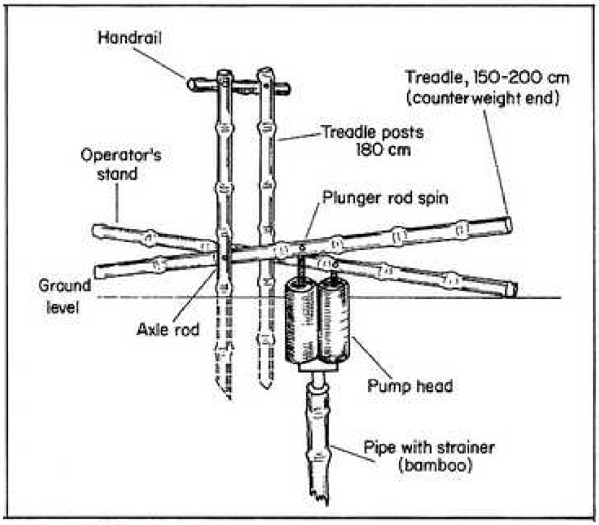
Thirty-five Water Conservation Methods for Agriculture, Farming, and Gardening. Part 4.

Please note that this is the fourth of a special four-part series here at Big Picture Agriculture listing and describing methods for producing more crop per drop in farming. This Part 4 post lists methods 26 through 35.

26. Pumps for Irrigating

It wasn't until motorized pumps powered by fossil fuels were used to irrigate from underground water sources, that aquifers and groundwater sources could be pumped beyond natural replenishment rates. This has led to unsustainable drops in aquifer levels in India, China, and the U.S.

But, there are simple, nonmotorized methods to pump water from underground sustainably that are immensely valuable to small farmers in undeveloped regions of the world.

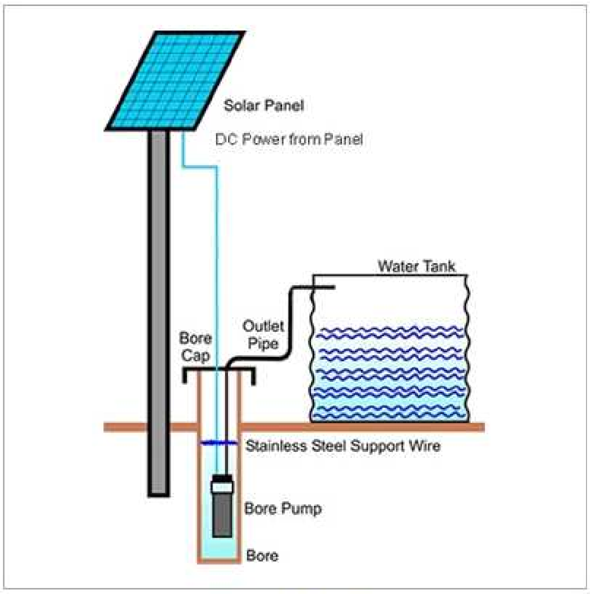


Treadle water Pump Diagram
Source: IRRI Images @ Flickr

Treadle pumps: Bamboo (or metal) treadle water pumps have enabled poor farmers in places like Bangladesh to access groundwater during the dry season. Treadle pumps draw groundwater to the surface using a manually powered suction system. They can be made locally and there have been programs to supply them in certain areas. Today, there are more than two million of these that have been distributed world wide. They can be used to fill containers used for micro-irrigation or bucket drip irrigation systems. These are viewed as a stepping stone between hand lifting water and obtaining motorized pumps.

Hip Water Pump
Credit: Kick start (wikipedia)

Hip Pumps: According to KickStart, this $30 pump which began selling in 2008 can irrigate an acre or more. It can pull water from 7 meters and push wa-



Solar Water Pump System
Source: AOV International

ter an additional 14 meters above the pump. These micro-irrigation pumps are available in Africa, Asia, and Latin America.

Solar Pumps: Solar and wind energy can be used to power pumps for irrigation as can small biomass plants, and micro-hydroelectric plants.

Motorized Pumps: China has been exporting around four million pumps annually, after decreasing the weight and the cost of small irrigation pumps. Now, more than 60 percent of India's irrigation is being done by smallholder farmers pumping groundwater.

