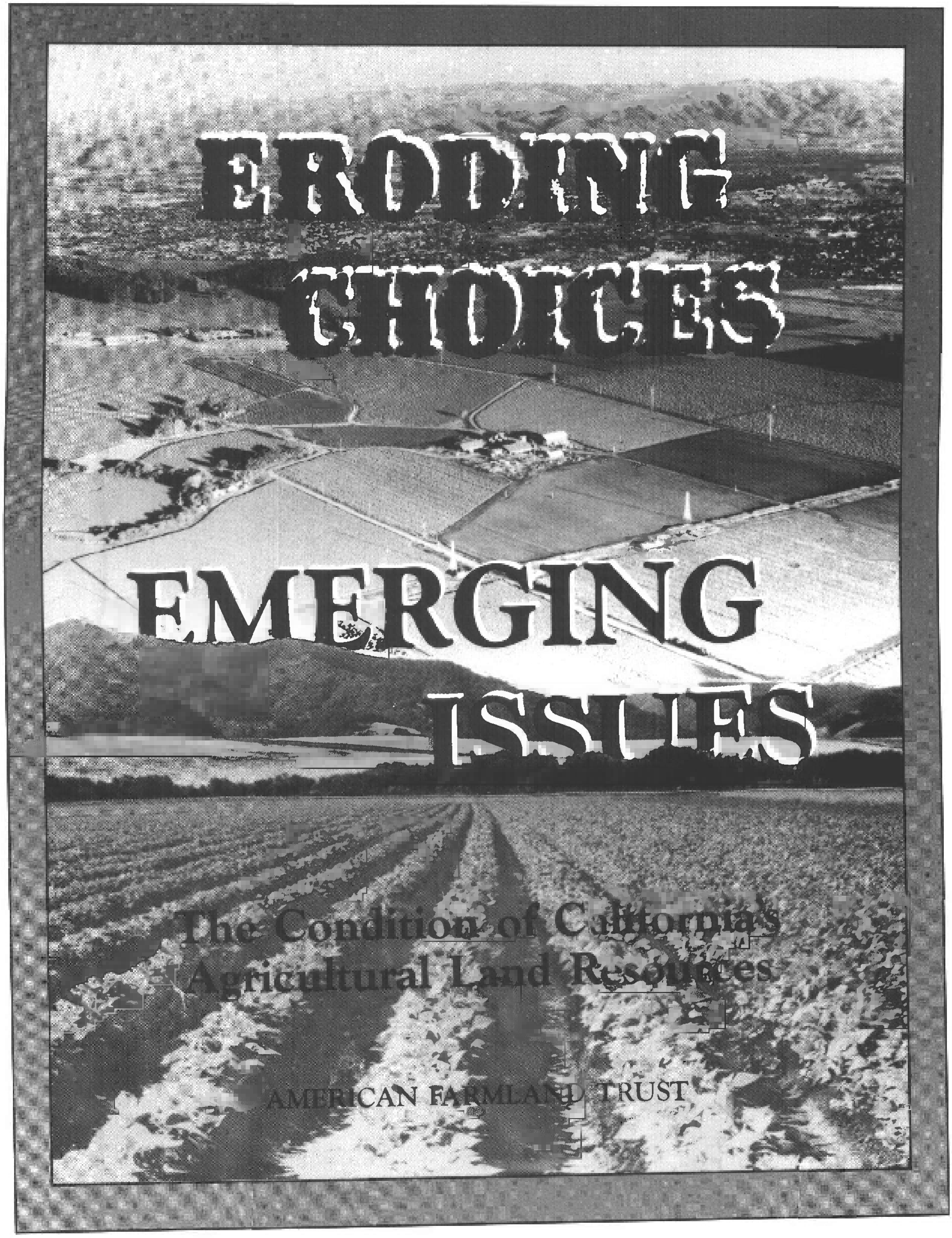

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EMERGING ISSUES

The Condition of California's Agricultural Land Resources

AMERICAN FARMLAND TRUST

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ERODING CHOICES

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The Condition of California's Agricultural Land Resources

Prepared by
The American Farmland Trust

PREFACE

In California, agriculture is very big business, the largest industry in the state both in terms of employment and total economic impact. While there are constant efforts at both the state and local levels to attract new industry to California, there seems to be only passing concern for the need to protect that which already exists. In fact, in many communities there is an attitude that agriculture only exists as an interim use for the land.

While the conversion of farmland to non-agricultural uses may be the most visible problem affecting California's farmland, soil erosion, salinity and groundwater overdraft also have a great impact on the ability to produce food and fiber. State involvement in soil and water conservation is almost non-existent when compared with other states. A lack of information on the issues has led to confusion about the causes, effects and extent of agricultural resource depletion, and this in turn, has inhibited the development of remedial strategies.

With this in mind, the American Farmland Trust (AFT) undertook the California Farmland Information Project (CFIP). This report is the cornerstone of CFIP and has as its objectives:

(1) Increasing public awareness about the nature and extent of farmland conversion, soil erosion, salinity and water supply problems and how these problems may affect the state's future ability to produce food and fiber; and

(2) Providing a menu of options for state and local policy makers to consider when addressing agricultural resource issues.

California has always been a trend-setting state, especially on resource issues. However, on the issue of its agricultural resources, it has fallen near the back of the pack. With this report, we hope to move the issue off the back burner, out of the realm of arguing over numbers, and into the minds of the policy makers and hands of those most concerned.

We are grateful to the James Irvine Foundation, Atlantic Richfield Foundation, Heller Charitable and Educational Fund, Skaggs Foundation and the Wheeler Foundation, whose contributions have made possible the completion of this report. Will Shafroth, Director of AFT's California Field Office, and Martha Lee Turner, Public Education Director of the California Field Office, deserve special credit for directing this project.

California agriculture is one of the nation's greatest success stories. However, its foundation — the farmland itself — is showing signs of stress and weakness. Acknowledging that long-term resource conservation issues are difficult to put into perspective beside the short-term economic and social demands of the day, we ask our readers to question whether we can afford not to. The problems do not justify immediate panic, but they do suggest that action be taken before they become unmanageable.

Ralph Grossi, President
American Farmland Trust

ACKNOWLEDGEMENTS

This report culminates a one and half year study on California's agricultural lands. It would not have been possible without the dedication and diligence of staff and consultants and those who generously gave their support to a project they thought important.

