International Journal of Agriculture and Environmental Research

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

RESULTS FROM THE PERFORMANCE-BASED INCENTIVE FOR CONSERVATION IN AGRICULTURE PROGRAM IN STRAWBERRY PRODUCTION IN THE PAJARO VALLEY, CALIFORNIA

Gerardo Spinelli[1*], Sacha Lozano[1]

[1]Resource Conservation District of Santa Cruz County,
820 Bay Ave, Capitola, CA 95010

*Corresponding author

INTRODUCTION

The Pajaro and lower Salinas Valleys on the central coast of California, support a multi-billion vegetable and berry specialty crop industry. Cool coastal climate and a long growing season allow for multiple crop cycles and remarkably high productivity in a relatively small farmable area. The region's agriculture industry is almost entirely reliant on groundwater supply, and at the same time suffers from persistent groundwater overdraft and seawater intrusion, which are aggravated by drought and weather extremes associated to climate change. In 2017 about 7500 acres of strawberry were planted in the Watsonville- Salinas district and produced a crop value of $900M (Source: California Strawberry Commission). The substantial irrigation requirements of the crops grown in the area, combined with the critical aquifer overdraft, seawater intrusion and the drought that affected California in the past years have caused concern about the long-term sustainability of this industry. In this context, water conservation is paramount and incentives to encourage growers to conserve water have been developed.

The Resource Conservation District (RCD) of Santa Cruz County implemented the Performance-based Incentive for Conservation in Agriculture (PICA) program in the Watsonville-Salinas district in the Central Coast of California. The program aims at promoting conservation among ranchers through the collection of water use data and the calculation of performance indexes (water use relative to crop demand). Performance data and comparison to peers are reported to growers anonymously and incentives are offered to growers that improve their water management practices. This paper shows the results of the water monitoring project for the years 2013-2017 and discusses the data obtained in the context of the agro-meteorological environment of the Central Coast and in comparison with the relevant literature.

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

MATERIALS AND METHODS

Performance index

The performance index used was the ratio between applied water and crop evapotranspiration (ETc), thus a larger index indicates poor performance and a smaller index indicates good performance. The index does not take into account the efficiency of the irrigation system (distribution uniformity) nor other beneficial uses of water such as leaching requirement, land preparation and frost protection. Applied water was measured from flowmeters installed at the pump or at the irrigation block (Netafim WMR and WST series and McCrometer McPropeller). Records were kept on paper or with electronic dataloggers (Campbell Scientific CR1000 and CR200 series). ETc was obtained from the web application CropManage (https://cropmanage.ucanr.edu/) developed by the University of California Cooperative Extension.

Meteorological data

Precipitation and reference evapotranspiration (ETo) datawere obtained from CIMIS (http://cimis.water.ca.gov) for the station located in Pajaro, CA (#129) for the period January 1st 2013 until December 31st 2017.

Ranch data

Ranch area and marketable yield were obtained from the ranchers that collaborated in the program.

RESULTS

The meteorological data indicated a relatively high ETo during the first three years of the project (2013- 2015), a dip in 2016 and an increase in 2017. ETo was consistent across years ranging from 42 inches in 2016 to 47 inches 2017. Conversely, precipitation was variable, ranging from 3.5 inches in 2013 to 28 in 2017 (Figure 1).

The ratio water applied/ETc showed a large variability across ranches, during each year ranging from 0.69 to 1.49 for the whole dataset.

The ratio water applied/ETc in 2013 was collected from 26 ranches but is reported here as an average value of 1.36. In the following years, the average ratio water applied/ETc decreased substantially, with 1.08 in 2014, 0.97 in 2015, 1.02 in 2016 and 0.97 in 2017 (Figure 3). The ratio water applied/ETc appears to display an inverse relationship with rains. However, there was

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

no statistical difference in the ratio water applied/ETc across the years, due to the high variability of the index collected among different ranches.