27. Collecting Fog or Mist

Some call it harvesting water from thin air. This ancient practice, evident in archaeology of Israel and Egypt is being revived again today. By using nets strung across mountain passes, or stretched on poles located in foggy areas, gravity collects clean potable water for local residents. Water droplets attach to the netting and run down into gutters beneath the nets. The collected water may be further collected into tubes, taking it to a lower village or point of water storage. One square meter of netting can provide five liters of water per day.

The plastic netting is a coarse woven mesh, used to shade fruit trees. It is inexpensive and readily available. Various collection methods can be constructed, to fit the specific setting.

In addition to gaining potable water for drinking, collecting water from fog can be used for agriculture and starting trees for reforestation, too. Nets have been used to provide direct irrigation to quinoa in South America.

The areas with the best climatic and geographic conditions for collecting seasonal fog include some mountainous areas, the Atlantic coast of southern Africa and South Africa, Oman, Sri Lanka, China, Nepal, Mexico, Kenya, Morocco, Yemen, Guatemala, Chile, Peru, and Ecuador. In Chile, this method has been used for over 30 years.

28. Deficit Irrigation

In deficit irrigation, the goal is to obtain maximum crop water productivity rather than maximum yield. By irrigating less than a crop's optimal full requirement, you might reduce the yield by 10%, but save 50% of the water. With supplemental irrigation to rainfed crops in dry lands, a little irrigation is selectively applied during rainfall shortages and during the drought-sensitive growth stages of a crop. (These important stages are the vegetative stages and the late ripening period.)

The end goal is to maximize irrigation water productivity, even if it means some loss of production. As a success story example, results from using deficit irrigation have been quite dramatic for wheat production in Turkey.

29. Mycorrhiza Fungus in Soil Can Reduce Plant Water Needs by 25 Percent

Mycorrhizae (the white strands attached to the brown roots of this woody plant) are specialized fungi that enhance the functioning of roots.
Photo credit: Enrico Bonello, The Ohio State University

Mycorrhiza, which means "root-fungus" grows in healthy soils and functions symbiotically with plants by enhancing the uptake of phosphorus and other nutrients. The fungus attaches to plant roots, increasing the root surface area which comes in contact with the soil. It excretes enzymes which allow it to dissolve soil nutrients, and extends the life of the root.

This fungus increases the drought tolerance of plants and can reduce water needs by 25 percent. It increases the fruit and flowering of plants while reducing the need for water and fertilizer. It also enables plants to grow in salty or contaminated soils and increases the temperature stress tolerance for plants. It helps protect plants from disease, and helps store carbon in the soil. Mycorrhiza has the potential to bring poor and degraded lands back into cultivation.

It is possible to encourage mycorrhiza growth in soils by adding compost to your garden soil, by not using synthetic chemicals, using minimum tillage, rotating crops, and growing cover crops. By cold composting, or mulching your garden with shredded leaves each fall, you can promote optimal Mycorrhizal fungi growth. Or, it can be purchased and added directly to sterile potting soils, or degraded soil.

30. Using Less Water to Grow Rice

rice terrace at Petulu, Ubud - Bali ~ Photo credit: Flickr CC via Pandu Adnyana

Paddy rice consumes far more water than any other cereal crop, although much of this water is recyled. It also is the staple grain for half the people of the world. Three-fourths of the rice produced comes from irrigated fields, and irrigated rice uses up to 39 percent of global water withdrawals for irrigation. It takes about 2,500 litres of water to produce 1kg of rice.

Traditional rice varieties tend to have lower yields and longer crop cycles but they require less fertilizer, use less expensive seeds, and are preferred by consumers, bringing a higher price. Because of higher input costs and lower market values for high-yield rice varieties, farmers often opt to plant traditional rice varieties instead.

Ecologists have labeled five categories of rice plants according to water needs as being rainfed lowland, deep water, tidal wetland, rainfed upland and irrigated rice. Researchers have been investigating improved ways of growing rice with less inputs and/or water.

Below, are some ways found to reduce water use in rice growing.

1. System of Rice Intensification (SRI) (See #5 in this series.)

2. Alternate Wetting and Drying [AWD] lets fields fall dry for a number of days before re-irrigating them, which can maintain yields with 15 to 30 percent of water savings. In Bangladesh, the AWD technique reduced water consumption by 30 to 50 percent.

