gallons a minute. Therefore, a showerhead using only 2" gallons a minute can save as much as 75 gallons of water during a normal 10-minute shower.

- To determine whether a low-flow showerhead needs to be installed, check the flow rate of the current showerhead by using the water meter or by putting a gallon container under the showerhead while the water is on and measuring the time it takes to fill the container at the usual shower setting. If it fills in less than 20 seconds, the flow is greater than 3 gallons per minute.

- Low-flow showerheads can be purchased at most department, hardware and plumbing stores.

- Models costing from under $3 are available. A showerhead can usually be installed in 10 minutes.

2. Place displacement devices in the toilet.

- Three types of displacement devices can be used in toilets, but they should not be used in newer, low-water use toilets which use less than 3" gallons per flush.

- To determine the capacity of the toilet tank, either turn off the water supply valve to the toilet (usually located on the pipe behind the toilet) or hold the float ball up so that the tank does not refill, and flush the toilet. Measure the capacity of the tank by filling it to the normal level with a gallon container.

- Toilet dams can be installed in toilet tanks to reduce the amount of water used, typically saving " to 2 gallons per flush. Toilet dams are available from many utilities or from most plumbing supply stores from under $5 per pair.

- A plastic bottle filled with water and weighted down with a few stones can accomplish the same purpose as dams. It is important to place the bottle in the toilet tank where it will not interfere with the flushing mechanism. A plastic bottle in the tank will save " to 1 gallon per flush.

- A toilet bag which is available free of charge from many utilities, can also be used in place of dams. A displacement bag in the tank will save " to 1 gallon per flush.

- Bricks should not be used in the tank because small pieces can break off and permanently damage the plumbing system.

3. Install faucet aerators.

   - The standard faucet flow rate is 5 gallons a minute. A low-flow aerator can reduce this flow to approximately 2" gallons a minute while still providing adequate water for washing and rinsing. Installing aerators on the kitchen sink and lavatory faucets will save hot water and cut water use by as much as 60 gallons a month for a typical family of four.

   - Most aerators have either internal or external threads. Before purchasing aerators, the location of the threads and the diameter of each spout should be determined.

   - If the faucet already has a standard aerator (not a low-flow type), it can be removed and taken to the store to ensure that the correct low-flow size is purchased. Aerators are available for less than a dollar from most stores that sell plumbing fixtures.

   - If the kitchen has a portable dishwasher that must be connected to the faucet, do not install a low-flow aerator because the reduced flow may affect the performance of the dishwasher and result in dishes that are not properly cleaned.

4. Change your water use patterns.

   - The washing machine and dishwasher should only be used when fully loaded. This practice can save at least two loads or approximately 60 gallons each week.

5. Examine personal water use habits.

   - Changing tooth brushing habits can save as much as 14 gallons of water a day. Instead of allowing the tap water to run while brushing, use a cup, and run the tap just to rinse the toothbrush.

   - The same method can be used to conserve additional water when shaving, washing hands or taking a shower.

   - Use a pan when washing vegetables or rinsing dishes in the kitchen instead of running water constantly.

6. Find water leaks.

   According to water utilities, leaks can easily account for 10 percent of a water bill and waste both water and energy if the source is a hot water tap.

   - Toilet Leaks. When a toilet leaks, water escapes from the tank into the bowl. Toilets are notorious for hidden or silent leaks, because leaks are seldom noticed unless the toilet "runs" after each flush (which can waste 4 to 5 gallons a minute).

- To determine if the toilet is leaking, look first at the toilet bowl after the tank has stopped filling. If water is still running into the bowl or if water can be heard running, the toilet is leaking.

- Often the toilet may have a "silent leak. "To test for a silent leak, mix a few drops of food coloring or place a dye capsule or tablet (available from many utilities and hardware stores) into the water in the toilet tank after the water has stopped filling and the tank is full. Do Not flush the toilet. Wait for about 10 minutes, and if the dye or food coloring appears in the toilet bowl, the toilet has a silent leak.

- Leaks of this type usually are caused by a defective flush valve (flapper) ball or a corroded or scaled valve seat. Replacement balls and valves, which can be installed in less than 30 minutes, are available from most hardware and plumbing stores for under $3.

