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The Changing Face of Farmland in California's Central Valley: Crop Types and Land Quality

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We examine spatial and temporal trends in crop-specific land-use decisions at the parcel level by land capability class—land quality—in California's Central Valley from 2008 to 2021. Our findings indicate that the land-use share of perennial crops has increased by 9 percentage points since 2008, though this growth varies depending on land quality. Specifically, the land-use share of perennial crops increased 11 percentage points for high-quality lands and 7 percentage points for low-quality lands. The land-use share of annual crops significantly decreased for both high-quality and low-quality land, but only marginally decreased for poor-quality land.

In this article, we show the changes in agricultural land use by land quality, which has important implications for the productivity and environmental sustainability of the agricultural sector. Understanding agricultural production decisions by land quality is crucial for the future viability, sustainability, and resilience of the agricultural sector in California in response to climate change. Crop cultivation on high-quality land is characterized by a few limitations, including physical (such as soil fertility, water-holding capacity, and topsoil depth), topographical, and meteorological. A wider set of constraints on crop production characterizes lower-quality land (e.g., salinity, soil erosion, and water-holding capacity).

The primary goal of this article is to describe how growers in California change their cropping patterns depending on land quality. Our analysis indicated that farmers have adjusted their acreage from annual crops to perennial crops on high-quality land and have expanded perennial crops on less suitable land. Land-use decisions disaggregated by land quality at the parcel level are informative for understanding the potential for climate adaptation.

Land-Use Shares and Land Quality in California

We analyzed a sample of 83,873 geo-referenced farmland parcels in California's Central Valley obtained from ATTOM Data Solutions. For our analyses, we first merged the farm-level data with the annual Cropland Data Layer (CDL) available at a 30-by-30-meter resolution for 2008 through 2021. The cropland data captures the area planted each year.

In a second step, we linked the farm to the land capability class (LCC), a global land evaluation ranking, which groups soils based on their potential for agricultural and other uses. The LCC is used to measure land quality. We obtained LCC data for California from the California Soil Resource Lab at UC Davis, which is available in grid cells of 800 meters. LCC has eight land capability classes from class I through VIII—the constraints on soil suitability for crop cultivation increase from I to VIII. The constraints of the LCCs are characterized by soil erosion and runoff, excess water, root-zone depth, climate limitations, and limitations on mechanized farming activity. Class I soil has a few limitations, which do not restrict its use for crop cultivation, while class VIII soil has severe limitations that reduce the choice of plants that can be grown in it and increase the need for special conservation practices.

Table 1 reports the land-use shares of perennial, annual, and non-cultivated crops (fallowed or idle land and natural vegetation) by land quality and year in the study region. To maintain readability, we grouped the quality of land into three land-capability classes (LCC12: classes I–II, LCC34: classes III–IV, and LCC5678: classes V–VIII) and two time periods (2008–2014 and 2015–2021). Out of the wider range of years that was possible, we selected these two periods to create an equal number of years for both periods. High-quality (LCC12) and low-quality (LCC34) land has an average parcel size of 65 and 76 acres, respectively. The poor quality land (LCC5678), much of which is idle or has natural vegetation, has an average area of 178 acres.

Panel A in Table 1 shows the share of land allocated to perennial crops. The analysis indicates that the share of perennial crops increased in the second period by nearly 11 percentage points in high-quality land and 8 and 4 percentage points, respectively, in lower quality lands (LCC34 and LCC5678). Most of the increase in perennial crops land-use shares across all land qualities can be attributed to almonds, pistachios, and other nuts such as walnuts and pecans in the second period for all land-quality types (between 3–11 percentage points). Meanwhile, grapes and other tree crops land-use shares showed only a slight increase (between 0.5–1.5 percentage points).

