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Kern Soil & Water

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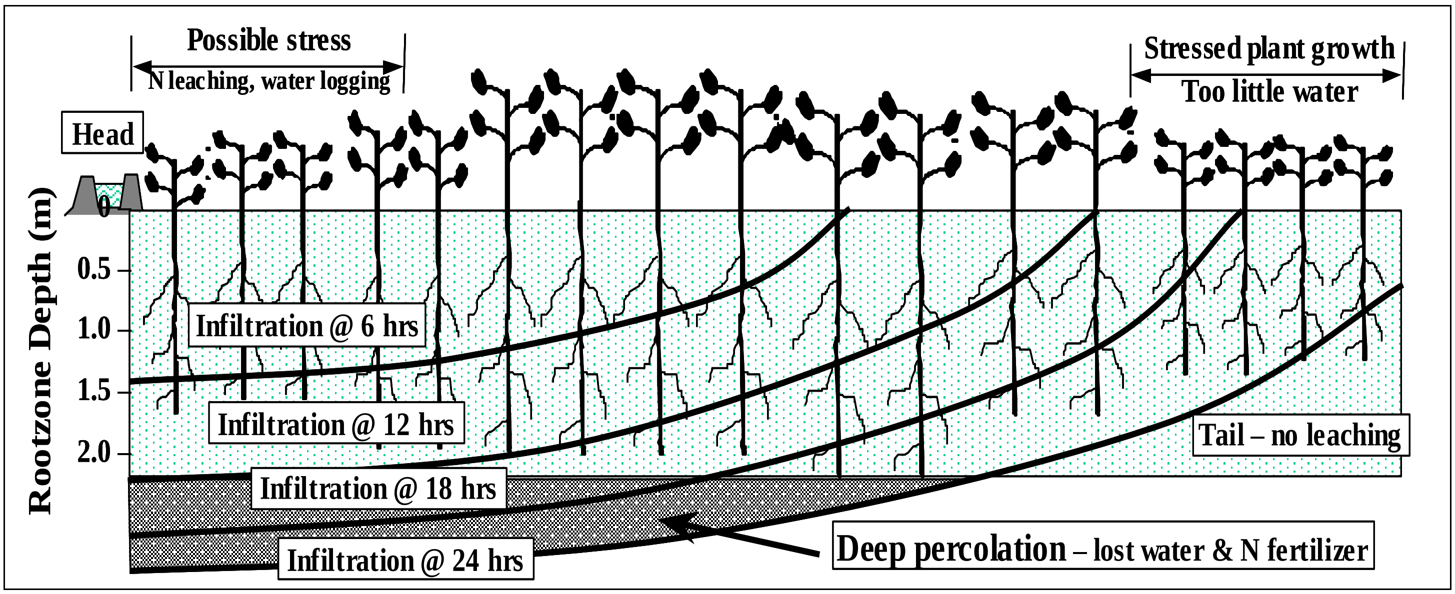
THIS EDITION:	--IRRIGATION UNIFORMITY
	--ENERGY USE CALCULATOR
	--SURFACE IRRIGATION WORKSHOP Friday June 3

IRRIGATION UNIFORMITY & EFFICIENCY IN KERN COUNTY

by Blake Sanden & Brian Hockett

The final uniformity and efficiency of an irrigation system is impacted by a wide variety of factors. **Distribution Uniformity (DU) and Irrigation Efficiency (IE)** are the two terms we use to describe the performance of an irrigation system. The below figure is a vertical view of water penetration down a furrow after a surface irrigation event, and in this case would represent about a 65 to 70% DU.



The formula to calculate DU is simple: $$\text{DU (\%)} = 100 * \frac{\text{“low quarter” infiltration}}{\text{Average field infiltration}}$$

If the above example is a ¼ mile run (1300 feet) then DU = 100 * (Net infiltration around 1150ft) / (Avg infiltration over the whole field, or Net infiltration around 650 feet) = **100 * (4”/6”) = 67%**

Not bad, but the reality is that means that the head end of the field infiltrates more than TWICE the water infiltrating at the tail end.

Micro irrigation (drip, etc.) and other pressure systems, such as sprinklers, have DU's that are determined by the mechanics of the system and not by the variability of infiltration down the furrow. In micro systems DU is the lowest one quarter of pressure points and emitter flows divided by the average flow for the whole

Table 1. Kern micro system DU, 1988-2014.

