

CALIFORNIA AVOCADOS

Avocados are grown on approximately 60,000 acres, primarily in southern and central California, typically in regions tempered by coastal climates. Most of the avocado acreage lies between San Luis Obispo and San Diego. Avocados are produced in 15 counties but five coastal counties account for essentially all of the state's production. Based on 2002 USDA census data, San Diego, Santa Barbara, and Ventura Counties are the top producing counties, accounting for approximately 80% of the total avocado acreage in California (USDA, 2002). San Diego County is the leading county, producing nearly 47% of California market value for avocados (USDA, 1999a), accounting for 39% of the state's avocado producing acreage (USDA, 2002). Other counties with significant production are Riverside (14%) and Orange (3%) counties. California produces 95% of the avocados grown in the United States and 10% of the world's production. From 1990 to 1998, California's average production was 323 million pounds, with typical fluctuations of 5% (USDA, 1999a). This crop requires relatively few chemicals to control insect pests. Beneficial insects are used as part of an Integrated Pest Management (IPM) approach in which harsh chemicals are avoided to maintain this balance.

Several varieties of avocados are harvested in California including, Haas, Lamb Haas, Bacon, Zutano, Fuerte, Pinkerton and Gwen. The Haas variety is the predominant tree accounting for roughly 90% of the total production. Due to California's unique coastal micro-climate, avocados are harvested year round with a typical tree yielding 60 lbs of fruit per year. The official avocado crop year runs from November 1 through October 31. Avocado fruit can be held successfully after harvest in cold storage for approximately 2 to 4 weeks. The size and oil levels of the harvested fruit, in part, determine the grade of the harvest.

Avocados are typically grown in well-drained, fine or coarse sandy loam soils. Micro sprinkler and drip irrigation systems typically are used to deliver water to the grove floor. Avocado roots are relatively shallow, so deep watering is unnecessary. There are over two-dozen avocado bearing soils in San Diego, Santa Barbara, and Ventura Counties alone (USDA, 2006). Approximately 63% of avocado bearing soils in these counties are in drainage groups C and D. Of these, the Cieneba series is the most common avocado bearing soil with moderate expected yields under irrigation (Table 5). The Cieneba series accounts for approximately 37% of avocado bearing soil acreage (USDA, 2006). Cieneba soils are thermic, shallow Typic Xerorthents located on uplands with slopes of 9 to 85 percent (USDA, 1999b). Location and metfile selections are often the most important developments affecting scenario vulnerability and protectiveness. Because this scenario is intended to represent avocado production along the southern coastal area of California, the metfile closest to the center of the primary avocado producing county (San Diego) was chosen. The Cieneba soil series was selected for this scenario because it is both representative of avocado bearing soils (Oster, 2006), is predominant in San Diego County as well as central and southern California, represents the majority (44%) of avocado soils in drainage, the fourth most erosive soil type, and is among the steeper sloped avocado bearing soils (Table 5).

Cieneba is a Hydrologic Group C soil, which represents the majority (44%) of these soils in drainage. Cieneba soils have a USLE K factor of ranging from 0.24-0.32; approximately 82% of avocado bearing soils have a USLE K factor between 0.24 and 0.32 (Table 5). Approximately 10% of avocado bearing soils have a pH lower than Cieneba soils (5.8 - 6.5), although soil pH is not currently a PRZM input parameter and is not expected to often affect chemical fate in the acidic range. Based on the official soil series description, Cieneba soils have an A horizon from 0 to 10 inches (0-25 cm) deep and a C horizon from 10 to over 30 inches (25-76 cm) deep, however the C horizon is primarily weathered granitic material with remnant rock structure. (USDA, 2006). Cieneba coarse sandy loam was used to parameterize this scenario (USDA 2005).

The Met station chosen was the San Diego station (23188.dvf) located at 32° 44' N, 117° 10' W and at an elevation of approximately 4 meters above sea level. This station receives an average of approximately 25.2 cm of rainfall annually. The station is the closest available station to this scenario with data necessary for PRZM.