Next, we discuss the land-use shares of annual and non-cultivated crops. Although land allocation to annual crops has decreased in all three land-quality types in the second period, the decrease was especially significant in high-quality land (10 percentage points), as shown in Panel B of Table 1. This reduction in the annual crops share in LCC12 and LCC34 is primarily due to the decrease in land-use shares for alfalfa and grains, which are 5 and 4 percentage points, respectively. Vegetables

Table 1. Land-Use Shares by Land Quality and Year in the Study Region

	High-Quality		Lower-Quality			
	LCC12		LCC34		LCC5678	
	2008–2014	2015–2021	2008–2014	2015–2021	2008–2014	2015–2021
Average Parcel Size (in Acres)	64.7	63.5	76.7	76.2	178.7	177.6
A. Land-Use Shares Allocated to Perennial Crops (%)						
Almonds, Pistachios, Other Nuts	28.7	39.6	19.8	27.9	7.1	10.3
Grapes	11.5	11.8	10.7	11.6	1.6	2.3
Citrus, Other Subtropical Fruit	3.3	3.3	11.4	11.3	1.1	1.1
Other Tree Crops	4.7	4.5	4.3	3.9	1.2	1.5
Total Perennial Crops	**48.2**	**59.1**	**46.2**	**54.8**	**10.9**	**15.3**
B. Land-Use Shares Allocated to Annual Crops (%)						
Alfalfa	10.9	6.0	8.0	4.4	1.0	0.8
Grains	11.7	8.8	9.8	7.9	2.9	2.2
Cotton	3.4	2.5	2.4	1.8	0.1	0.0
Tomatoes	3.2	3.0	1.6	1.5	0.1	0.1
Corn	2.4	1.5	1.6	1.1	0.3	0.2
Rice	1.4	1.1	5.8	5.0	23.0	19.3
Hay	1.0	1.3	1.4	1.6	1.9	1.1
Other Vegetables, Berries, Melons, Squash, Cucumbers	2.9	2.9	2.2	2.3	0.7	0.6
Other Field Crops	0.9	0.8	0.8	0.7	0.3	0.2
Total Annual Crops	**37.7**	**27.8**	**33.7**	**26.3**	**30.1**	**24.5**
C. Non-Cultivated Land-Use Shares (%)						
Fallow/Idle	12.4	11.0	14.8	13.1	12.3	10.5
Natural Vegetation	1.7	2.1	5.4	5.8	46.7	49.8
Total Non-Cultivated Land	**14.1**	**13.1**	**20.1**	**18.9**	**59.0**	**60.2**

Source: Authors' calculations based on data from ATTOM Data Solutions, CDL data from NASS USDA for 2008–2021, and LCC data from California Soil Resource Lab at UC Davis. CDL data is available at: https://nassgeodata.gmu.edu/CropScape/. LCC data is available at: https://casoilresource.lawr.ucdavis.edu/soil-properties/.

Note: Mean value is reported. We construct land-use shares by dividing the shares for each crop within a parcel by the total cropland from that parcel. A parcel from our sample may be associated with one or more crops.

and other field crops were either unchanged or had a slight decrease in the second period. For example, tomatoes either remained unchanged or experienced a slight decrease in high- and lower-quality lands in the second period. Hay and other pastures saw a marginal increase in LCC12 and LCC34 (less than half a percentage point).

Finally, Panel C of Table 1 shows the fallow/idle land and natural vegetation share. Fallow/idle land-use shares have declined between 1 and 2 percentage points, while there has been a modest increase (between 0.5–1.5 percentage points) in natural vegetation in LCC34 and LCC5678. In summary, the temporal variations in perennial and annual land-use shares disaggregated by land quality suggest that growers in the Central Valley have substituted annual crops for perennial crops in both high- and lower-quality lands, particularly almonds, pistachios, and other nuts.

Trends in Land-Use Shares by Land Quality

This section presents the trends in annual and perennial crops shares by land capability classes. The vertical axes in the three panels of Figure 1 represent the average land-shares ratio by crop type (perennial and annual crops) and is constructed by dividing the share of each crop type over the base year land-shares (i.e., 2008). The slope of the crop types' land-use shares can be interpreted as the rate at which the acreage of perennial crops within a parcel increases or the rate at which annual crops within a parcel decrease, compared to the baseline. The perennial crops shares within a parcel increased all years in our study across all land quality classes. Specifically, the shares of perennial crops in land class LCC12 and LCC34 experienced a nearly 40% increase between 2008 and 2021, except for 2010 and 2018, which saw a slight dip in the otherwise rising upward trend. The perennial crops share in LCC5678 experienced nearly a 50% increase.