3. Aerobic Rice is grown in water-scarce regions, without ponded water and saturated soil. It uses 50 percent less water, and produces 20-30 percent less yield. These are high-yielding varieties that grow under non-flooded conditions in non-puddled, unsaturated (aerobic) soil. They rely on irrigation water, greater fertilizer application, and greater use of pesticides. The shorter growth cycle of these varieties enables farmers to grow other crops (rice or other plants) after the rice crop is harvested.

4. New varieties like short-season rice significantly reduce water use. Rice produced 40 to 45 years ago required 160 days from seed to harvest, compared to 135 days for short-season varieties which has reduced the amount of water needed by about 20 percent over the last 30 years.

5. Pioneered by China, hybrid rice – a cross-bred robust variety – has increased land and yield productivity while reducing water use. It is taking China about 1,750 liters of water to produce 1 kilogram of rice as compared to 3,500 liters in India.

6. Genetic modification might be able to improve water efficiency of rice by another 30 to 40 percent.

7. Good land management, using laser leveling of compact soil fields with channels and dikes helps save water in California.

8. In Australia, rice grown with saturated soil culture used 32 percent less irrigation water than conventional methods in wet and dry seasons.

9. ACIAR is supporting trials of permanent raised beds in mixed cropping systems (rice–wheat and other combinations) in India, Pakistan and China.

10. About 13 percent of global rice area is dryland rice. Yields are quite low and it is mostly grown for subsistence. In Southeast Asia, most dryland rice is grown on rolling or mountainous land. Some newer rainfed rice varieties can achieve yields close to those of irrigated fields, however.

11. A newer variety of flood tolerant rice has also been shown to withstand drought better. About 8 percent of the world's rice is classified as flood prone.

Some of the above methods also reduce methane emissions from rice growing, significantly.

Finally, to achieve more 'crop per drop,' wheat and crops that do not grow in flooded areas have the potential to produce food with less water. A rice field takes 2 to 3 times more water than a wheat or corn field. So, it is possible that in the future wheat might supply a growing share of the world's staple grain.

31. Soil Moisture Sensors

The Watermark Soil Moisture Sensor

Incorporating soil moisture sensors into an irrigation system is an important tool for water conservation. It not only prevents over-watering, but saves unnecessary pumping costs and helps prevent leaching of fertilizers.

By monitoring soil moisture conditions, yield increases can be dramatic through careful water applications during the most critical plant growth stages.

By watering less, plant roots grow deeper and there is less disease.

Moisture sensors can be used for commodity crop farming, vegetable farming, or orchards.

The probes are made up of multiple soil moisture sensors. They range in price, with the higher priced models generally more accurate.

Some center pivot irrigation systems combine soil moisture sensors with a computer that controls the operation of the pivot.

The University of Nebraska now provides a Crop Water App for the iPhone and iPad based on Watermark sensors from IRROMETER® which are installed at depths of 1, 2 and 3 feet.

32. Good Drainage

Photo credit: Government of Ontario Canada

Too much water is as great a problem as too little. Good drainage is important in water management because poor drainage leads to soil degradation and salinity which can greatly diminish the yield and quality of most crops. Drainage factors include soil type, compaction, and topography.

Soil compaction reduces the amount of pore space in soils and results in soil that will not drain quickly. This affects plant growth because plant roots require air. Most plants cannot survive for too long under water or in damp soils. Poor drainage causes diseases and root rot. It not only affects the returns to the producer but also can result in increased runoff during heavy rainfall events, therefore increasing water erosion.

When trying to improve damaged land that is saline or waterlogged, moving soil, installing drainage pipes, and mulching can help. Other methods of improving drainage include good crop rotation practices, adding manure and compost to improve macropores in the soil, and reduced tillage.

Chinampas: This farming system is thousands of years old from the Aztecs of Mexico's lake country. Chinampas are long narrow patches of ground, called "floating gardens", bordered by canals on each side. Approximately 98 feet by 8 feet (30 meters by 2.5 meters), they are man-made by building up earth during canal excavation through stacking alternate layers of canal muck and rotting vegetation.