	1988-96	1997-05	2006-14
Drip	77%	84%	91%
Micro Sprnk	80%	82%	86%

system. Many of you have had this test performed on your fields by Brian Hockett who runs the NW Kern Resource Conservation District Mobile lab. In fact, from 1988-96 the average Kern flood furrow DU was 71%, while the average orchard/vineyard border strip flood irrigation with a tail water return averaged 84% -- a better DU than the micro system average in those early years! That said, Table 1 shows how steady improvements have been made over the last 26 years with micro-system DU in 1,607 field evaluations due to improved components, design and performance. An irrigation design analysis showing a 90-95% DU these days is quite reasonable.

A theoretically 'perfect' irrigation is one that just refills 87.5% of the rootzone (the average requirement of the low quarter). This assumes that some deficit irrigation can be tolerated on 12.5% of the field. Thus, a field that is irrigated on a schedule that never stresses the crop will have an **Irrigation Efficiency** that equals or is less than the DU.

Irrigation Efficiency (IE) is the percentage of total water applied for the season that was beneficially used by the crop. Average almond and pistachio IE's in Kern County are generally higher than the corresponding DU as many growers schedule their system run time hours to just match estimated "normal year ET" during the season. Google "cekern irrigation" to get to my website to find these. This matches the average engineered design depth of water applied by that system to the ET for that week. For example: a field that may have a DU of 80% can have an overall IE better than 95% if the run time is scheduled to just meet ET for that week. That sounds great from an efficiency standpoint but now instead of just 12% of the field being short on water you have 50% of the field deficit irrigated. This occurs on many of our soils that develop infiltration problems over the season. Some heavy soils require long intervals between irrigations to prevent water logging and damage to crop roots. This can cause increased stress but also may increase IE. Many drip system operators figure out the gallons/day/vine or tree to meet ET, multiply that number by the number of vines/trees in the field, and then run the pump to put out that many gallons. If the estimate of ET is conservative, and the DU of the system is less than 70%, then less than half the field may get adequate water even though the overall IE looks good. One drip system in grapes was found to have a DU of 58% but an IE of 97%! This kind of scenario will depress yield.

When the engineering fit of crop, soil type, field slope, and on-flow rate is optimized even furrow and border irrigation uniformities have exceeded 90%. For a deep-rooted and moderately drought tolerant crops like cotton for which irrigations are scheduled in a timely manner the seasonal irrigation efficiency can also be as high as 90%. However, on a different soil type and different crop, the same slope, flow rate and irrigation schedule could result in a DU and IE less than 60%. Where topography, soil types, or crop rooting patterns are a problem then pressure application systems (sprinkler to drip) are often preferable to surface systems.

The take-home message is two-fold: 1) There is no silver-bullet irrigation system. Spending more $/acre rarely increases water use efficiency and yields without . . . 2) There is no substitute for walking the field; check pressures, clean filters, adjust valves, flush hoses, replace plugged emitters and worn nozzles. Dig holes in the driest and wettest parts of the field and compare. If you are not doing these things at least once a month chances are that your system is performing at less than optimum.

IRRIGATION UNIFORMITY & PUMPING PLANT EFFICIENCY IMPACTS ON ENERGY COSTS

by Blake Sanden

Energy costs are a significant part of the Kern County water bill. Pressure systems with worn parts and out of adjustment manifold pressures in the field either mean more stress on the crop or more water and energy costs to supply crop water needs. The below table illustrates the potential energy and water savings that could be gained by improving the irrigation distribution uniformity and pumping plant efficiency on a hypothetical 150 acre block of almonds with a variety of irrigation systems. The biggest savings are realized by decreasing the lift cost of the well water by improving pump efficiency and decreasing the total ac-ft pumped through increased system uniformity.

Pump efficiency ratings (output water plus pressure horsepower divided by the electrical horse-power) of 40-60% due to wear in older deep well turbines and boosters is not uncommon. In pressure systems such as micro-sprinklers (Fanjets) a 50% well and booster pump efficiency and 80% in-field DU could ***cost you an extra $18,400*** over 150 acres compared to a tuned up system with 65% electrical pumping efficiency and 90% DU (see Table 2 below). If pressure in your micro system is suboptimal due to worn pump bowls, you will be able to decrease set times or decrease the total number of irrigations for the season after a pump repair. But it is most likely that the DU of the system will improve (with suitable field maintenance on your infield pressure regulators and emitters and provide more water to previously stressed parts of the field. This should translate into improved yields.