John Hart, an experienced writer on California resource issues, wrote and undertook much of the research for this report. John's commitment to the project combined with his expertise on the issues has greatly contributed to the quality of this report.

Like any report of this type, an extensive amount of tedious research had to be done. Debby Stuart deserves recognition for her attention to detail and the valuable contribution she made to this report.

Special recognition goes to Robert Yoha, Farmland Mapping and Monitoring Program Manager for the Department of Conservation, for helping to conceive and completing the research and compilation of the coastal cropland study. Robert spent innumerable nights and weekends working on the study and his dedication has allowed this important information to be made public for the first time.

We are also grateful to Esther Kovari, who provided information on agricultural economics and David Strong and Norm Hetland of University of California at Berkeley, for undertaking a California agricultural land value study.

Special thanks to the Soil Conservation Society of America for permitting us to use definitions from their *Resource Conservation Glossary* for our glossary.

Preparation of this report would not have been possible without the cooperation of the Department of Water Resources and the Soil Conservation Service. DWR's Jim Wardlow and SCS's Mike Whiting were very helpful in supplying AFT with the data upon which much of this report relies.

Other Contributors:

Many other people reviewed draft chapters of this report or contributed information or insight in the process. In no way are they responsible for any errors contained herein.

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We also thank the many county farm advisors, agricultural commissioners, SCS employees, DWR field staff, and farmers and ranchers throughout the state whose expertise we often relied upon.

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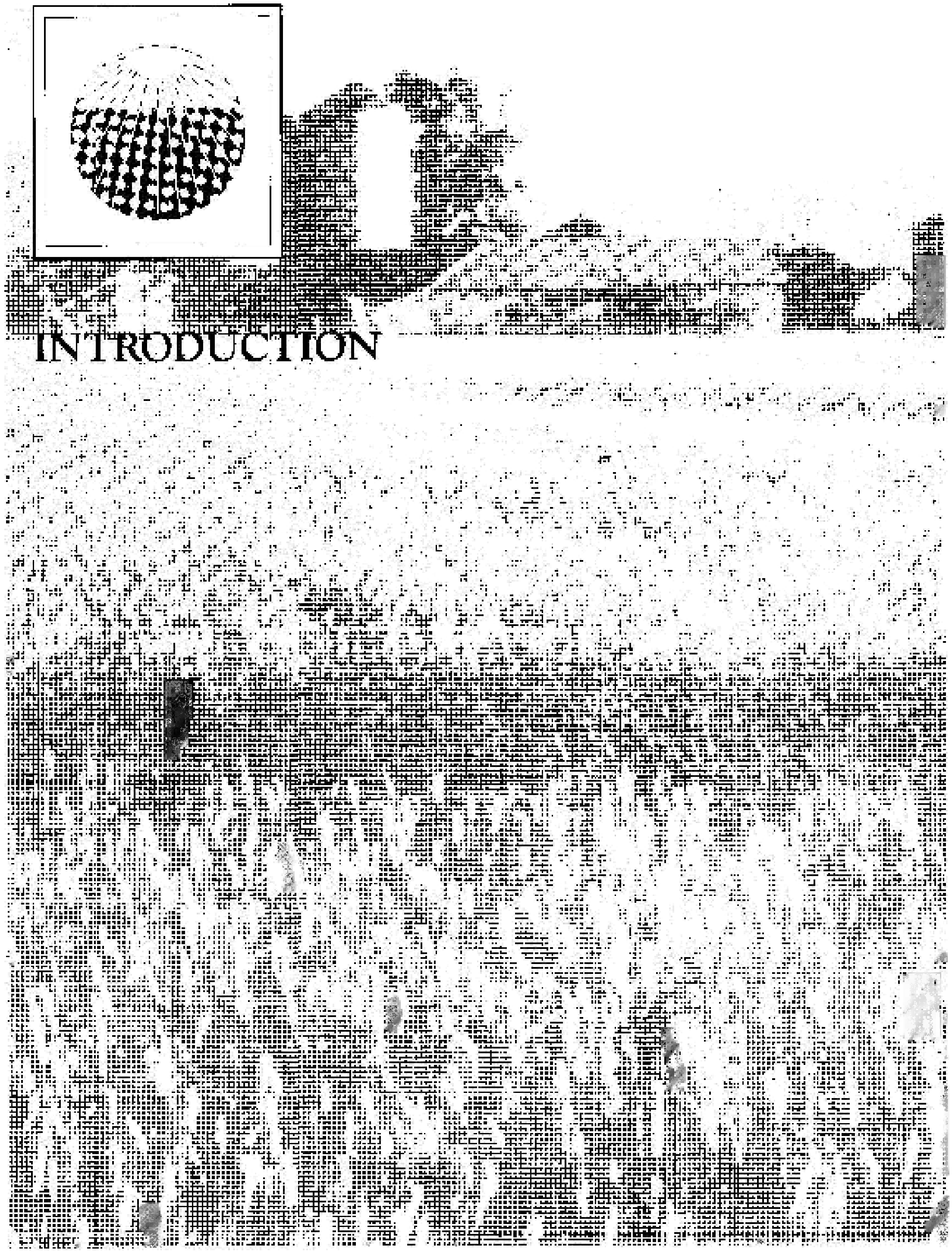