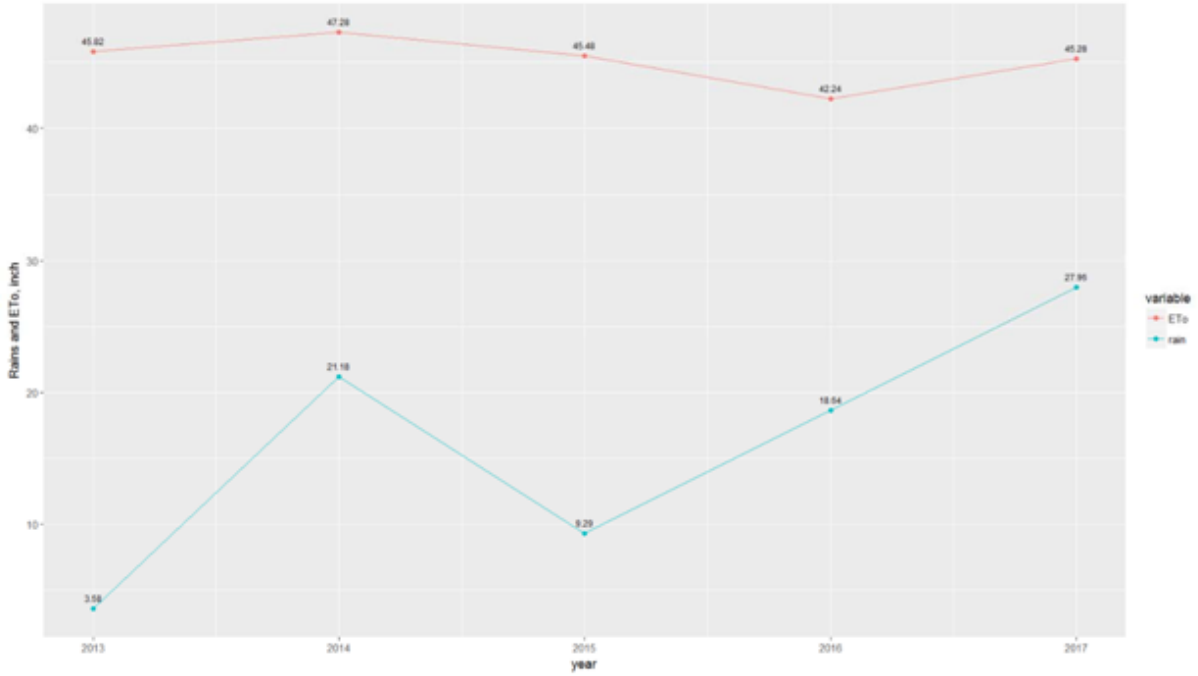

Figure 1: Reference ET and rains from the local CIMIS station for the five years of the project.