- Faucet Leaks. Faucet leaks are obvious. However, periodically check seldom used taps in the basement or outside the house. The cause of faucet leaks is frequently a worn washer that can be replaced with two or three hand tools. Replacement washers can be purchased from most hardware and variety stores and cost only a few cents.

7. Use efficient outside watering practices.

- Plant native vegetation. Once established, which usually takes two years, these plants require less frequent watering. Water grass only when needed. If grass springs up after being walked on, it does not need watering.

- Soak grass long enough for water to reach the roots. Water slowly and deeply.

- Water during the cool, early morning hours to minimize water loss by evaporation and discourage disease. Do not water on windy days.

- Use sprinklers that produce droplets instead of mist and that have a low trajectory. This type of sprinkler will lose less water by evaporation and be less affected by the wind.

- Use drip irrigation systems for shrubs, flowerbeds and other frequently watered areas.

- During the summer, keep the grass about 2 to 3 inches high. This height shades the root system and holds soil moisture better than does a closely clipped lawn.

- Do not water streets and sidewalks. Adjust the hose or sprinkler until it waters just the grass or shrubs. For flowerbeds, shrubs and trees, use drip or soaker systems.

Reading a Water Meter To Measure Leaks

If your house has a water meter, the entire plumbing system can be checked for an undetected leak in five easy steps:

1. Find the water meter. (It may be outdoors or hidden in a dark corner of the basement.)

2. Turn off all running water and water-using appliances, and do not flush the toilet.

3. Read the dial (or dials) and record the reading.

4. After 15 to 20 minutes, re-check the meter.

5. If no water has been turned on or used and the reading has changed, a leak is occurring. The rate (gallons per minute) of the leak can be determined by dividing the number of gallons by the elapsed time.

6. If the leak cannot be found and fixed, a plumber should be called. Before calling, check all toilets for silent leaks.

Installing a Low-Flow Showerhead To Conserve Water

1. In some cases, a newly purchased low-flow showerhead may not fit on the existing pipe. This is often the case when the neck ends in a ball joint.

   Most necks can be unscrewed and replaced, or an adaptor can be used. Adapters or replacement necks are readily available in plumbing and most hardware stores.

2. When installing the new showerhead, teflon tape or pipe joint compound could be applied to the exposed threads of the new neck so that the joint will be sealed and provide a leak proof connection.

3. If the shower neck has been on for a few years and the neck joint is too stiff to unscrew with moderate pressure, consider having a plumber replace it.

Installing Shower Flow Restrictors to Conserve Water

Restricting devices fit into the space between the showerhead and the shower neck. These devices range from a simple washer with a small hole in it to small chrome-plated pressure compensating fittings. While restrictors reduce water flow, low-flow showerheads produce a flow that is more satisfying to most individuals.

Installing Toilet Dams, Toilet Bags and Plastic Bottles to Conserve Water

Many of the toilets in homes today use from 5 to 7 gallons per flush. Several effective retrofit devices are available that can reduce the volume of water used with each flush by 2 to 3 gallons.

While these devices can be used in some of the low-flush toilets on the market today that use from 3 to 4 gallons per flush, they generally perform better when used in the older 5- to 7-gallon per flush models.

The height of water in the toilet tank (not just the volume) causes the bowl to flush, so the purpose of displacement devices is to reduce the volume of water used in each flush without affecting water height in the tank. The following three types of devices have proven to be effective.

1. Toilet Dams:

   To install a dam, flex or bend the dam and insert it into the tank.
   The dam should fit tightly against the tank sides and bottom and should curve outward away from the plumbing fixtures in the tank. Most tanks work best when a single dam is used.

2. Toilet Bags:

   Fill the bag with water, securely seal the top of the bag with the bag clamp and hang the bag in the tank by using the bag clip and hanger that are provided. Make sure the bag is located in the tank so it does not interfere with the operation of the toilet tank.

3. Plastic Bottles:

   Fill a plastic bottle with water and weight down with a few stones, and place in the most open portion of the tank. This will save as much water as is displaced by the bottle. Make sure the bottle does not interfere with the operation of the moving parts of the tank.

Check all such devices periodically to ensure that they remain in place.

Water Saving Steps When Remodeling or Replacing Fixtures and Appliances

1. Hot Water Pipes.

   Where possible, insulate hot water pipes from the hot water heater to fixtures and appliances. This will reduce the time between turning the water on and the time hot water comes out of the faucet and reaches a constant temperature.