INTRODUCTION

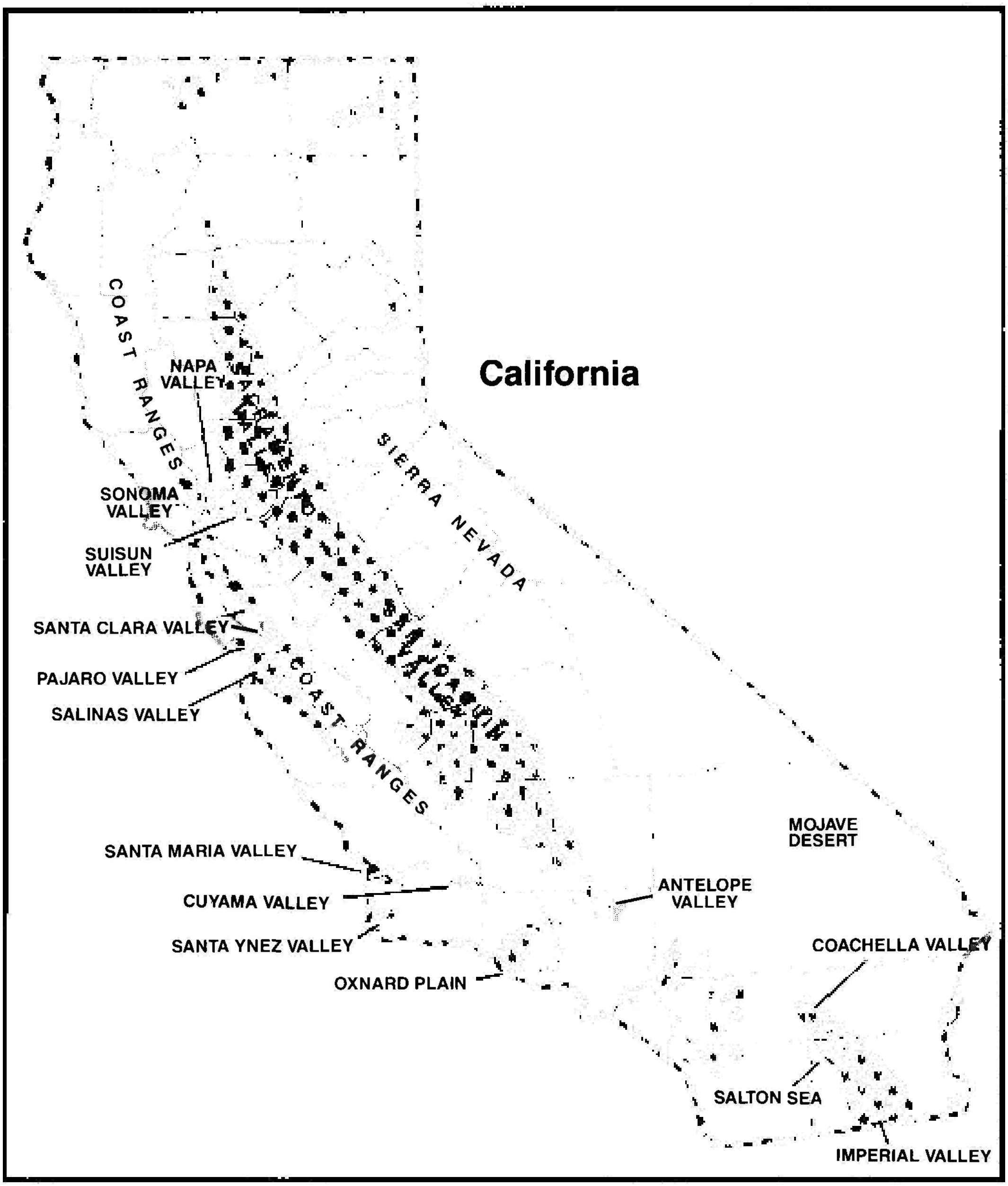
Many California farmers and ranchers face difficult times. High interest rates, foreign trade barriers, high exchange rates for the dollar and falling land prices make the environment for farming unusually hard. Not a few owners, deeply in debt, are losing their properties to foreclosure.[1]

The hardships farmers suffer make it difficult for some to think about the long-term future of California agriculture and its dependency on the quality and availability of land and water resources. Yet the basic questions must be considered. It is the purpose of this report to do so.

Concern about the basic resources of California agriculture is not new. For at least two decades, fear has been expressed that the land supply is shrinking, perhaps very rapidly, and water is being depleted. Yet, when skeptics ask for numbers, such losses have proven difficult to pinpoint. Trustworthy and comprehensive information about our changing stock of farmland and irrigation water is surprisingly hard to come by. Meanwhile, others — who also lack adequate data — assure us that "new" land is being brought into production and "we'll get the water somehow."

This report is a fresh look at California's agricultural land resource. It examines four major forces affecting agricultural land — urban growth, salinity, soil erosion and water supply problems — and answers the following questions:

- To what extent, where, and at what rate is agricultural land affected by each of these resource problems?
- What types of agricultural land are most affected?
- What is the combined effect of these problems?
- To what extent can farmland removed from production in one location be replaced by land developed for farming elsewhere?
- If California is losing agricultural land, how will that affect the state's ability to produce food and fiber?
- Will technological improvements allow us to grow just as many crops of similar variety and yield on less land?
- What options do state and local governments have to conserve agricultural land?



SOURCE: California Department of Water Resources, *Bulletin 162-83*

$54 Billion Industry at Stake

California's agriculture is nothing less than awesome. This one state raises more than half the vegetables and fruit produced in the United States. Over 250 commodities are produced in California; California is the leading source of 48 of them. Of the 10 top farm counties in the nation, eight are in California.[2]

Gross farm income in California exceeded $13 billion dollars in 1984,[3] nearly 10% of farm income nationwide.[4] California also typically accounts for about 10% of the U.S. farm product exports.[5]

Agricultural output, like that of other industries, has a ripple effect in the economy. To make the land produce, farmers must pay workers and buy supplies; after harvest, the yield must be processed and transported. Someone earns money at every stage. When this "multiplier effect" is taken into account, economists say, agriculture's contribution is not less than $54.4 billion to a gross state product of $450 billion.[6]

At least 500,000 people, including landowners and their families, work on California farms. Though some agricultural operations are very large, less than 1% of the state's 80,000 farms and ranches are run by non-family corporations. The average farm size is 390 acres, 11% less than the average nationwide.[7]

California's 10 Leading Farm Products
Ranking and Value: 1984

Commodity Ranking, 1984	Farm Product	Value - 1984*
1	Milk and Cream	1,986,376
2	Cattle and Calves	1,418,141
3	Cotton	1,064,151
4	Grapes	847,902
5	Nursery Products	720,148
6	Hay	651,682
7	Lettuce	648,490
8	Flowers and Foliage	524,371
9	Almonds	470,270
10	Tomatoes, Processing	427,145

* Based on value of quantity harvested for crops and on value of quantity marketed for livestock and poultry products.

SOURCE: California Department of Food and Agriculture, *California Agriculture, 1984*

Major Agricultural Regions

The Central Valley is California's crop-producing heartland. It has three parts: the Sacramento Valley in the north; the Delta region in the center where the Sacramento and San Joaquin rivers meet tidewater; and southward, the most productive area of all, the vast San Joaquin Valley.

The Central Valley contains almost half of the agricultural land in the state, almost two-thirds of the cropland, and nearly three-quarters of the irrigated land.[8] Its major farm counties are consistently among the highest agricultural producers in the nation. Major Central Valley products include rice, fruits, nuts, vegetables, grapes, wheat, cotton, alfalfa, poultry and milk.[9]

A second major crop production area in California consists of irrigated valley lands in the deserts east and south of Los Angeles.