Next, the annual crops shares have been continuously declining in all land quality classes since 2011, especially in LCC12 and LCC34 between 2008 and 2021. However the decline in LCC5678 is marginal. This may suggest that high-value perennial crops are replacing annual crops within high-quality parcels of land over the years. Declines in low-value annual crops shares during 2008–2021 may be attributed in part to water scarcity, as this period coincided with several droughts (2008–2009, 2012–2016, and 2020–2021).

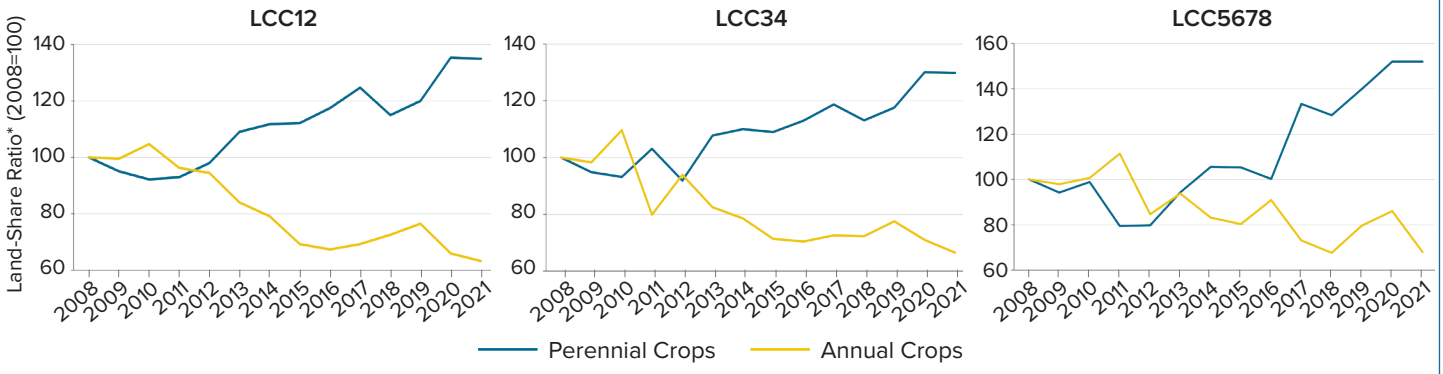
Spatial Variations in Land-Use Shares by Land Quality

This section explores the spatial variation in county-specific land-use shares of perennial and annual crops in the Central Valley by land capability classes. To do that, we first estimated the percentage difference in perennial crops shares (Figure 2, upper panel, on page 4) and the annual crops shares (Figure 2, lower panel) between the first period (2008–2014) and the second period (2015–2021).

We start with the percentage change in the perennial crops shares, as shown in the upper panel of Figure 2. In LCC12, Solano County saw the greatest increase (107%) in land-use shares of perennial crops, followed by Placer County (79%), and Yolo County (54%). In LCC34, Solano County again saw the greatest increase (191%) in land-use share of perennial crops, followed by Kings County (96%), and Placer County (91%). In LCC5678, Merced, Stanislaus, and Solano counties saw an increase in land-use shares of perennial crops by 95%, 78%, and 71%, respectively.

Next, we discuss the percentage changes in the annual crops shares, as shown in the lower panel of Figure 2. In LCC12, Madera (41%), Fresno and Solano counties (38% each), and

Figure 1. Trends In the Land-Use Shares of Perennial and Annual Crops in California Between 2008 and 2021 by Land-Capability Classes.



Source: Authors' calculations based on data from ATTOM Data Solutions, CDL data from NASS USDA for 2008–2021, and LCC data from California Soil Resource Lab at UC Davis.

Note: *The upward and downward trends can be interpreted as the increase in perennial crop acreage and decrease in annual crop acreage, respectively.