2. New or Replacement Fixtures and Appliances.

   Install low-water use fixtures when remodeling or replacing fixtures.

   Install toilets that use 3" gallons or less per flush. Install low-flow showerheads that flow at 3 gallons or less per minute.

   Install water-saving dishwashing and clothes-washing machines. Be sure to check the water efficiency of appliances when shopping for replacement appliances.

3. Pools and Hot Tubs.

   Run the filter backwash onto the lawn rather than down the sewer.

   Purchase covers for hot tubs and pool to reduce evaporation losses.

Making Repairs To Toilets To Stop Water Loss

Some types of toilet leaks are relatively easy to fix. Other leaks may require the services of a plumber. Several simple repair steps that can be done without contacting a plumber are listed below.

> If the water is too high in the toilet tank and is spilling into the overflow tube, the float can be adjusted by turning the adjustment screw or by very gently bending the float arm down so that the water shuts off at a level slightly below the top of the overflow tube.
>
> Ideally, the water level should be set so that it is about even with the fill line on the back of the toilet tank.
>
> A frequent problem that causes a toilet to leak is a worn flapper ball or a flapper ball that does not seat properly into the valve seat. If the flapper ball is worn, it can be removed and replaced with a new flapper ball.
>
> When replacing a flapper ball, take care to note how the chain is adjusted before the old ball is removed. Also, check the valve seat for scale or corrosion and clean if necessary. If cleaning does not work, install a retrofit valve seat, available from most plumbing or hardware stores.
>
> If the handle needs to be jiggled to keep the toilet from "running," the guide-wire or the handle itself may be sticking. If the handle is sticking, adjust the nut that secures it in the toilet tank. If that does not work, replace the handle.
>
> If none of the preceding steps solve the problem, contact a plumber to repair the toilet.

Repairing Faucet Leaks

1. Leaky faucets, which can develop even in new houses, are wasteful and a nuisance. With a few simple tools, a leaky faucet can be repaired in less than an hour.

2. Most water faucets in houses today are compression-type units in which a washer is compressed over a pipe opening when the faucet is closed, thus closing off the water.

   All compression-type faucets may not look alike, but all are similar in their operation and repair.

3. The exact point where a leak appears on a faucet is a good clue to finding its cause:

   A spout drip is usually caused by a worn upper faucet washer or a corroded seat.

   Leaks at the stem result from a loose cap nut or worn cone or bonnet packing.

   A cap leak, or water oozing below the cap nut, indicates a worn bib or packing washer.

   A leak at the base of the faucet results from water seeping past a worn lower faucet washer.

4. To repair a leaky compression type faucet, use the following steps:

   Turn off the water supply at the valve nearest the faucet. Next, open the tap to drain the faucet.

   Remove the handle screw and lift handle off the spindle. Unscrew the cap nut. Use a protective cover of adhesive tape or a rag to avoid marring the finish.

   Unscrew the stem with finger pressure and lift it out.

   Remove the screw from the bottom end of the spindle. Scrape away all worn washer parts. Be careful not to damage the rim. Install a new washer. (Take either the old washer or the complete spindle unit with you to purchase the correct size and shape (flat or conical) replacement washer.) Double-check to make sure the replacement is like the worn washer.

   Check the seat (which is located down inside the faucet) to make sure it is not pitted or rough. If the seat is scarred or rough, use a seat-dressing kit to grind the seat to a smooth finish.

A leak at the stem usually means that the packing inside the cap nut needs replacing. To replace the packing, pry out the old packing washer with a screwdriver. If a washer is used, replace it with a new one. If there is not a washer, wrap the spindle tightly with "packing wicking." String can be used if commercial wicking is not available.

Reassemble the faucet. Tighten the cap nut just enough to prevent leaking. Screwing the nut down too tightly causes rapid wear on the stem.

Turn the shutoff valves to the on position and check the faucet for leaks.

5. A mixing faucet may look more complicated than a single faucet, but repairs are made in much the same way.

   Actually, a mixing faucet is two separate units with a single spout.

   Mixing faucets are used on sinks, bathtubs and laundry tubs. Repairs must be made separately on each faucet unit. Follow the same steps listed above, but remember to turn off the water before beginning work.