California's Crop-growing Regions

Most important are the Imperial and Coachella valleys, which face each other across the Salton Sea.

A third component of California's agricultural land base must be singled out: croplands within a few miles of the coastline. Here the moderate maritime climate allows the production of a great variety of crops year-round. The industry uses this versatile land largely to grow winter vegetables and specialized crops such as avocados, artichokes and Brussels sprouts.[10]

Grazing land. It is easy to overlook grazing land in a discussion of agriculture, but in California it is significant. The state has about two acres of hilly grazing land for every acre of valley fields. Dairy products lead the list of California agricultural products by value, and cattle and calves are second.[11] The productivity of this range varies from marginal in arid inland areas to extremely high in coastal counties, where the grasslands are among the nation's richest.[12]

The Vast Resource Base

How much agricultural land does California have?

About 31 million acres, according to the Soil Conservation Service's 1982 National Resource Inventory. Of this, more than a third, 10.5 million acres, is cropland, of which 9.0 million acres are irrigated. The remainder is pasture and range.[13]

Some of this land is considered prime, a term for which, unfortunately, there are conflicting definitions. The most useful is the one used by the U.S. Department of Agriculture's Soil Conservation Service: land that "combines favorable soil quality, growing season and moisture supply, and under careful management can be farmed continuously at a high level of productivity without degrading either the environment or the resource base." The SCS estimates that in 1977 California had 7.8 million acres of prime land, of which 6.5 million acres were planted to crops.[14]

Where the Numbers Come From

Of the many sources of statistical information on agricultural lands, the California Department of Water Resources (DWR) and the Soil Conservation Service (SCS) provide the most reliable data.

The SCS conducts the National Resources Inventory (NRI) every five years, gathering information on agricultural land, on non-agricultural land, and on soil resource problems including erosion and salinity. This report frequently uses SCS estimates.

The DWR maps urban land and cropland (not rangeland) in detail, using aerial photographs that are interpreted, then field-checked on the ground. The DWR uses a seven-year cycle for most areas, with roughly one-seventh of the land surveyed each year.[15] DWR is also the key source for information on water use and water supply.

Considering the differences between their inventories, the two agencies' totals are surprisingly close. The DWR, for instance, estimates there were 9.5 million acres of irrigated cropland in 1980,[16] only 500,000 above the SCS estimate. For purposes of this report, DWR's 9.5 million acre figure will be used.

The 4 Primary Problems

Four major resource problems face agriculture in California: conversion of farmland to urban area, soil erosion, salinity and possible shortages of affordable water.

Farmland conversion is simply the changing of land from agriculture to any non-agricultural use, including parks and reservoirs as well as residential and commercial development. This report is chiefly concerned with conversion to urban uses. The Department of Water Resources estimates 44,000 acres of California cropland became urbanized yearly between 1972 and 1980. An additional 48,000 acres of land, some of it rangeland, was urbanized each year.[17]

Erosion is not often thought of as a California problem, because most of the state's cropland is flat and has deep soil. But certain areas of cropland are affected, and so is much of the state's grazing land. In fact, the Soil Conservation Service estimates that sheet, rill and gully erosion is damaging 1.8 million cropland acres — over 16% of California's cropland, and nearly 7 million acres of grazing land, over 35% of the state total.[18]

Salinity impacts about 4.5 million acres of California cropland: 2.9 million acres have saline/sodic soils which affect crop yields, and yields on 1.6 million acres are reduced because of poor drainage or high water tables. Salinity-related problems are likely to intensify in the future.[19]

Water supply problems affect farmland in more complex ways. Because of rising water demand and the high cost of new water projects, agriculture may have less water at its disposal in the future than it does today; for a number of reasons, the cost of irrigation water on the farm seems sure to rise. Adjustments will be required. In some limited areas, farmers may lose their water supply entirely, or find it priced out of reach.

The four major problems are related, sometimes in unexpected ways. More expensive water, for instance, may eliminate the competitive advantage of some California farms and hasten the conversion of farmland to other uses. The low water prices of the past, on the other hand, made feasible the irrigation of the areas now suffering salinity problems. The urbanization of excellent cropland near cities has displaced that agriculture to more remote and often less suitable areas, where erosion and other problems are more likely to develop.

The most obvious connection among the various factors depleting California farmland, though, is simply this: They all reflect the fact that fine agricultural land is a limited resource in a world of growing population and resource demands.

In analyzing governmental response to these factors affecting California's farmland, the American Farmland Trust uncovered certain deficiencies in state government policies. The most glaring of which is a lack of information about agricultural resource problems. AFT has identified 20 changes to state policy that could be made to encourage and allow for the conservation of agricultural resources.

This report will attempt to sort out the available information about these problems; to consider whether new kinds of actions are needed to deal with them; and to examine the various forms that such response might take — the realistic options that policy makers have before them to promote and preserve California's unparalleled agriculture.

Notes

1. Bank of America, *An Overview of California Agriculture and Bank of America Recommended Policy Guideline* (San Francisco, 1985), pp. 1-2.

2. Security Pacific National Bank, *California's Agricultural Trends and Issues* (Los Angeles, 1985), p. 1.

3. Bank of America, *Overview*, p. 1.

4. Security Pacific National Bank, *Trends and Issues*, 1985, p. 1.

5. California Association of Resource Conservation Districts Select Committee, *California's Soil Conservation Report* (Sacramento, 1983), p. 3. See also Security Pacific National Bank, *Trends and Issues*, p. 3.

6. Security Pacific National Bank, *Trends and Issues*, 1985, p. 1.

7. U.S. Department of Commerce, Bureau of the Census. *1982 Census of Agriculture, Preliminary Report* (Washington, D.C., 1984), p. 1.

8. Ann Foley Scheuring, ed., *A Guidebook to California Agriculture* (Berkeley: University of California, 1983), p. 25.

9. Scheuring, *Guidebook*, p. 25.

10. Frank H. Bollman, *Regional Shifts Since 1980 in the Production of Vegetable, Fruit and Nut Crops: California and Arizona*, 1979. Unpublished technical paper, prepared for the U.S. Water Resources Council as a contribution to the National Agricultural Land Study. See also Scheuring, *Guidebook*, pp. 27, 51, 155, 167, and County Agricultural Commissioners' reports.