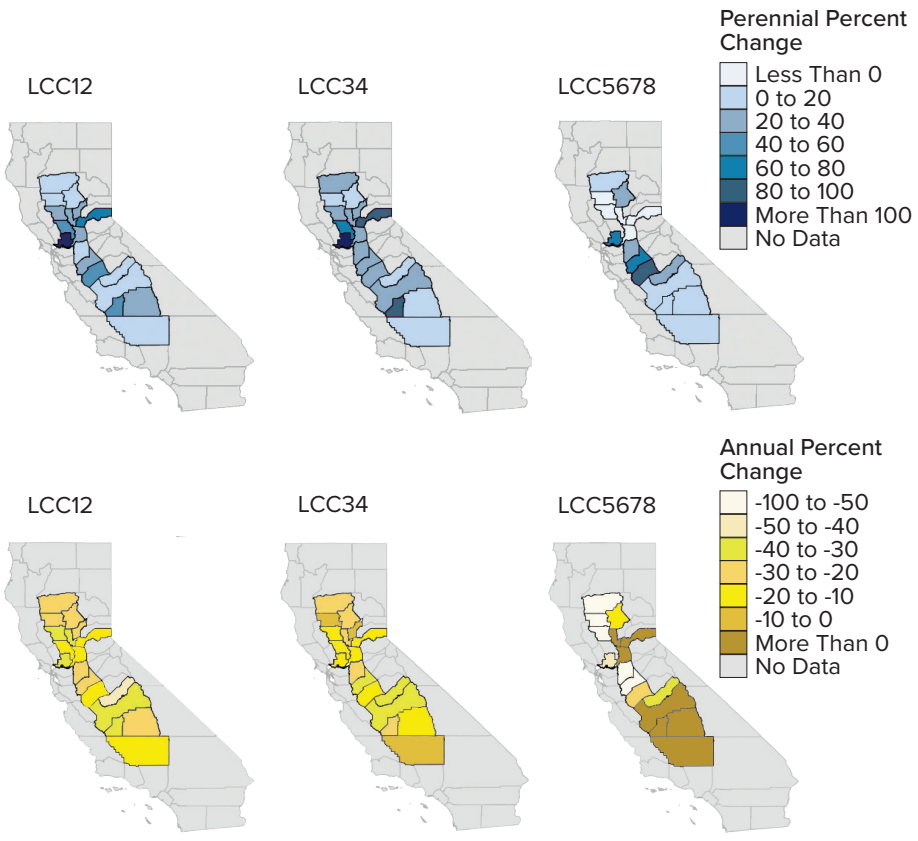
Kings and Colusa counties (34% each) experienced the largest reduction in annual crop shares. In LCC34, Fresno and Stanislaus counties each saw a decline of 36% in the land-use shares of annual crops. In contrast, the changes in land-use shares of annual crops in LCC5678 were mixed, with Placer, Kings, Kern, and Sutter counties experiencing increases.

Together, these maps indicate that the share of perennial crops across land qualities in the Central Valley is increasing, particularly on less suitable land. This could be due in part to the availability and adoption of irrigation technologies and new management practices that go with the new irrigation technologies. Conversely, the share of annual crops decreased significantly in LCC12 and LCC34, but only marginally in LCC5678.

Concluding Remarks

We examined trends in land-use shares by land quality in California between 2008 and 2021, partly explained also by recurring droughts. We showed that perennial crops shares have increased across all land-quality types, but more dramatically in the LCC5678 land-quality type in recent years. It is plausible to assume that the widespread adoption of irrigation technologies, particularly micro- and drip irrigation, in the Central Valley may partially offset the reduction in plant productivity in lower-quality lands. The county-specific spatial variation suggests that perennial crops land-use shares have significantly changed in the central and southern counties of the Central Valley. Despite an overall decrease in annual crops shares in high- and low-quality land, they have only marginally decreased in poor quality lands.

Figure 2. Spatial Variation in the Long-Run Differences in Perennial and Annual Land-Use Shares by Land Quality



Source: Authors' calculations based on data from ATTOM Data Solutions, CDL data from NASS USDA for 2008–2021, and LCC data from California Soil Resource Lab at UC Davis.
Note: The map shows the long-run percentage difference in perennial (upper panel) and annual (lower panel) shares between first period (2008–2014) and the second period (2015–2021).

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For additional information, the authors recommend:

Kishore, Siddharth, Mehdi Nemati, Ariel Dinar, Cory L. Struthers, Scott MacKenzie, and Matthew S. Shugart. 2024. "Parcel-Level Agricultural Land Use and Climate Change: Evidence from California's Central Valley." University of California, Riverside, School of Public Policy Working Paper Series. Available at: https://bit.ly/3AR9dFY.