6. Every washer less and single-lever faucet model is a little different. When repairs are required, homeowners can purchase a repair kit for their model which includes instructions and the parts that generally will be worn. By replacing all the parts at once, the faucet should function for several years without needing further repair.

Adding New Landscape Or Redesigning The Yard To Conserve Water

When planning to add new landscaping or to redesign existing landscaping, the following suggestions may help you to save 50 percent or more of the water needed to maintain a traditional lawn.

1. If hiring a landscape architect orgardener, select one who is experienced in Xeriscape, the conservation of water and energy through creative landscaping.

2. Design the yard to reduce the grassed areas to only that amount which will actually be used for recreation and entertainment. Front and side yards are most frequently just for show and are logical areas that can be completely or partially converted from lawns to native grasses, ground covers and shrubs.

3. Use native grasses, ground covers, shrubs and trees. Many beautiful Varieties of native species can be used in landscaping and are preferable to imported species.

   The advantage of native species is that, once they are established (usually about 2 years), they do not need to be watered as frequently (about to " as often), and they can survive a dry period without any watering.

4. When installing an irrigation system for lawn, shrubs and trees, sprinkler heads for the lawn should be low-angle spray heads that sprinkle the grass without spraying the water high into the air or allowing the water to drift onto the sidewalks and streets. The heads should produce droplets of water instead of a mist. The preferable irrigation system for shrub beds and trees is a drip-type system. There are several varieties, including soaker hoses, bubblers and "leaky pipe."

   If a sprinkler system is installed for shrubs, an upright pipe extension may be needed if low-angle spray heads are to be used. This is done to spray evenly without obstructions.

   Automatic controls will allow the proper watering time and minimize waste.

   Regular spacing between spray heads will provide uniform coverage.

   For more information, contact a licensed landscape irrigator or a reputable dealer.

5. Shape the soil to protect against erosion and use conditioners to promote water penetration and retention.

   Shape the soil into earthen basins around all shrubs.

   If the original soil is rocky, shallow or a heavy clay, improve the soil by adding 2 to 4 inches of organic material or topsoil that is compatible with the soil type.

6. Watering needs vary:

   Plants: During summer month, most plants will need about 1 inch of water every 5 to 7 days.

   Lawns: The frequency of watering depends on the type of grass.

A water conscious landscape design can reduce water use for landscape maintenance by 50 percent or more and also reduce the amount of maintenance required. Of equal importance, the natural beauty and function of the landscape also can be preserved by using adapted plant materials.

1. By using plant materials adapted to specific areas, water needs for landscape maintenance can be reduced by more than 50 percent.

   Water conscious landscaping involves more than just using adapted plant materials it includes the use of other conservation techniques and practices.

   Water saving practices include the use of low pressure drip or trickle irrigation systems for watering trees, shrubs, gardens and individual plants or beds; the use of mulches around shrubs, beds and gardens to conserve water; the use of bark, rock or other landscape material in ground cover in areas difficult to water or in areas where plants are not needed; the use of vegetative groundcovers such as ivy, jasmine, liriope and vinca in small, isolated areas, sloping sites that are difficult to water and in heavily shaded sites.

2. Water conscious landscape designs minimize intensively maintained lawn space. Manicured lawn areas may be the focal point of the landscape, but they do not need to cover the entire area unless the lawn is used as a playground or sports field. Highly maintained grass areas generally require more irrigation than any other component of the landscape. On golf courses, for example, only the landing areas need to be intensively maintained. Rough areas may have a more drought tolerant grass, taller mowing heights and a separate water system.

   Large open areas of the landscape where a grass cover is needed can be planted to low maintenance grasses such as buffalo grass, centipede grass or bahiagrass. Native plants and wildflowers also can be allowed to develop in these areas.

   Such plantings require very little maintenance and no supplemental water once they become established.

3. Proper site preparation will produce a more beautiful landscape and result in more efficient water utilization.

   Slopes, areas with shallow topsoil, compacted soils and deep sands are difficult sites to establish grass and are inefficient with respect to water use.

   Modifying or amending the sites before planting is more effective than waiting until problems develop.

4. As the foundation is the strength of a building, the seedbed is the support for a turf. The seedbed refers to the few surface inches of soil that are modified prior to planting.

   Poor soil conditions result in continuous turf maintenance problems.

   To prepare a seedbed, first remove all debris such as large stones, wood or o other trash that may have been left after construction.