11. Security Pacific National Bank, *Trends and Issues*, 1985, p.4.

12. People for Open Space, *The Productivity of Bay Area Rangeland* (San Francisco, 1980), pp. 13-15.

13. United States Department of Agriculture Soil Conservation Service (SCS), *California Multiyear Plan* (Davis, California, 1984), p. 4-3. Figures in the *California Multiyear Plan* were derived from the California Resources Inventory (CRI). Mapped at a scale of 1:100,000, CRI figures differ from the National Resources Inventory. Both, however, indicate significant resource problems.

14. People for Open Space, *California Farmland Resources: A Summary of Current Information* (San Francisco, 1980), pp. 4-5.

15. J.M. Wardlow (DWR), Letter, August 29, 1984, to George Pyper concerning DWR land-use surveys.

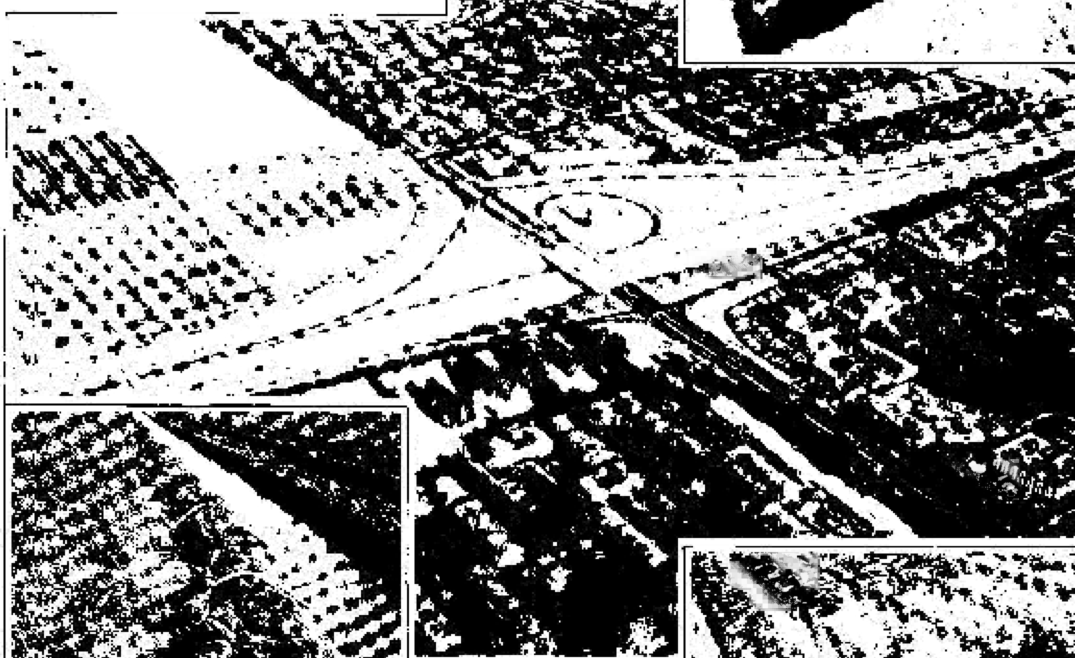
16. California Deptartment of Water Resources (DWR), *The California Water Plan: Projected Use and Available Water Supplies to 2010 (Bulletin 160-83)* (Sacramento, 1983), p. 29.

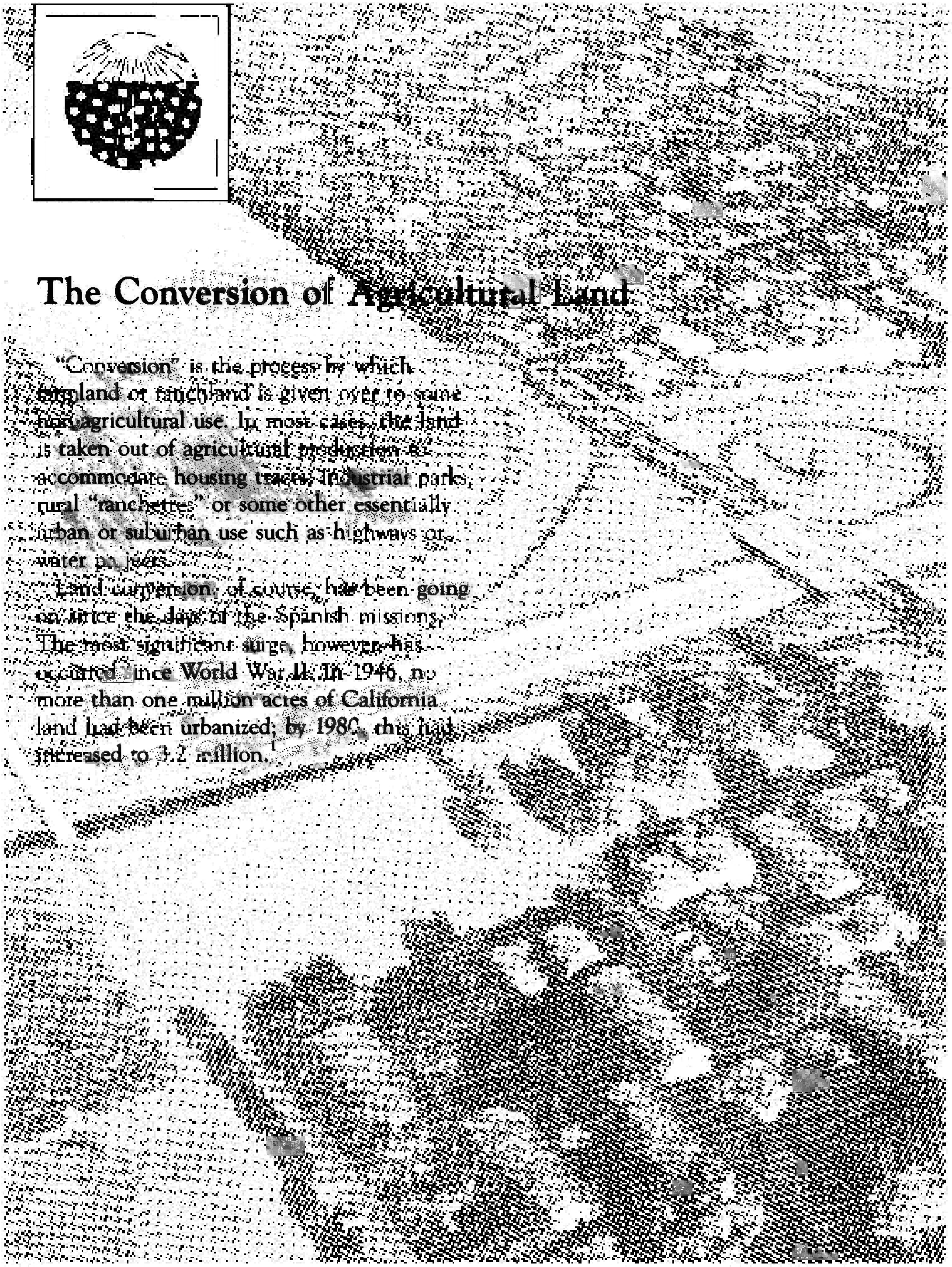
17. Will Shafroth, "Memo, 1985," based on conversations with state agricultural officials.