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

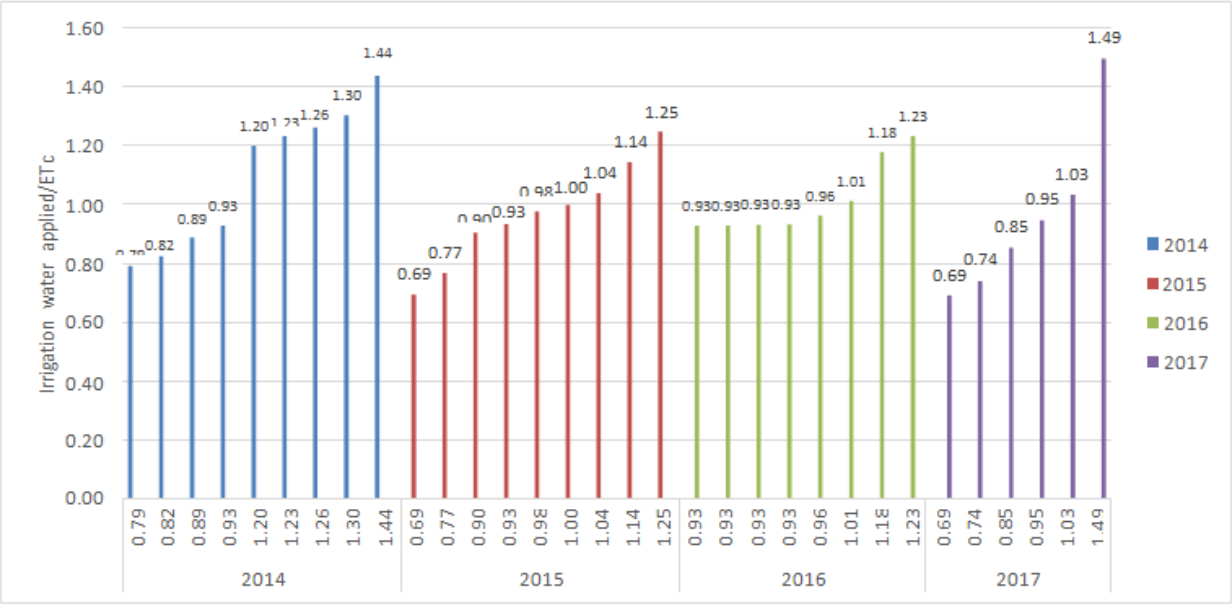

Figure 2: Ratio water applied/ETc from all ranches for the four years of the study.

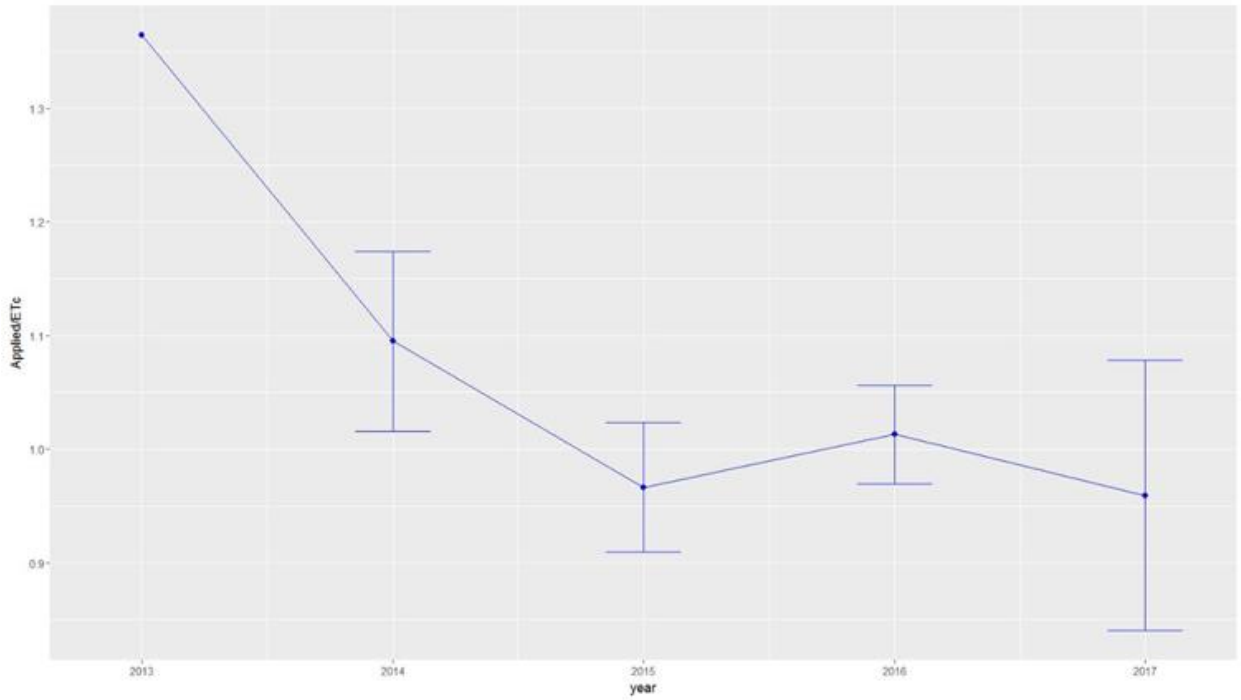

Figure 3: Average of the ratio water applied/ETc (applied irrigation water/crop evapotranspiration) obtained in the four years of the study. The bar indicates the standard error.