Photo: Wikipedia

33. Agroforestry

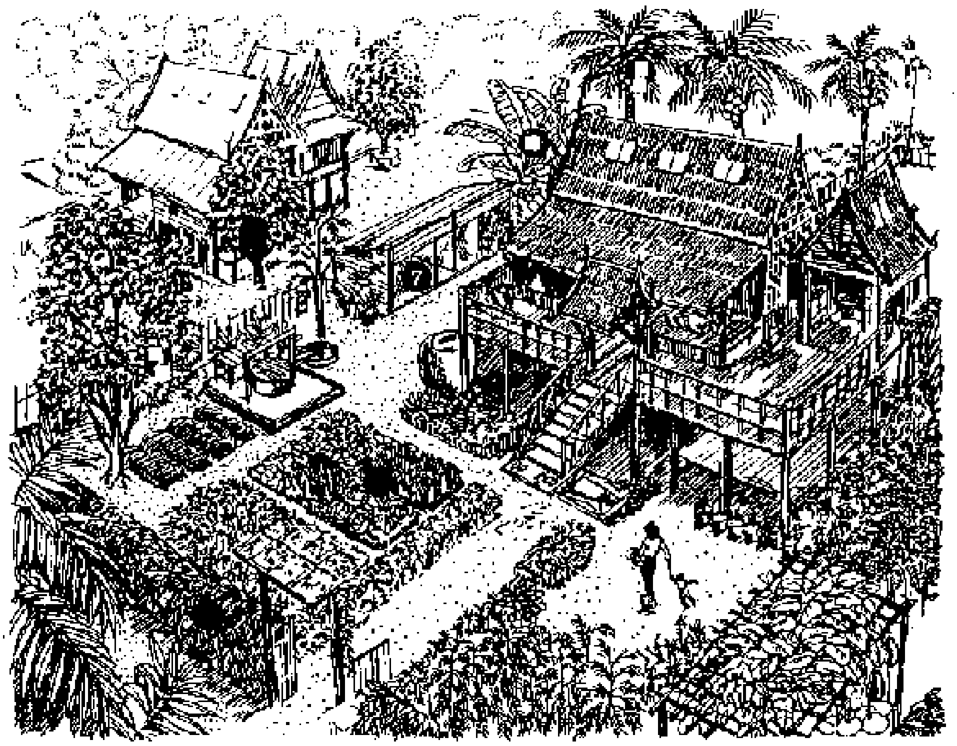


Photo credit: FAO

Agroforestry, or using trees as part of the agricultural landscape, can improve water and soil quality and reduce evaporation rates. These biodiverse systems have reduced nutrient and soil runoff, or erosion. The trees drop leaves and twigs which improve soil quality so that rainwater infiltrates better. Many crops are shade tolerant. The trees can be trimmed to allow more sun to reach the garden spaces and for use for firewood.

One system of agroforestry mixes livestock with trees and forage. The animals benefit from shade and the trees can provide nuts or timber or fruit.

Intercropping with trees can produce honey, fruits, nuts, maple syrup, medicinal plants such as ginseng, and mushrooms.

As field windbreaks, trees help to control wind erosion, provide wildlife habitat, control soil erosion, and protect livestock.

Although not meant to produce a large amount of a single crop, these systems can provide good yields with a variety of outputs. By mixing trees, shrubs and seasonal crops there is more resilience to insects, diseases, drought, and wind damage.

34. Reduce Food Waste

Dumpster Food. Photo Credit: Flickr CC via sporkist.

Food wasted is water wasted and so much more. More than 30 percent of the food produced is lost or wasted. Food waste can be lessened through improvements in every step of the supply chain – storage, transportation, food processing, wholesale, and retail. The consumer must learn to purchase and eat wisely, so as not to waste.

When processed food gets thrown away, all of the water, energy, and labor used to process, transport, refrigerate, and distribute that food was wasted. When fresh produce or meat is thrown away, everything that went into the production and cooking of those foods was wasted.

Some waste in a food system is normal, and it can be put to good use as compost to create rich soils for growing next year's food. It would be great if all food that is not consumed could be recycled into compost. The *"huge"* problem of obesity results in the squandering of both food and health.

In the developing world, small, local storage silos can greatly reduce rot, waste, and rodent damage to crops. Refrigeration, improved communication, and distribution infrastructure advancements will also help.

35. Water Conservation Also Means Keeping Our Water Clean and Uncontaminated

The Root River near La Crescent, Minnesota. Photo credit: Flickr CC via chief_huddleston.

What good would it do to conserve water if the water that remains is contaminated?