18. SCS, *Multiyear Plan*, p. 4-3.

19. SCS, *Multiyear Plan*, p. 4-2.

ISSUES CONCERNING THE AGRICULTURAL LAND RESOURCE BASE

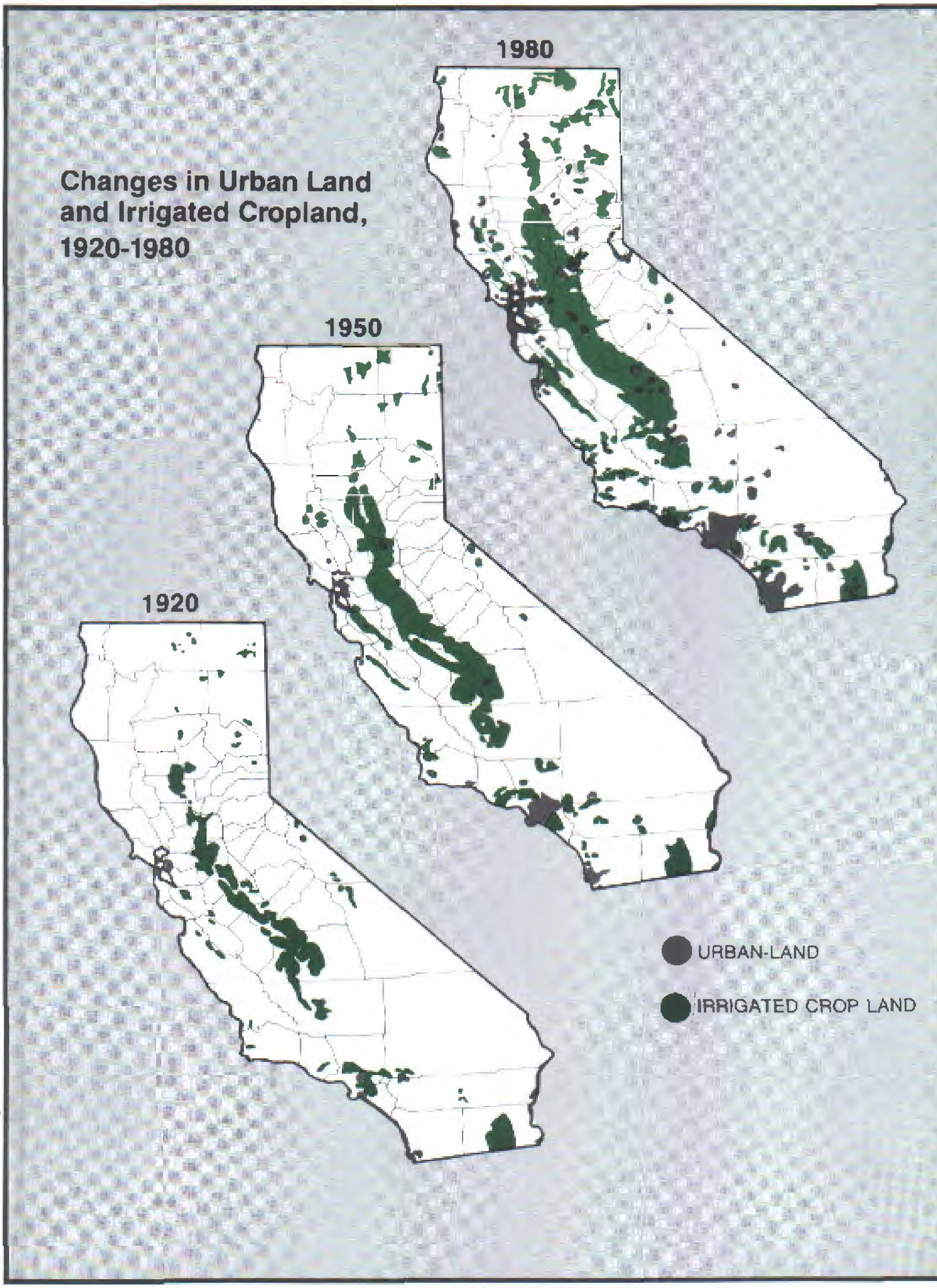




The Conversion of Agricultural Land

"Conversion" is the process by which cropland or ranchland is given over to some non-agricultural use. In most cases, the land is taken out of agricultural production to accommodate housing tracts, industrial parks, rural "ranchettes" or some other essentially urban or suburban use such as highways or water projects.

Land conversion, of course, has been going on since the days of the Spanish missions. The most significant surge, however, has occurred since World War II. In 1946, no more than one million acres of California land had been urbanized; by 1980, this had increased to 3.2 million.[1]



SOURCE: California Department of Water Resources. *Bulletins* #176 and 160-83.

How Fast Is Conversion Occurring?

In 1980, the USDA National Agricultural Lands Study estimated that 50,000 acres of California cropland were being urbanized each year.[2] When this figure was published, it aroused some skepticism. But statistics developed independently by the California Department of Water Resources have since substantially confirmed the NALS findings.