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

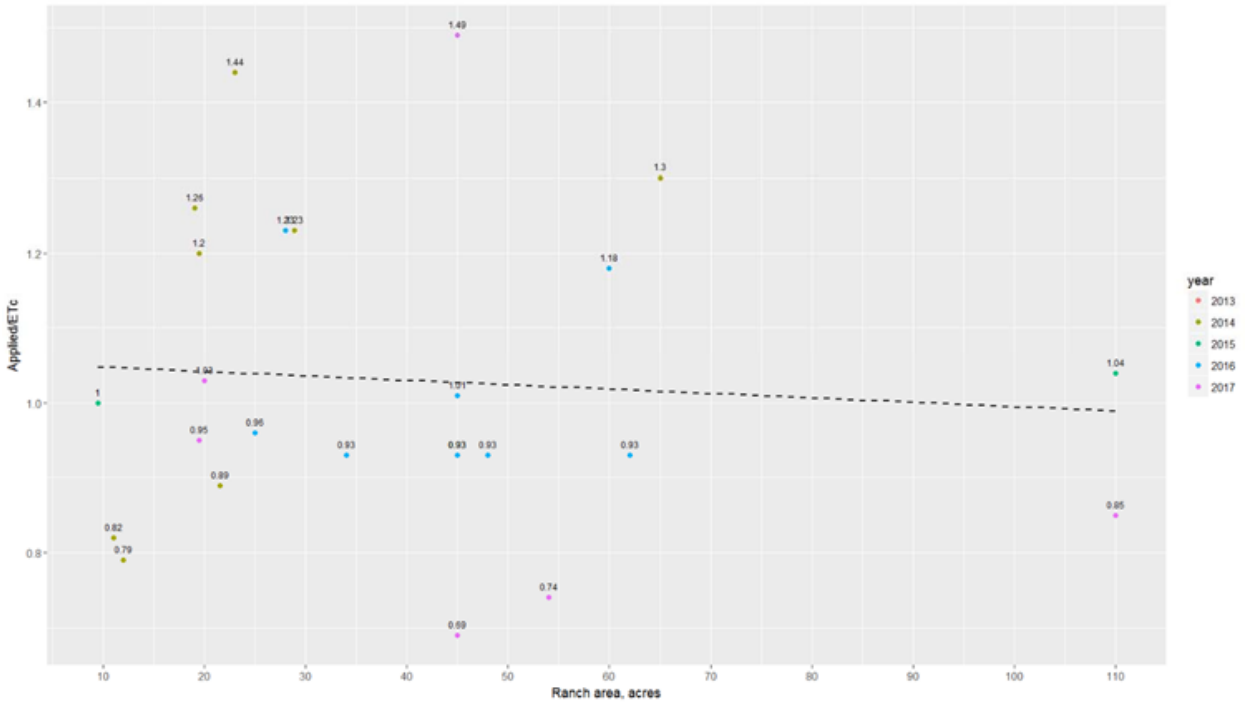

Figure 4: Relationship between the ratio water applied/ETc and the ranch size. The dashed line indicates the linear regression.

Table 1: Linear regression analysis of the relationship between the ratio water applied/ETc and ranch size.