We must embrace smart practices and have government regulations in place that protect our water from becoming contaminated. Agriculture is guilty of water contamination from unsustainable land overuse practices that result in the runoff of fertilizers, manure, pesticides, soil, and herbicides.

Industrial agriculture runoff has contributed to the Dead Zones in various coastal locations around the world. Here in the U.S., our Dead Zone is located in the Gulf of Mexico and is a hypoxic water area the size of New Jersey. It results from agricultural and municipal waste runoff that funnels into the Mississippi River.

Overuse of nitrogen fertilizer has contaminated large amounts of ground water in regions such as Minnesota, where industrial agriculture is practiced. This has resulted in the loss of safe drinking water from underground wells for the families who live in these areas.

Poor farming practices that lead to soil erosion and harmful chemical runoffs not only degrade the land, but contaminate streams, lakes, and rivers. By nurturing wetlands, keeping waterways natural with buffered areas, incorporating grassy and woody buffer strips into farmed land, and building terraces or contours on slopes, farmers can help to keep their local water clean. By using methods which keep soil healthy — including organic farming, minimum tillage, rotational grazing, and crop rotations — soil absorbs and keeps water pure.

(End of Part 4.)

- **35 Water Conservation Methods for Agriculture, Farming, and Gardening. Part 1.**
- **35 Water Conservation Methods for Agriculture, Farming, and Gardening. Part 2.**
- **35 Water Conservation Methods for Agriculture, Farming, and Gardening. Part 3.**
- **35 Water Conservation Methods for Agriculture, Farming, and Gardening. Part 4.**

This entry was posted in **Africa**, **agroforestry**, **farm methods**, **food security**, **irrigation**, **low tech solutions**, **Mycorrhiza**, **permaculture**, **waste**, **water** on **February 15, 2013 [http://www.bigpictureagriculture.com/2013/02/more-crop-per-drop-water-agriculture-325.html]** .

19 thoughts on "Thirty-five Water Conservation Methods for Agriculture, Farming, and Gardening. Part 4."

Dr K.B.Wanjari
February 18, 2013 at 9:03 am

The water conservation is a subject where awareness need to be developed at all level. When water and food are amply available man should learn to utilize it more judiciously, avoiding wastage and exhaustion. Early begining on the issue will make us to sustain within our limitations. The content of this text is very useful for human on this globe.

K. McDonald Post author
February 18, 2013 at 9:22 am

Thankyou very much, Dr. Wanjari. I worked very hard for a long time on the 4-part post.

Anthony Boutard
February 18, 2013 at 3:30 pm

Kay,

This is a wonderful and useful survey of water efficiency measures. Thanks for all of the work you have done to pull together all of the information. I learned a lot.

Number 27 stood out for me. In the coastal coniferous forests the trees with their fine needles and cone-shaped crowns intercept a great deal of moisture from foggy and misty nights. In some places poor forestry practices have reduced the water interception role of the forest, and the resulting recharge of aquifers. It also started me thinking about the role of plant breeding in water conservation.

In corn and other crops, there are natural adaptations for collecting moisture from the fog. Specifically, trichomes, surface hairs on the leaf and stalks, intercept large amounts of water overnight even in the absence of fog. Walk through our field of flint corn in August, and you will be soaked to bone. This sort of useful ornamentation also costs the plant resources. Breeders who focus on yield and do not include other considerations, can lose these traits if they do not specifically select for them.

In a similar vein, a crop's accommodation of mycorrhizae is also governed by the plant's genetics. Yet few crops are evaluated for their capacity for mycorrhizal colonization. This is especially important for organic growers. If varieties are not well-adapted to colonization, the benefits of organic methods are reduced. Maybe someday seed breeders will evaluate plants for positive fungal interactions, just as they do for powdery mildew and other pathogens. Unfortunately, the extensive nature of F-1 hybrid vegetables, which is the trend even in organic agriculture, leads to the loss of many useful traits in the development of inbred lines. In open pollinated varieties, it is much easier for farmers to select out advantageous but hidden traits, such as mycorrhizal colonization, by observing general plant vigor.

The variable frequency drive (VFD) is another technological advance that improves water conservation. On a regular irrigation pump, it runs at a given speed and water delivery without getting too far into the details. The VFD allows the operator to change the speed of the pump. With our VFDs we can dial in the exact pressure we need, so if we are watering a smaller field, the pump will run slower. Although most of our watering is done with drip which needs about 18 psi, on occasion we need to use sprinklers and we can up the pressure to 50 psi for that watering set.