Table 1. PRZM 3.12 Climate and Time Parameters for San Diego, California – Avocado.		
Parameter	Value	Source/Comments
Starting Date	Jan. 1, 1961	Meteorological File from San Diego County, (W 23188)
Ending Date	Dec. 31, 1990	Meteorological File from San Diego County, (W 23188)
Pan Evaporation Factor (PFAC)	0.70	PRZM Manual Figure 5.1. Value represents San Diego region.
Snowmelt Factor (SFAC)	0	In areas where climatology prevents snow fall, SFAC should be set to 0.0 - PRZM Manual (EPA 1998)
Minimum Depth of Evaporation (ANETD)	32.5 cm	PRZM Manual (EPA 1998) Average of 30-35 cm

Table 2. PRZM 3.12 Erosion and Landscape Parameters for San Diego, California – Avocado.		
Parameter	Value	Source/Comments
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.24	USDA NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
USLE LS Factor (USLELS)	3.63	PRZM Manual (EPA, 1998) LS value for 12% slope and 400' slope length; LS equation (Haan and Barfield, 1978)
USLE P Factor (USLEP)	1.0	Set to 1 for orchards (EPA, 2004)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	1	PRZM Manual Figure 5.12 (EPA, 1998) Type I, IREG=1
Slope (SLP)	12 %	Slopes for Cienega coarse sandy loam exceed 12%. Set to 12% as per PRZM scenario guidance (EPA, 2004). Some data indicate slopes as high as 16% (Oster and Arpaia 2006)
Hydraulic Length (HL)	600 m	Shipman Reservoir (EPA, 1999)
Irrigation Flag (IRFLAG)	1	Year round irrigation. EPA, 2005
Irrigation Type (IRTYP)	4 (drip)	Irrigation Guidance for developing PRZM Scenarios, Table 3; (EPA 2005).
Leaching Factor (FLEACH)	0.0	Set to 0 as per Irrigation Guidance for developing PRZM Scenarios, Table 3; (June 15, 2005).
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	0.5	Set to default as per Irrigation Guidance for developing PRZM Scenarios, Table 3; (EPA 2005).
Maximum Rate at which Irrigation is Applied (RATEAP)	0.056 cm hr ⁻¹	Irrigation Guidance for developing PRZM Scenarios, Table 1; (June 15, 2005). For CN = 79 and f = 0

Table 3. PRZM 3.12 Crop Parameters for San Diego, California – Avocado.		
Parameter	Value	Source/Comments
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2004).

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Parameter	Value	Source/Comments
Initial Surface Condition (ISCOND)	3	Orchard residues are left behind between rows, under trees are cleared to reduce disease. Consistent with the FL avocado scenario and other orchard type scenarios.
Number of Different Crops (NDC)	1	Set to number of crops in simulation.
Number of Cropping Periods (NCPDS)	30	Set to weather data in meteorological file: San Diego, CA (W23188).
Maximum rainfall interception storage of crop (CINTCP)	0.25	Recommended value for orchards (EPA, 2004).
Maximum Active Root Depth (AMXDR)	25 cm	Set to horizon depth. Most of the roots for Haas avocados grown in an orchard with Cieneba soil type were located above 15 cm (Oster and Arpaia 2006)
Maximum Canopy Coverage (COVMAX)	70	Taken from FL avocados scenario
Soil Surface Condition After Harvest (ICNAH)	3	Plant residues are left behind. Consistent with the FL avocado scenario and other orchard type scenarios.
Date of Crop Emergence (EMD, EMM, IYREM)	01/01	Values are set to keep E/T and canopy coverage terms working correctly for this evergreen scenario.
Date of Crop Maturity (MAD, MAM, IYRMAT)	02/01	Values are set to keep E/T and canopy coverage terms working correctly for this evergreen scenario.
Date of Crop Harvest (HAD, HAM, IYRHAR)	31/12	Values are set to keep E/T and canopy coverage terms working correctly for this evergreen scenario.
Maximum Dry Weight (WFMAX)	0.0	Not used in scenario
Maximum Crop Height (HTMAX)	914	Avocado trees typically grow to 20-40 feet California Avocado Commission
SCS Curve Number (CN)	84, 79, 82	Gleams Manual Table H-4; meadows; hydrological group C (USDA, 1990)
Manning's N Value (MNGN)	0.023	RUSLE Project; C25CFCFN for California citrus with full cover (USDA, 2000).
USLE C Factor (USLEC)	0.040 - 0.062	RUSLE Project; C25CFCFN for California citrus with full cover (USDA, 2000).