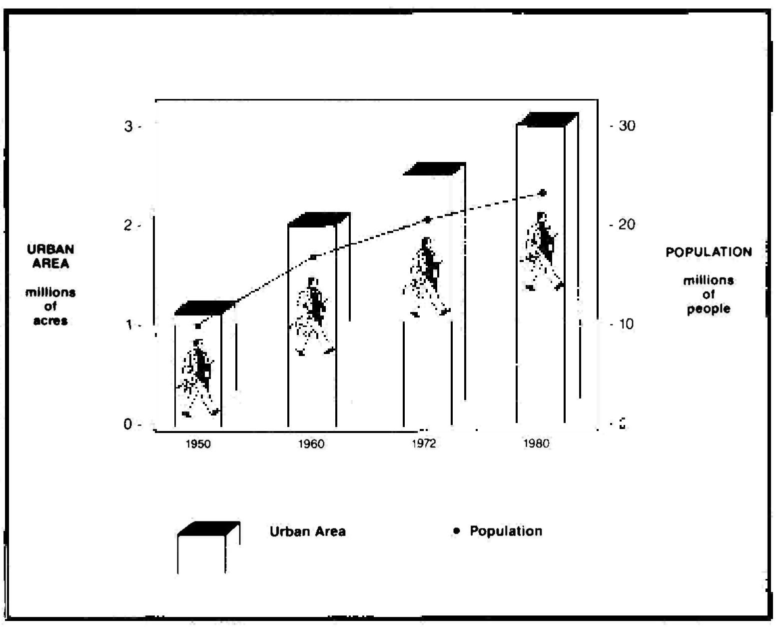
DWR surveys show that between 1972 and 1980, California cropland was converted to urban uses at the rate of 44,000 acres a year, of which 36,000 acres were irrigated land. If this conversion rate continues, a recount in the year 2000 would show almost another million acres of cropland gone. In addition, 48,000 acres of "other" lands per year were also urbanized; some of this additional total was presumably rangeland, though DWR statistics do not reveal how much.[3]

These figures, it should be noted, are gross numbers, not net; they do not take into account the fact that some land is being brought into agriculture, or at least put under irrigation, even as presently farmed land is being lost.

The Pressure of Urban Growth

From 1972 to 1980, California's population grew from 20.6 million to 23.7 million.[4] The urban area increased by 736,000 acres.[5] These figures suggest that California has been using 237 acres of land to house each 1,000 new residents. According to the Population Research Unit in the state Department of Finance, the state's population will reach 31.4 million by the year 2000, a 7.7 million jump in 20 years.[6] At that rate, almost 2 million additional acres of land would be devoted to urban uses, much of it currently farmed land.

Population and Urban Land 1950-1980



SOURCES: California Department of Water Resources, *Bulletins 160-2, 160-63, 160-74, 160-83* and California Department of Finance, Population Research Unit.

Definitions of "Urban"

It is not always easy to determine whether a given piece of land has been urbanized, as the agencies that do the counting use slightly different definitions to decide.

The Department of Water Resources, whose figures are used in this report for statewide urban acreage, defines as "urban" any land "dedicated to a commercial, industrial, or other urban type use (including urban parks) or land surrounded by urban uses not actively being used for an agricultural use." DWR maps show urban areas as small as two acres.[7]

The Soil Conservation Service provides urban acreage figures county-by-county. SCS uses the phrase "urban and built-up" and gives it a detailed definition: "land used for residences, industrial sites, commercial sites, construction sites, institutional sites, public administrative sites, railroad yards, cemeteries, airports, golf courses, sanitary landfills, sewage treatment plants, water control structures and spillways, and so forth. Highways, railroads, and other transportation facilities are counted as part of Urban and Built-up if they are surrounded by other urban areas. If roads or railroads form the boundary of an Urban and Built-up Area, one-half of the road is counted as Urban and Built-up and one-half as rural transportation."

As a rule of thumb, a given 10-acre area with six or more houses on it meets the 1.5-acre average density standard for urban. "At the urban fringe," the SCS definition instructs, "consider the true use of the land."[8]

The two agencies produce slightly different tallies of urban land, with DWR coming in a few hundred thousand acres higher. For practical purposes, however, the two coincide.

Regions

Most of California's urban growth has taken place in the coastal counties, with the bulk of this growth at the expense of agricultural land. Some counties are particularly graphic examples. Santa Clara County, once an agricultural powerhouse, continues its decline—135,000 acres were irrigated there in 1950, 43,300 acres in 1978.[9] Irrigated acreage in Orange County fell from 129,614 in 1948 to 25,250 in 1981.[10]

Development in the coastal counties continues to spread outward from the old urban centers. Between 1977 and 1982, the Soil Conservation Service found, 60,000 acres were urbanized in San Diego County alone, and 100,000 more in the four counties containing the greater Los Angeles metropolis (Los Angeles, Orange, Riverside, San Bernardino). In five San Francisco Bay Area counties (Contra Costa, Alameda, Santa Clara, San Mateo and Marin), 41,000 acres were converted.[11] Two formerly rural counties on the fringes of this urban complex — Sonoma to the north and Santa Cruz to the south—have grown so much that they are now classed as Standard Metropolitan Statistical Areas. (See Glossary)[12].

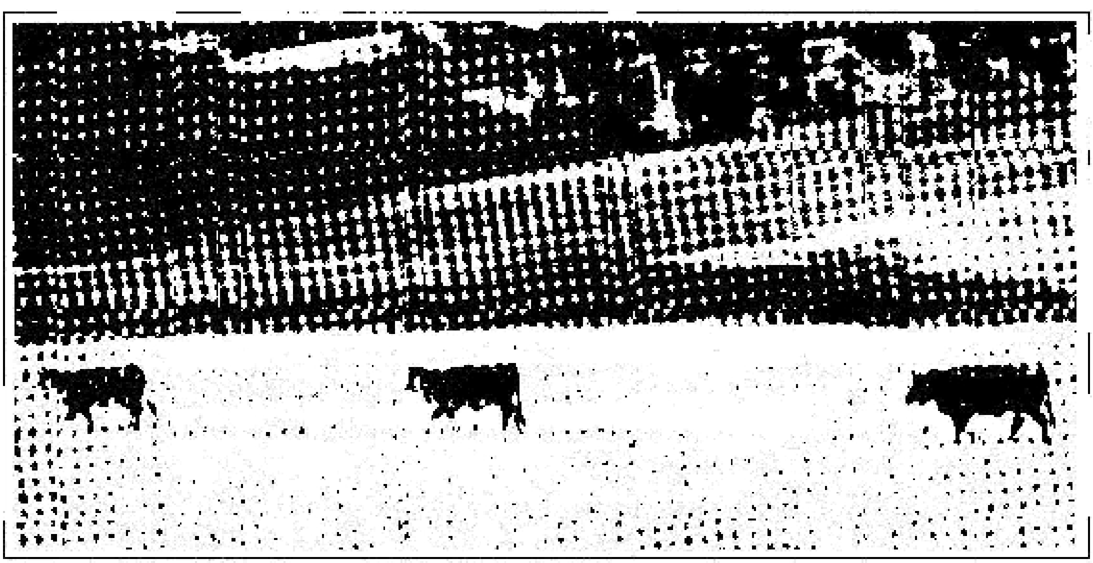
Vegetable production displaced from the northern and southern coastal counties has been forced to move into the central coast. Cropland acreage is still expanding in the counties of Santa Cruz, Monterey, San Luis Obispo and Santa Barbara.[13] But even these strongholds are increasingly under pressure. In this region, 12,000 acres were urbanized between 1977 and 1982.[14] The combined population of these counties, now just over one million, is expected to approach 1.3 million by the turn of the century.[15]