Once again, thanks for your work on this and other topics, as well as "Luddite Thursday." Though, as your research on water illustrates, there is a lot old and simple wisdom worth tapping out there and as a farmer I would be inclined to call it "Illuminating Thursday."

Anthony Boutard
Ayers Creek Farm

K. McDonald Post author
February 18, 2013 at 4:16 pm

Anthony,

It is always my pleasure to see you leave a comment here, because, for one, the comment is always valuable like this one.

I got your book for Christmas, by the way, as "Beautiful Corn" was on my wish-list and Santa came through with it. It is a treasure.

You have done exactly what I would like to see more of. People are welcome to add water saving agricultural methods that were not included above.

K. McDonald Post author
February 18, 2013 at 10:37 pm

As I find new ones, I will also add to this list.

Here is one more: Indian farmers tout the use of Panchagavya, an organic manure, to increase yields in dry conditions. It is made mostly with cow dung and urine and it is sprayed every 15-22 days, preventing cracks in the soil, according to The Hindu online. **http://www.thehindu.com/news/national/tamil-nadu/a-panacea-for-farmers-of-waterstarved-tirunelveli/article4422899.ece**

Don Greenfield
February 19, 2013 at 8:36 am

Kay, Thank you for sharing such a comprehensive collection of water conservation methods…there is something that will work for everyone. I'm particularly attracted to the idea of striving for best use of water resources without necessarily achieving the highest level of production. In a culture where high productivity seems to be the most important standard of measure, we need to integrate other standards of measurement which may also benefit mother earth. As natural resources (water) diminish we may have to alter some of our thought processes and embrace more practices that are weighted to our new realty of scarcity.

K. McDonald Post author
February 19, 2013 at 8:41 am

Bingo, Don. I think the mantra about feeding people is too often an excuse to exploit the resources, especially in a nation such as ours.

Harbans Lal
February 21, 2013 at 9:12 am

I really enjoyed all four parts of this report. Having worked in ICRISAT, India and CPATSA/EMBRAPA Brazil on dryland agriculture I have personally been involved in adopting and developing technologies for improved usage of scare water resources. One system which I conceptuallized and experimented with in Brazil during my tennure there from 1974-79 was called W-shaped in-site rainwater harvesting system. This system provided distict areas for planting zone and the rainwater harvesting zone which could be managed distictly for their own purpose.

Having moved to US in 1979, I have had no opportunity to further work and enhance this technique. However, I would be very eager to learn if someone has seen or worked with this technique.

Once again, great report and it brought my old memories back.

K. McDonald Post author
February 21, 2013 at 10:09 am

Thanks, interesting. I can't immediately find anything online showing the W-shaped system you speak of. If you know of any diagrams or articles, please let me know. Or, you might consider doing a wikipedia page on it?? Perhaps, If we get 10 more items listed in comments here, I'll do a part 5 someday!

Kar
February 21, 2013 at 10:46 am

You did not mention Hugelkultur.
http://www.richsoil.com/hugelkultur/

K. McDonald Post author
February 21, 2013 at 11:26 am

Thanks. I knew about Hugelkultur beds but never realized they helped save water! Good addition to this thread.

Christopher de Vidal
February 22, 2013 at 2:59 pm

Another addition: Swales (Permaculture)
http://midwestpermaculture.com/2012/07/hugelkultured-swale-with-linear-food-forest/

K. McDonald Post author
February 23, 2013 at 10:16 am

Here is a list put out by Texas A&M which advises farmers how to conserve water following their terrible drought period:

Texas A&M Agrilife Research provides the following list of irrigation management recommendations to manage water limited supplies with input from the Lower Rio Grande Valley Water District Managers' Association:

Agricultural producers should take advantage of this drought period to level their land if it is not leveled. The land that is already leveled should be retouched to improve efficiencies.

Farmers should buy flow-meters and measure their water, so they have records on how much is being applied per irrigation, and should have rain gauges to keep track how much rainfall they are receiving on their farms.

Farmers with more area should reduce irrigated area and give priority to perennial crops such as sugarcane, citrus, and grapes. Sugarcane is very sensitive to water shortages, while citrus and grapes have low to medium sensitivity.