Table 2. Pumping energy costs as a function of irrigation system DU, pumping plant efficiency, pumping depth.

ENERGY COSTS FOR DIFFERENT IRRIGATION SYSTEMS AND EFFICIENCIES
Average energy cost/kwh over season: $0.14

Crop: Almonds | **Acreage: 150** | **Crop ET (in): 52**
Old pump flow (gpm): 1100 | **Deep Well Pumping Level (ft): 220**
Improved flow (gpm): 1400

Example: Border (Old) shows data and energy costs that are often found in old systems.
Border (Potential) shows data and costs after reasonable improvements.

	BORDER		**DRIP**		**MICROSPRINKLER (FANJET)**	
	(Old)	**(Potential)**	**(Old)**	**(Potential)**	**(Old)**	**(Potential)**
Pumping Efficiency	**50 %**	**65 %**	**50 %**	**65 %**	**50 %**	**65 %**
Distribution Uniformity	**70 %**	**85 %**	**80 %**	**93 %**	**80 %**	**90 %**
Required Water (in)	74.3	61.2	65.0	55.9	65.0	57.8
Total Water (ac-ft)	928.6	764.7	812.5	698.9	812.5	722.2
Water Saved (ac-ft)		**163.9**		**113.6**		**90.3**
Hours On for Season	4,586	2,968	4,013	2,712	4,013	2,803
Booster Pressure (psi)	0	0	35	45	35	45
Booster HP Reqd	0	0	45	57	45	57
Well HP Reqd	122	120	122	120	122	120
Booster KWH/ac-ft	0	0	165	164	165	164
Well KWH/ac-ft	450	346	450	346	450	346
Total Booster KWH	0	0	134,413	114,353	134,413	118,165
Total Well KWH	417,999	264,796	365,750	242,018	365,750	250,085
Total Energy Cost	$58,520	$37,071	$70,023	$49,892	$70,023	$51,555
Potential Annual Savings		**$21,448**		**$20,131**		**$18,468**

This calculator will be available on my website and should be useful for calculating KWH and water savings for system efficiency changes that are important for qualifying for California Department of Food and Ag SWEEP (State Water Efficiency Enhancement Program) grants. To qualify for these grants, which over the last year were up to $250,000 per project, you must show that you can reduce water consumption and Green House Gas (GHG) emissions (reduce electrical consumption).

Surface Irrigation Efficiency Workshops

This workshop is designed to give growers and water managers tools and insights on how to better conduct surface irrigation activities including furrow, border and basin (flood) irrigation. Topics include basic system design issues, performance evaluation approaches and commonly used practices to improve the distribution uniformity and efficiency of applied water.

Friday June 3, 2016

Location:	UC Kearney Agricultural Center 9240 S. Riverbend Ave Parlier, CA 93648 Nectarine Room
Date:	June 3, 2016
Time:	9:00 AM- 12:00 AM
Registration Fee:	Free

Agenda

8:30 AM- 9:00 AM	Registration and Refreshments
9:00 AM-9:10 AM	Introductory remarks and welcome- Nicholas Clark, UCCE- Kings/Tulare County 9:10 AM -9:30 AM Practical Application for Improving Surface Irrigation Efficiencies, Dan Munk, UCCE-Fresno County
9:30 AM-9:50 AM	Understanding Irrigation Efficiency with Different Systems: How it's Defined, Why it's Important- Khaled Bali, UCCE-Imperial
9:50 AM- 10:10 AM	Irrigation Systems and Energy Efficiency, Daniele Zaccaria, UC Davis
10:10 AM-10:30 AM	Break
10:30 AM-11:10 AM	Improving the Efficiency of Surface Irrigation Systems, Eduardo Bautista, ARS-USDA 11:10 AM-11:30 AM The relationship between irrigation efficiency and field geometry, field condition, and inflow rate into the irrigated field, Eduardo Bautista, ARS-USDA
11:30 AM- 12:00 PM	Q&A

To register for the workshop or for additional information, please email or call Dan Munk or Terri Gonzalez (email:dsmunk@ucanr.edu, 559-241-7515). Event registration is optional but preferred to estimate attendance.

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