   Next, the nature of the soil may need to be altered. A sandy loam soil high in organic matter is best for turf. If the original surface soil is a heavy clay or a fine sand, add organic matter to improve soil structure. This organic material can be peat, compost, decomposed gin trash, rice hulls, bark or sawdust (preferably hardwood), leaf mold or similar material. Thoroughly mix 1 inch of organic matter with the top 3 to 4 inches of soil to produce a uniform seedbed.

   This mixing can be done by repeated cultivation with a garden tiller or with a tractor and rotovator.

   When adding un-decomposed organic matter to the soil, also add 3 pounds of ammonium nitrate or 5 pounds of ammonium sulfate per 1,000 square feet to aid decomposition of the organic material. Most soils are deficient in the major nutrients required for turf. Sandy soils normally are deficient in nitrogen, phosphorus, potassium and lime. In the blackland areas, nitrogen and phosphorus may not be adequate for good turf development. Potassium in the soil may become deficient for turf growth when high amounts of nitrogen are used in areas not normally deficient in potassium.

   If possible, base rates and combinations of fertilizer nutrients on the results of soil tests. In the absence of a soil test, apply a complete fertilizer to the surface of the seedbed. Apply a fertilizer with a 1-2-1 (10-20-10, 6-12-6) or 1 (8-8-8) ratio at a rate to supply 1 pound of phosphorus per 1,000 square feet of lawn.

   Grade the seedbed to provide surface drainage away from structures, walks and driveways. A fall of 6 inches for every 40 to 50 surface feet is adequate for drainage on sandy soils, provided no pockets or depressions exist.

   Clay or clay loam soils may require twice that slope to provide adequate surface drainage. In some cases, subsurface drainage systems may be needed to remove excess water from poorly drained sites.

   If a considerable part of the landscape needs to be filled, use a loam or sandy loam soil. Repeated wetting of the filled site will help settle the soil.

   The final step in seedbed preparation is raking the surface to remove large clods and stones. At the same time, fill depressions that have developed and level high spots. Walks and driveways should be about 1 inch above the final soil surface. The site is now ready to be seeded, sprigged or sodded.

5. Conservation and reduced maintenance costs are enhanced by good cultural practices. By some estimates as much as 50 percent of the water used for landscape maintenance is wasted through run-off and evaporation.

   Proper timing and method of application will reduce much of this water loss.

   The most important water conserving practice is to water only when grasses show symptoms of water stress.

   Grasses wilt and begin to go off color when under moisture stress. Shrubs and small trees wilt and begin to drop their leaves under moisture stress. Ideally, water shrubs before the first sign of moisture stress.

   When water is needed, thoroughly wet the soil 4 to 6 inches deep by applying water slowly or at intervals to avoid run-off. One inch of water, properly applied, will wet most soils 4 to 6 inches deep. (One inch of water is equivalent to 62 gallons per 100 square feet.) During summer months an inch of water will meet most plant needs for 4 or 5 days. But wait until the plants (or grass) show moisture stress before watering again. Early morning dew, cooler temperatures or rain may extend the interval between irrigations several days.

6. Mowing is the key to maintaining neat, attractive turf areas. Low maintenance grasses such as buffalo grass require less mowing than Bermuda grass or St. Augustine. But regular mowing will improve the density and uniformity of all turf areas.

   During the growing season, weekly mowing is ideal for lawn areas. When mowed weekly, there is seldom a need to pick up grass clippings. The clippings break down rapidly in the lawn and recycle plant nutrients. When clippings are picked up, they can be composted or used for mulch in gardens.

   During hot, dry conditions raise mowing heights to reduce water needs. Grass mowed at 2 to 3 inches maintains a deeper root system than grass mowed at 1 inch. Supplemental water needs are reduced with more effective use of water in the soil by deep rooted grasses. Mow St. Augustine, bluegrass and tall fescue lawns at 3 inches during drought conditions. Do not mow Bermuda grass and zoysia higher than 2 inches.

7. Thatch, the organic layer between the soil and the green leaves, can slow water movement into the soil and cause excess run-off.

   Thatch accumulation results from heavy fertilization, improper mowing practices, over watering and frequent pesticide use.

   Aeration and thatch removal increase water penetration and reduce run-off. Under some conditions wetting agents (surfactants) improve water penetration in a heavily thatched lawn.