Farmers should plant more water resistant crops such as dry-land sorghum, dry-land cotton, and sunflower. If rains received in the next season and irrigation districts can allocate more water. Then irrigation should be applied.

Corn, melons, onions and cabbage have medium to high sensitivity to water stress. It is preferable to not stress these crops.

For cotton is important to maintain adequate soil water during germination and establishment. An irrigation will be necessary if not enough moisture is available to establish the crop and obtain good stand. If water for an additional irrigation is available later on, it should be applied during the onset of flowering to peak flowering. Irrigation should be targeted on this stage.

Maize is relatively tolerant to water deficits during the vegetative and ripening periods. The greatest decrease of yields is caused by deficits during the flowering periods (tasselling and silking).

Therefore, it is important to target irrigation during flowering and if extra-irrigation is available, it is recommended to apply water during yield formation.

Soybeans require adequate water during germination. The periods more sensitive to water stress are flowering and pod formation.

Citrus that have water stress, have retarded growth, leaves curl and drop, young fruits fall, and fruits that mature are deficient in juice and quality. The most critical growth stage period for water stress in citrus is during flowering, and then during fruit set. Water deficits during fruit set can cause fruit drop.

Reduce tillage can be helpful to store moisture in the soil. Leaving some stubble and crop residue will help reduce evaporation and will prevent runoff in case of rain.

Pastures can be stressed more. It is imperative that land should be leveled to irrigate pastures.

It is important to avoid runoff. Furrows should be blocked at the lower end. Irrigation needs to be supervised to avoid spills and runoff.

Irrigators should use flexible plastic pipes and gated pipes to irrigate.

In furrow irrigation, some strategies to increase uniformity and reduce deep percolation losses are: irrigate alternate rows, irrigate the tractor wheel rows, irrigate with surge irrigation. It will be also a good strategy to use packers and smothers on the rows to advance the water faster to the end of the row. It is important to have a good flow-rate per furrow to advance water as fast as possible in the row without eroding the soil. A small flow-rate will increase percolation at the upstream end, and will lixiviate fertilizer.

In furrow irrigation, some strategies to reduce runoff are: decrease the wetting length of the rows, block the rows at the lower end, and supervise irrigation closely to avoid runoff.

In many situations if there is good soil moisture at planting, irrigation can be delayed. At physiological maturity irrigation can be terminated without affecting crop yields.

For more information, please contact Dr. Juan Enciso (email: **j-enciso@tamu.edu**)

Anil Shenoy
October 30, 2014 at 1:28 pm

Kay… a great 4 part series.. great research and really appreciate the time you took to put it together. Hope it reaches a lot of people to help us save this precious resource before we run out of it… there is a lot of information in the comments.. I hope you make the 5th part with the updates.

K. McDonald Post author
October 30, 2014 at 2:30 pm

Thanks, Anil, notes of encouragement are always helpful. I have been contemplating more work with this series – and in what fashion.

K. McDonald Post author
February 23, 2013 at 12:54 pm

Here's another: Water in the Arab World – Management Perspectives and Innovations. 2009. World Bank.

http://siteresources.worldbank.org/INTMENA/Resources/Water_Arab_World_full.pdf

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K. McDonald Post author
July 21, 2013 at 10:17 pm

Here is another:

Solid Rain, a water saving technology: Ross Brooks tells us about Solid Rain, a highly absorbent polymer called potassium polyacrylate, which soaks up water to 500 times its original size, like the substance in baby diapers. Used in agriculture, it can increase yields, according to studies by the Mexican government. "Three examples include oatmeal, which yielded 5000 kg per hectare with Solid Rain, versus 2500 kg per hectare without, sunflowers . 3000kg with versus 1000kg without, and bean which yielded a staggering 3000kg with versus 450kg without."

http://solid-rain.com/

http://www.psfk.com/2013/07/powdered-water-gel.html

Harshan gowda
November 25, 2013 at 10:50 pm

In my village we have a good rainfall which can be sufficient for cultivation and animals need but we are not able to conserve it or save for long time say (for more than 2 months).so please suggest me any ideas for conserving water for upto 6 months.

Tshepang gerald ntlhaemg
June 1, 2014 at 9:21 am

Thanks to all docters you really inprove our lives as youth of this country.we thank all of you for shering what you know with us.keep growing south african education

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