Table 4. PRZM 3.12 Cieneba Soil Parameters for San Diego, California – Avocado.		
Parameter	Value	Source/Comments
Total Soil Depth (CORED)	25 cm	NRCS Soil Data Mart (SDM) (http://soildatamart.nrcs.usda.gov)
Number of Horizons (NHORIZ)	2	NRCS Soil Data Mart (SDM) (http://soildatamart.nrcs.usda.gov). The third horizon from SDM was excluded because it is bedrock.
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 15 cm (HORIZN = 2)	NRCS Soil Data Mart (SDM) (http://soildatamart.nrcs.usda.gov).
Bulk Density (BD)	1.55 g/cm ³ (HORIZN = 1) 1.55 g/cm ³ (HORIZN = 2)	NRCS Soil Data Mart (SDM) (http://soildatamart.nrcs.usda.gov). Midpoint of the reported range. PRZM Scenario Guidance (EPA, 2004).

Initial Water Content (THETO)	0.168 cm ³ /cm ³ (HORIZN =1) 0.168 cm ³ /cm ³ (HORIZN =2)	NRCS Soil Data Mart (SDM); values are mean 1/3-bar water contents of Cieneba coarse sandy loam soils.
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 5 cm (HORIZN = 2)	NRCS Soil Data Mart (SDM) (http://soildatamart.nrcs.usda.gov). PRZM Scenario Guidance (EPA, 2004).
Field Capacity (THEFC)	0.168 cm ³ /cm ³ (HORIZN =1) 0.168 cm ³ /cm ³ (HORIZN =2)	NRCS Soil Data Mart (SDM); values are mean 1/3-bar water contents of Cieneba coarse sandy loam soils.
Wilting Point (THEWP)	0.08 cm ³ /cm ³ (HORIZN =1) 0.08 cm ³ /cm ³ (HORIZN =2)	NRCS Soil Data Mart (SDM); values are mean 15-bar water contents of Cieneba coarse sandy loam soils.
Organic Carbon Content (OC)	0.44% (HORIZN = 1) 0.44% (HORIZN = 2)	NRCS SDM; values for horizons 1 to 3 = mean %OM / 1.724. PRZM Scenario Guidance (EPA, 2004).