Year	Number of ranches (n)	Range in ratio water applied/ETc	Range in ranch area, acres	Regression slope	P-value
2014	9	0.79 to 1.44	11 to 65	0.00483	0.35 NS
2015	9	0.69 to 1.25	9.5 to 110	-	-
2016	8	0.93 to 1.23	25 to 62	-0.00067	0.86 NS
2017	6	0.69 to 1.49	19.5 to 110	-0.00193	0.67 NS
Overall	33	0.69 to 1.49	9.5 to 110	-0.000586	0.72 NS

* = significant at the 0.05 level, ** = significant at the 0.01 level, *** = significant at the 0.001 level

There was a negative relationship between the ratio water applied/ETc and ranch size, suggesting that larger ranches obtained lower ratio water applied/ETc indicating better irrigation management.

However, the relationship was not statistically significant.

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

A positive relationship was observed between the ratio water applied/ETc and marketable yield. This correlation suggest that ranches that applied more irrigation water compared to ETc, produced better yields. The relationship was statistically significant for the 2016 data and pooling together all the data from all years. The data for the other years taken individually showed a non-significant relationship. This relationship may suggest that growers that applied water in excess to ETc, perhaps to leach salts and reduce soil salinity, obtained better yields.

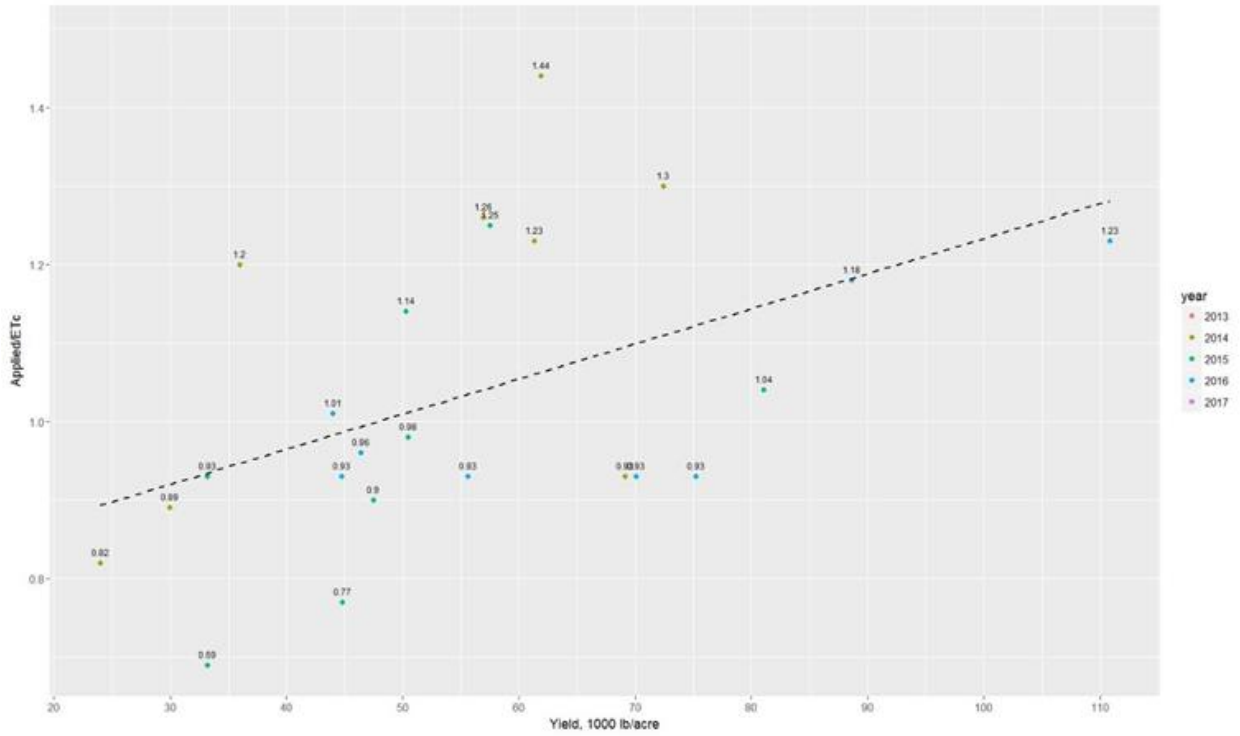

Figure 5: Relationship between the ratio water applied/ETc and marketable yield. The dashed line indicates the linear regression.

