



## Spatial and Temporal Analysis of Application Efficiencies in Irrigation Systems for the State of California

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### Conclusions

Based on the analysis done, combining the irrigation surveys with theoretical application efficiencies, it was possible to estimate overall application efficiencies for 20 crops and by hydrologic region for two years, 2001 and 2010. Table 1 shows the application efficiency for each hydrologic region and statewide. For the whole state of California, it is estimated that the mean *AE* has increased 3.1% from 74.5% to 77.5%. All hydrologic regions improved their *AE* ( $\Delta AE$ ), except North Lahontan, where a minimal -0.1% decrease in *AE* has been estimated. The three regions with highest increase in *AE* are: Sacramento River (4.8%) and South Coast (4.3%) and San Francisco Bay (3.9%).

Table 1 –Application Efficiencies for California Hydrologic Regions

Hydrologic Region	2001 Survey			2010 Survey			$\Delta E$
	Low (%)	Mean (%)	High (%)	Low (%)	Mean (%)	High (%)	
North Coast	64.4	73.6	82.1	67.2	77.3	87.0	3.7
San Francisco Bay	66.7	74.9	82.9	68.2	78.8	88.9	3.9
Central Coast	68.3	76.4	84.7	70.5	79.8	88.9	3.4
South Coast	65.6	74.4	83.3	69.2	78.7	87.7	4.3
Sacramento River	62.2	71.8	80.9	65.8	76.6	86.6	4.8
San Joaquin River	65.0	74.8	84.4	67.0	78.0	88.3	3.2
Tulare Lake	65.5	75.5	85.5	66.7	77.8	88.3	2.3
North Lahontan	59.2	73.6	84.3	61.8	73.5	85.0	-0.1
South Lahontan	66.8	76.3	85.9	67.9	78.5	88.6	2.2
Colorado River	63.0	72.9	82.8	63.9	75.3	86.1	2.4
Statewide	64.8	74.5	83.9	66.7	77.5	87.8	3.1

Similarly, the *AE* by crop has increased for most of the crops, as shown in Table 2. The crops with highest *AE* in 2010 are vineyards, followed by subtropical trees, almonds and pistachio, tomato (process), and onion and garlic (Column of 2010 Survey - Mean). The 2010 *AE* values for almost every crop increased [column  $\Delta(AE)$ ] compared to estimated *AE* in 2001, except for safflower and pasture. The largest increases in *AE* from 2001 to 2012 [column  $\Delta(AE)$ ] occurred in onion and garlic, tomato (process), potato, other deciduous (apples, peaches, prunes, pears, etc.), and turfgrass and landscape. At least 14 crops improved their *AE* by 2% or more (cotton, other field crops, cucurbit, onion and garlic, tomato-fresh, tomato process, other truck crops, almond and pistachio, other deciduous, subtropical trees, turf grass and landscape, and vineyards).

Table 2 –Application Efficiencies by Crop

Crop	2001 Survey			2010 Survey			$\Delta IE$
	Low (%)	Mean (%)	High (%)	Low (%)	Mean (%)	High (%)	
Corn	59.7	72.5	84.6	59.6	72.9	85.5	0.4
Cotton	59.9	71.6	83.4	62.2	74.6	86.4	3.0
Dry beans	61.8	72.0	82.2	63.3	74.3	84.6	2.3
Grains	60.6	72.0	82.6	60.1	73.0	85.3	1.0
Safflower	59.4	71.3	81.9	58.9	71.1	82.9	-0.3
Sugarbeet	60.0	72.5	85.0	62.0	74.4	86.0	1.9
Other Field crops	60.9	72.1	83.0	62.0	74.2	85.9	2.1
Alfalfa	61.9	72.5	82.8	60.6	73.1	84.9	0.6
Pasture	57.7	72.0	82.6	58.5	71.4	83.9	-0.5
Cucurbit	65.0	74.6	84.2	66.8	77.9	88.5	3.3
Onion and Garlic	56.0	61.2	66.4	69.6	79.0	88.0	17.9
Potato	61.1	68.7	76.3	70.5	78.9	86.5	10.2
Tomato (fresh)	66.5	75.9	85.4	67.7	78.5	89.0	2.6
Tomato (process)	60.3	70.4	80.4	70.9	80.9	90.6	10.6
Other Truck Crops	64.3	72.8	81.6	67.2	77.1	86.6	4.3
Almond & Pistachio	69.0	76.9	84.7	72.0	81.2	89.8	4.3
Other Deciduous	63.4	71.2	78.9	68.3	78.0	86.9	6.7
Subtropical Trees	69.7	77.1	84.5	73.0	81.6	89.4	4.5
Turfgrass & landscape	61.4	68.6	75.8	64.8	74.4	83.8	5.8
Vineyard	70.9	79.7	89.0	73.1	83.0	92.6	3.3

## LIMITATIONS

The objective of this analysis is to obtain a rough estimation of on farm *AE* across different hydrologic regions and crops across California. This was possible by considering several assumptions that may not be valid. The main assumptions are: (1) the irrigation survey is a representative sample of the population, (2) every farmer knew their irrigation system *DU* and their crops target depth, (3) the target depth was obtained considering the low quartile depth and the distribution uniformity, and (4) water losses from the irrigation system were not considered. For the first assumption, further statistical analysis is needed to test if the irrigation survey is representative of the population. For the second assumption, it is very unlikely that every farmer knows the *DU* of their irrigation system, or their target depth, nonetheless, this assumption was considered to make equal the *DU* and *AE* values. The third assumption considers that farmers do not waste water and only apply the required amount of water in every irrigation event, however this is not always true, lacking of knowledge of their *DU*, crop water requirement and target depth can provoke to use more water than needed. Finally, for the fourth assumption, the authors recognize that there are water losses in irrigation systems and that these must be considered when data is available.