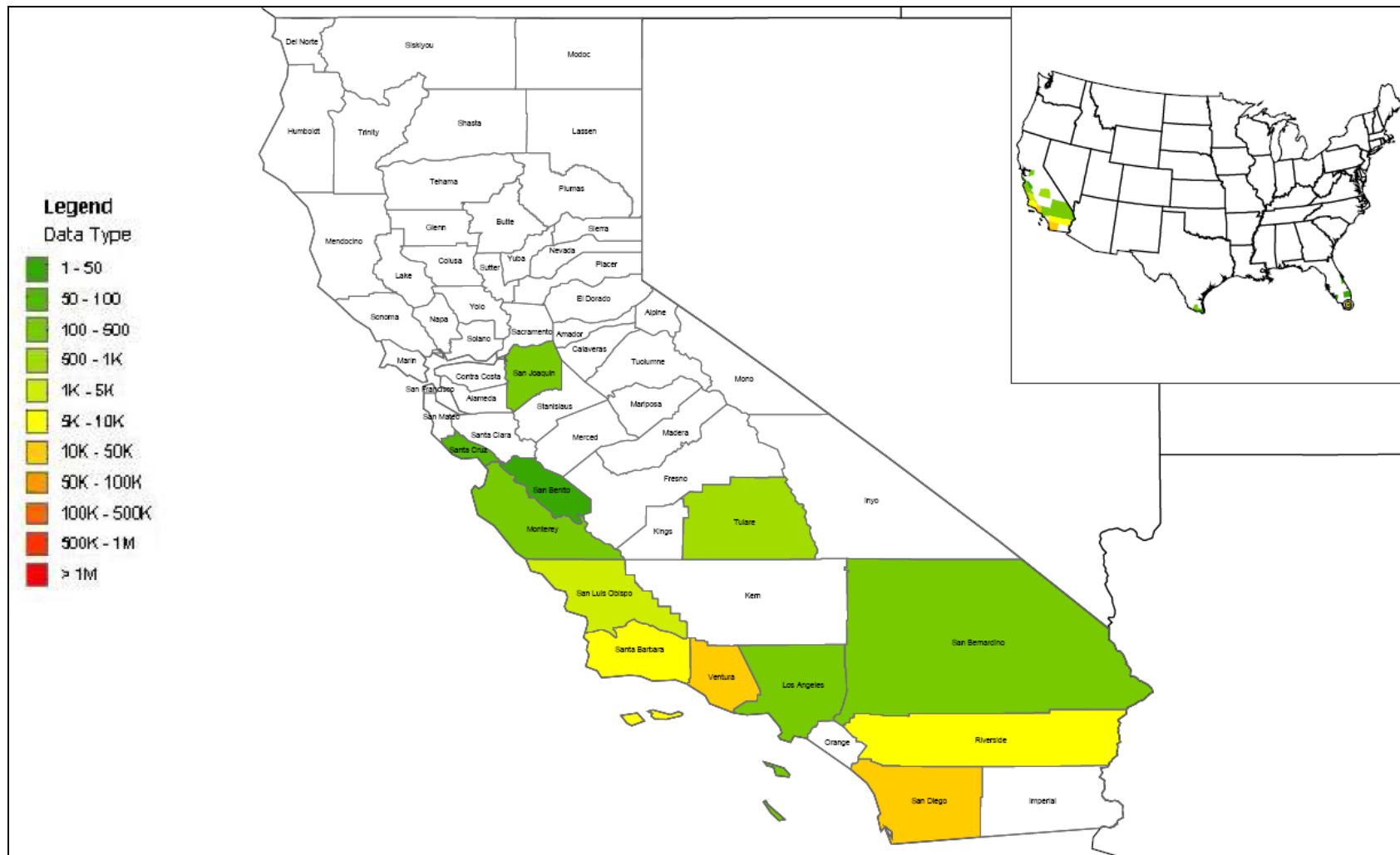


Figure 1. 2002 harvested acres for avocados based on USDA Census of Agriculture for California and conterminous United States (inset) Estimates do not include data for individual farms which NASS has excluded to protect the identify of individual farms.

Table 5. Avocado Bearing Soils of San Diego, Santa Barbara, and Ventura Counties (California) Ranked by Area.