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

Table 2: Linear regression analysis of the relationship between the ratio water applied/ETc and yield

Year	Number of ranches (n)	Range in ratio water applied/ETc	Range in yield, 1000 lb/ac	Regression slope	P-value
2014	9	0.79 to 1.44	24 to 72.4	0.007	0.12 NS
2015	9	0.69 to 1.25	33.2 to 81	0.006	0.15 NS
2016	8	0.93 to 1.23	44 to 110.8	0.004	0.02 *
Overall	17	0.69 to 1.49	24 to 110.8	0.0045	0.0167 *

* = significant at the 0.05 level, ** = significant at the 0.01 level, *** = significant at the 0.001 level

DISCUSSION

The large range in the obtained ratio water applied/ETc across ranches may be attributable to variation in distribution uniformity of the irrigation system, since growers with low distribution uniformity apply larger amount of water to overcome to match crop ET in the driest areas of the field. Additionally, salinity up to 1.05 dS/m was observed in the water of some wells (data not shown) and it is common practice to apply a leaching requirement, particularly in years following dry winters. Years 2013 and 2015 were dry and this may explain the average higher ratio water applied/ETc observed in 2014 and 2016. Cahn et al report well water salinity ranging from to 0.3 to 1.4 dS/m.

There was a decline of the ratio water applied/ETc (meaning better performance) associated to ranch size but this relationship was not significant. Larger operations commonly can afford better irrigation management and equipment. Most large farming operations can count on assistance provided by conservation programs from the company that refrigerate and commercialize the product. Additionally, larger ranches are located in valley bottom areas with minimal slope and better soils, where high irrigation system efficiencies are easily achievable. Conversely, small ranches tend to be located on marginal sloping land typically are less sophisticated operations.

The average ratio water applied/ETc obtained by Cahn et al. with data from 2011 season showed 0.94 app/ETc, with reported average rainfall 14.2 inches. This ratio indicates a better performance than the ones obtained in this study and during a year with rainfall similar to the one observed in this study. However, another study conducted by the same group monitoring 14 ranches during the 2012 season reported a ratio water applied/ETc of 1.46, which is substantially higher than the values obtained in this study.

There was a positive relationship between the ratio water applied/ETc and yield, indicating that

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

growers that applied water in excess of ETc also obtained better yield. This could be due to better soil moisture management and/or better soil salinity management. However, the data also show ranches that produced in excess of 70,000 pounds per acre of marketable yield with ratios water applied/ETc of 0.93 and 1.04, indicating that high yields can be achieved while conserving water with careful irrigation management.

In relation to potential incentives for growers to achieve higher water conservation and reduce pressure on the critically overdrafted aquifers, these results suggest that lowering irrigation water use may compromise crop yield and net revenue (unless irrigation is carefully and efficiently managed). Therefore, conservation incentives need to have substantial economic value in order to be attractive and drive changes in irrigation practices.

ACKNOWLEDGEMENTS

The project was supported by CDFA Specialty Crop Block Grant Program, USDA Conservation Innovation Grants Program, Sustainable Conservation, and the Pajaro Valley Water Management Agency.

The authors wish to acknowledge contributions from anonymous participant growers, Emily Paddock and Driscoll's Berries Co.

REFERENCES

Water Use of Strawberries on the Central Coast, Michael Cahn and Barry Farrara, UC Cooperative Extension, Monterey, Tom Bottoms and Tim Hartz, UC Davis. http://cemonterey.ucanr.edu/files/171011.pdf

Strawberry water use on the Central Coast, Michael Cahn and Barry Farrara UC Cooperative Extension, Monterey County, Tom Bottoms and Tim Hartz, UC Davis, Mark Bolda UC Cooperative Extension, Santa Cruz County. http://cemonterey.ucanr.edu/files/171007.pdf