Water movement into the root zone is even more difficult where compaction develops. Aeration of compacted soils once or twice a year helps break up the compacted layer and increases water penetration. Aeration also reduces run-off from sloping sites. 8. In soils containing high levels of sodium salts, gypsum can aid water penetration. Soil test information available through county Extension agents can reveal the presence of high levels of sodium. Like the other three factors affecting water use, the quality of the water used can influence the amount of water needed to keep a turf healthy.

Where salt is a problem, it is important to thoroughly wet the soil during each application. Light, frequent applications of water high in salts result in an accumulation of salts near the surface. Thorough watering helps move the salts below the root zone of grasses.

Watering Lawns and Plants During a Drought

1. If water is rationed during a drought, give priority to shrubs that are more expensive and harder to replace than grass and annual plants.

2. During a severe drought when outside watering is prohibited, water plants with "gray water" saved from bathing, dishwashing and clothes washing, if this is permitted by the city or local health department.

Special Considerations for Agricultural Producers

In addition to the precautions and responses covered in the previous pages, the agricultural producer will want to consider the following measures.

Developing a Crop Water Management Plan

Develop a water management system before you are faced with a drought situation.

1. Water Use Efficiency

   In areas where water supply is limited or expensive, it is economically important for farmers to attain high water use efficiency as well as high yields. Water use efficiency values can be calculated in several ways and should be clearly defined to avoid misinterpretation.

   Water use efficiency for a crop and irrigation system can be expressed as crop yield (pounds) per unit of water applied to or actually used by the crop (acre-inches).

2. Rainfall Patterns

   Average monthly rainfall data can be misleading because large variations occur. Therefore, percent probability that a certain rainfall amount will occur is a better way of assessing risk.

   Dryland crops should be grown during periods of high rainfall probabilities to allow more of the rainfall to be used for evapotranspiration.

Crop Water Requirements and Water Use Efficiencies

Experimental results for yield and water use efficiency have varied, but many common water management principles have emerged and are receiving widespread application by farmers. Limited irrigation is now being widely practiced on drought tolerant crops to take advantage of expected rainfall.

1. Sorghum

   Sorghum has good ability to adjust to water stress. Sorghum requires 13 to 24 inches of seasonal water use (evapotranspiration) from precipitation, stored soil moisture and irrigation to achieve grain yields of 3,000 to 6,700 pounds per acre.

   Dryland sorghum yields an average of about 1,600 pounds per acre, although yields of up to 3,000 pounds per acre are not uncommon during high rainfall years.

Pre-plant irrigation is often not needed and may be inefficiently applied, especially when using conventional graded furrow irrigation systems.

The same amount of water may be more efficiently used if applied at later stages of crop growth.

Conservation tillage can reduce the need for pre-plant irrigation of sorghum through improved soil moisture storage.

Irrigations should be timed to avoid water stress during periods of peak water use (boot, heading and flowering stages) to achieve reasonably good yields and maximum irrigation water use efficiency.

Two well-timed seasonal irrigations of 4 inches per application or the equivalent are adequate in normal years for good yields of medium maturity hybrids. Saving irrigation water by withholding a 4-inch irrigation reduces sorghum grain yields by only about 10 percent during the early 6- to 8-leaf stage but by almost 50 percent if withheld at the heading and bloom stage.

2. Corn

Corn is much more sensitive to water stress than sorghum, wheat or cotton. Corn is planted earlier than sorghum and typically allows more efficient use of the May-June wet season than sorghum.

The early planting date required for corn increases the need for pre-plant irrigation for stand establishment. The total seasonal water use to achieve any corn grain yield is about 13 inches.

Pre-plant irrigation is often necessary. Drought seasons require one or two additional irrigations.

Moisture stress caused by low soil water availability or hot, dry conditions during the flowering stage (which includes tasseling, silking and pollination) can severely restrict corn yield.

Reduced irrigation of corn has generally resulted in significant yield decreases. Planned water deficits into the stress range are not recommended and may be feasible only on soils with moderate to high water storage and during the early vegetative or grain ripening stages.

Reduced acreage, rather than reduced irrigation, offers the best way to adjust corn irrigation to limited water supplies.

3. Wheat

Winter wheat is a major drought-tolerant crop that grows vegetatively during the normal dry period from fall to early spring and develops grain during a period of increasing spring rainfall. Wheat is normally planted around October

1 and requires available soil moisture from irrigation or precipitation for germination and early growth.