Soil	Total Acreage	% Area	Drainage	Avocados-IrrYield (boxes)	Erodibility	Slopes (%)	pH	OM (%)	% Sand	% Silt	% Clay	Avocados-IrrYield (boxes)
CIENEBA	332,986	37.12%	C	250-400	0.24-0.32	9-75	5.8-6.5	0.75	67.9-68.5	19-19.6	12.5	-
VISTA	74,863	8.35%	B	500-615	0.28-0.32	15-65	6.7	0.75	65.4-66.8	22.2-23.6	11	-
GAVIOTA	62,334	6.95%	D	250	0.28-0.55	5-75	6.3-7.6	0.75	66.1-66.8	19.2-19.9	14	-
TERRACE ESCARPMENTS	57,147	6.37%	--	375	-	9-75	-	0	-	-	-	-
MAYMEN	49,991	5.57%	D	200	0.28	15-75	5.3-5.8	0.75-1.5	43-68.8	16.2-39.5	15-17.5	-
ARNOLD	38,078	4.25%	A	325-825	0.17-0.28	5-75	5.6-6.7	0.75	78.5-96	1.5-16.5	2.5-5	-
MOCHO	34,528	3.85%	B	1000	0.17-0.28	0-9	8.2	3	18.1-68.8	16.2-50.9	15-31	-
FRIANT	34,451	3.84%	D	150	0.2	30-70	6.3	1.5	66.1	19.9	14	-
LINNE	26,767	2.98%	C	250	0.2-0.32	30-75	8.2	2-3.5	18.1-35.4	33.6-50.9	31	-
SAN BENITO	25,075	2.80%	B	300	0.17-0.2	9-50	7.2-7.6	2.5	35.4	33.6	31	-
CORRALITOS	21,924	2.44%	A	300-330	0.15-0.28	0-15	5.8-6.7	0.75	80.5-96	1.5-17	2.5	-
LOS OSOS	21,084	2.35%	C	250	0.17-0.28	30-50	6.1-6.1	2.5-3	35.4	33.6	31	-
BOTELLA	18,581	2.07%	B	400	0.2-0.28	0-15	6.5	3-4	34.2-41.6	33.6-37.4	21-31	-
NACIMIENTO	11,550	1.29%	C	325-1000	0.28-0.32	9-50	8.2	2-3	18.1	50.9	31	-
SAN ANDREAS	10,936	1.22%	B	325-350	0.24-0.28	9-45	5.8-6.5	2.5	70.5	16.5	13	-
MARINA	10,843	1.21%	B	450-470	0.24	0-9	5.8	0.75	96	1.5	2.5	-
PICO	9,622	1.07%	B	400	0.2	0-9	8.2	2.5	65.1	18.9	16	-
BALLARD	9,036	1.01%	B	800-900	0.28	0-15	5.6-6.1	2	68.8	16.2	15	-
ANACAPA	8,355	0.93%	B	900	0.28	0-9	7.2	2	67.9	19.6	12.5	-
AYAR	6,803	0.76%	D	200	0.2	30-75	7.7-8.2	2	26.1	28.9	45	-
TODOS	6,670	0.74%	D	250-900	0.24	9-50	6.3	3	35.4	33.6	31	-
GOLETA	5,652	0.63%	B	1000	0.24-0.28	0-9	7.2-7.5	3	45.4-70.5	16.5-41.6	13	-
ROUGH BROKEN LAND	4,520	0.50%	--	375	-	15-50	-	0	-	-	-	-
MILPITAS	3,626	0.40%	D	300	0.37	15-50	6.1-6.7	1.5	68.8	16.2	15	-
CAMARILLO	2,658	0.30%	C	250	0.24-0.43	0-2	8.2	2.5	18.1-66.8	19.2-50.9	14-31	-
DIABLO	2,458	0.27%	D	200	0.2-0.24	30-50	7.3-7.5	2.5	22.1-23.3	27.9-29.2	47.5-50	-

BALLARD VARIANT	1,254	0.14%	B	325	0.28	2-9	6.1	1.5	68.8	16.2	15	-
CORTINA	1,177	0.13%	B	325	0.28	9-15	6.7	0.75	67.2	15.3	17.5	-
ORTHENTS	1,039	0.12%	B	375	-	50-75	-	-	-	-	-	-
CAMARILLO VARIANT	903	0.10%	C	500	0.32	0-2	8.2	2.5	68.1	14.4	17.5	-
BOTELLA VARIANT	808	0.09%	B	1000	0.15-0.17	2-15	5.8	2.5	18.1-35.4	33.6-50.9	31	-
ESCARPMENT	629	0.07%	--	375	-	75-99	-	-	-	-	-	-
POSITAS	616	0.07%	D	300	0.37	30-50	5.8	1.5	67.5	21	11.5	-

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