Wheat also should receive one late fall irrigation followed by two to three spring irrigations for high grain yields. One additional early irrigation (together with additional applied fertilizer) is usually needed for early planted wheat that is grazed and also managed for grain production.

The highest wheat yield response to irrigation usually occurs during jointing and boot stages. These stages also coincide with a period of relatively low probability of rainfall.

The least efficient irrigation is during grain filling, which normally is associated with increased rainfall.

4. Cotton

Cotton is a drought-tolerant, long-season crop that lends itself to limited irrigation despite a somewhat complicated pattern of water use, deficits and application.

Early fruit set is important in cotton production. However, the production, placement and retention of fruiting sites are sensitive to soil water availability.

Under dryland conditions, expected lint yields are in the range of 250 to 300 pounds per acre. Cotton requires more than 13 inches of seasonal water use to produce appreciable lint yields.

High levels of water application can decrease lint yield by causing excessive vegetative development and fall immaturity.

A pre-plant irrigation of 4 inches is usually advantageous, especially if spring rainfall is not adequate, but heavier pre-plant irrigations are not warranted.

Cotton has the ability to overcome moisture stress at most growth stages if water becomes available and low temperatures do not limit growth.

The most critical period for Irrigation is early to mid-bloom. If water is available, a second irrigation should be applied at peak to late bloom.

Developing and Improving Vegetative Cover

1. Good cover (standing vegetation and mulch) lessens the impact of rain that dislodges soil particles, and thus reduces the amount of sediment in surface run-off. Good cover also slows the movement of run-off so that more water soaks into the soil and more sediment is deposited on the grazing land rather than being carried into streams or ponds. Vegetative cover also entraps manure and prevents pollution of streams with animal waste.

2. Best management practices for preventing nonpoint source pollution from grazing lands include locating animal holding pens and feeding areas away from streams and other hydrologically sensitive areas, and establishing and maintaining good vegetative cover.

3. The amount and type of vegetation present significantly influence the rate of infiltration of water. Standing vegetation and a mulch or litter layer increase infiltration. Organic matter in the surface soil improves soil aggregation, making it easier for water to move through the soil.

4. Pores in the soil created by plant roots increase the rate at which water can enter the soil by providing pathways for water movement. Long-lived, perennial bunchgrasses have deeper root systems than sod grasses and allow water to move deeper.

5. The height of grass also affects water movement. Water moves more rapidly across closely grazed grass than grasses left with several inches of stubble.

6. If the watershed has been severely overgrazed, the vegetative cover will need to be improved by controlling undesirable plants such as broadleaf weeds and shrubs and/or seeding desirable plants.

Maintaining Vegetative Cover

1. If at least 10 to 15 percent of the desirable vegetation is present, the most practical and economical way to maintain a desirable vegetative cover is through proper grazing management.

   The key to proper grazing management is to balance the number of grazing animals with the forage produced. The proper balance will leave a sufficient amount of plant residue to maintain stored food reserves, plant vigor, a healthy root system and seed production of the desired plants.

   It also allows seedlings to become established.

2. For planning purposes, an appropriate long-term stocking rate may be determined based on the "take half and leave half" rule of thumb. However, a more realistic approach is to manage the grazing stocking rate so that a given amount of residue is left prior to resumption of growth in the spring.

   The amount of residue required will vary according to the area of the state and the vegetation types. For example, 300 pounds of plant residue may be adequate for a semi-arid area with short-grass vegetation, while 1,200 pounds of residue may be required in a more humid area with tall-grass v vegetation.

3. It also is important to properly distribute animals over the grazing land. Poor

distribution may result in extreme overgrazing of one area and little use of another in the same unit. Often these overgrazed areas are located near water, thus increasing the potential for pollution.

Practices which contribute to proper grazing distribution include the development and strategic placement of water sources, construction of fences, strategic location of salt and feeding sites, building of trails, fertilization, prescribed burning and spot seeding.

4. Plants benefit from periods of no grazing. Deferment from grazing is particularly useful on areas where vegetation needs to be improved.

5. Planned grazing systems divide an area into two or more grazing units to allow periods of grazing and rest from grazing in a sequence determined by management objectives, physiological needs of the plants and the design of the system.

   Grazing systems may include as few as 2 or as many as 30 or more grazing units.

   Some temporary soil compaction may occur with systems that concentrate animals in a small area for short periods of time. However, if the period is short, the soil will recover rapidly from the compaction. A planned grazing system makes more effective use of forage and, combined with the proper stocking rate, protects desirable range plants and water quality.

Managing Salinity

Salinity problems normally occur in arid or semi-arid climatic regions. Salinity is a major nonpoint source pollutant in the west as irrigation return flows can carry dissolved salts into waterways. In humid climates, soluble salts are generally leached downward through the soil profile where they cannot cause problems.

In general, accumulation of salt results from water evaporation at the soil surface. This condition can render land vegetatively nonproductive, and may lead to nonpoint source pollution through erosion and sedimentation. Further, the salt concentration may run off during a storm and affect adjacent lands. These problems normally occur where either surface seep areas appear or where a high water table exists in the soil profile.

Sometimes rainfall moves through the ground to the water table or to a barrier above the water table. Here it accumulates and moves laterally, often parallel with the land slope, toward an outlet or low point in the landscape. It then forms a wet weather or saline seep. During the summer or periods of low rainfall, such seepage spots may completely dry out. Only detailed analyses of borings, soils and surveys can establish the source and amount of groundwater contributing to seep areas.

1. Irrigated land in arid areas sometimes must be drained to prevent or reduce salinity problems. Topographic surveys and subsurface investigations should be made to obtain information on the soils, geology and water table

elevations. These data are the basis for determining the extent of the problem and for setting design parameters.

2. Plant nutrients and pesticides should be applied in such a manner as to limit the potential for contamination of surface and groundwater supplies by outflow from drainage systems.

3. One alternative treatment is to establish permanent salt tolerant species such as bermudagrass, aikali sacaton, gramas and kleingrass. Salt tolerant species will allow a vegetative cover where bare ground would otherwise lead to water quality problems.

4. Cropping with salt tolerant, seasonal species such as cotton or small grains assists in addressing the problem of saline soils. Planting high water use crops such as alfalfa, four-wing saltbush or trees above a seep area helps control the amount of moisture that accumulates.

5. Organic or inorganic additives to the soil surface will increase water infiltration. This will allow water to force dissolved salts below the root zones and prevent further concentration of salts on the soil surface.

   Organic amendments include cotton burs and gin "trash" that may be obtained from cotton processing facilities.

   Inorganic agents to increase soil tilth include gypsum or calcium sulfate.

6. Land alterations are sometimes used to alleviate salinity problems. Such constructed systems have a place in salinity control, but use caution when implementing them. In some cases, altering the land surface by smoothing or grading may eliminate the effects of the problem by confining the seep area or providing natural surface drainage.

   Practices such as closed-end terraces or basin terraces which impound water can be used on areas with minimal seepage, but should be scrutinized where they might contribute to problems associated with saline seeps. When seeps threaten downstream water quality, installing a fresh water interceptor drain above the seep may be an alternative treatment.

7. Drainage may be used in severe cases of salinity. The location of a suitable outlet and the quality of discharge and receiving waters is crucial in considering either a surface or subsurface drain. Surface drainage can be accomplished by several methods, depending on the conditions at the site.

   A surface drainage system may be the least expensive alternative, but potential maintenance problems and obstructions to farming operations should be considered. Maintaining water quality of any discharge waters is of utmost importance. Most subsurface drainage uses corrugated plastic tubing installed with a synthetic filter envelope. Again, as with any other drainage system, an adequate outlet is imperative, especially considering the discharge water quality in comparison to receiving waters.

8. Irrigation water management is important on saline soils. Salt accumulates in soils because of salts in irrigation water or the presence of a high water table. To prevent harmful accumulation of salts in soils irrigated with saline water, an additional quantity of water, above that required for the crop, must be passed through the root zone to leach salt from the soil.

   A high water table contributes to salt accumulation because capillary action causes water and soluble salts to rise to the soil surface. There the water evaporates, leaving behind salt deposits. Enough water must be applied periodically to leach out accumulated salts without excessive waste of water. If a seep area could be made worse by applying liquid agricultural waste, proper management must be used, including nutrient management.

Information in this document was compiled by the Texas Agricultural Extension Service and Hazard Reduction and Recovery Center