Conversion is by no means just a coastal issue, however. The 1980 census made it clear that population growth in California has begun to shift to the east and north, away from the crowded and expensive urban centers near the sea. People are heading into areas long regarded as permanently rural — northern, eastern, and central inland counties.[16] Inland cities, an Institute of Governmental Studies paper suggests, may be the next growth centers for California.[17]

The Department of Finance predicts the population of the San Joaquin Valley counties, now about 2.4 million, will reach 3.1 million by the year 2000.[18] In these counties, 65,000 acres of mostly agricultural land were urbanized between 1977 and 1982; at that rate, 300,000 acres will be converted by the year 2000.[19]

The current hot spot for growth is the greater Stockton region, which is rapidly becoming a Bay Area commuter suburb.[20] Between 1977 and 1982, San Joaquin County, where Stockton is located, developed as much land as Los Angeles County did — 30,000 acres.[21] Neighboring Stanislaus County has recently been classed as yet another Standard Metropolitan Statistical Area.[22]

The Sacramento Valley is another region of extensive growth; Sacramento County is expected to have almost 1.2 million inhabitants by the year 2000.[23] And the largest percent of population increase of all is taking place along the lower edge of the Sierra Nevada, in the foothill belt — an important cattle and orchard region.[24]



The Ranchette Phenomenon

The character of residential development in California has changed markedly in the last few years. More of the growth is taking place in scattered fashion across rural areas; and more land is being developed in a manner that the Soil Conservation Service characterizes as "rurban" — neither rural nor urban but something in between. "Rurban" land, says the SCS, is land outside incorporated city limits that, although not meeting the definition of "urban and built-up land", is broken up into units too small for agricultural production and is used primarily for residences.[25]

Such small semi-agricultural parcels are called variously "ranchettes," "hobby farms," "estates" or "boutique agriculture." Ranchettes may develop gradually, through lot-splits and sales over decades, or quickly, through large-scale planned subdivision. Parcels may run from an acre to 50 or even 100 acres.[26]

The SCS says California now has almost 2 million acres of this type of landscape, in addition to its 3.2 million acres of truly "urban" land.[27] The most "rurbanized" counties are San Bernardino, San Diego and Riverside, which together have 642,000 acres of "rurban" land; the Central Valley counties that include slices of the Sierra foothills also have large "rurban" areas.[28]

How much of this "rurban" development occurs at the expense of agricultural land? This question cannot be answered directly, but there are clues in another statistical source: the *Census of Agriculture*, conducted by the Bureau of the Census. Comparing *Census of Agriculture* figures for California from 1978 and 1982, a pattern emerges. The number of farms increased considerably during those years — from 73,000 to 82,000 — while the average size of those farms dropped from 447 acres to 390.[29]

A closer look at the figures shows why. The smallest category of all — "farms" of one to nine acres — grew by almost 40%. At the same time, the number of farm properties that brought in less than $5,000 in gross sales increased by 28%.[30] This suggests an accelerating breakup of farm properties into units that, though still qualifying as farms, are not really a part of commercial agriculture. While a small farm can be an efficient food producer, most of these small acreages are actually very large yards. They consume large amounts of land to house a very few people.

Most of this parcel breakup occurs on hilly rangeland, rather than on flat cropland. (Converted cropland is more likely to be covered with the more recognizable urban fabric of pavement, houses and suburban lawns.) Because the statistics on grazed land are much sketchier than for cropland, it is difficult to estimate the extent that parcelization is reducing the amount of agricultural land. On the outskirts of urbanizing regions, at least, it seems significant.

One study of the nine Bay Area counties concluded that for every acre there lost to outright urbanization, another acre has gone out of production due to parcelization and ranchette development.[31]

Something similar happened in San Luis Obispo County between 1969 and 1977: The number of parcels of more than 25 acres declined,[32] while those smaller than five acres rose by 55%. This undoubtedly reflects urban development. But the next category — lots of 5 to 25 acres — also rose by 22%. This seems to reflect ranchette-style parcel breakup.

The Conversion Process

The process by which farmland conversion occurs is complicated and varies greatly. An area under conversion pressure seems to pass through several stages; each step toward conversion makes the next one harder to forestall.

Public Investment

The first step toward conversion often occurs when a public agency allocates taxpayers' money for transportation improvements. Urbanization is impossible without the highways, bridges, tunnels and transit systems that improve access to areas. The interstate highway system, authorized in 1954, has been a tremendous boon to growth. The planning and laying out of such systems has not always taken into account the welfare of agriculture.

Insecurity in the Countryside

Conversion takes a step forward with the first substantial development, whether urban or "rurban", when people of urban tastes and habits begin to settle "in the country." The new inhabitants often come into conflict with the old. Farmers find themselves dealing with trespassers and vandals, with theft and with dogs that harass and sometimes kill livestock. The newcomers often had imagined the country to be without the odors, dust, smoke, flies, chemicals, noises and slow vehicles that go with working farms or ranches.[33]

As encroachment continues, farmers may become subject to what has been called the "impermanence syndrome." When development seems inevitable, why sink much money, or much labor or thought, into improving one's operation? Many owners become, in a sense, speculators, hanging on from year to year but awaiting, half in anticipation and half in dread, the purchase offer they will not be able to refuse.

Dairy owners, for instance, become reluctant to build modern milking barns and pollution control systems that will pay for themselves only over many years. Faced with such needs, the dairyman may stop milking and simply raise livestock (a less capital-intensive business) or even lease his land to a more active operator.

As conversion proceeds, land may go out of production entirely — the windfall from a sale seeming so close that owners don't bother to farm. This phenomenon, known as "idling," complicates the problem of counting acres converted. Is idled land agricultural, urban or something in between?[34]

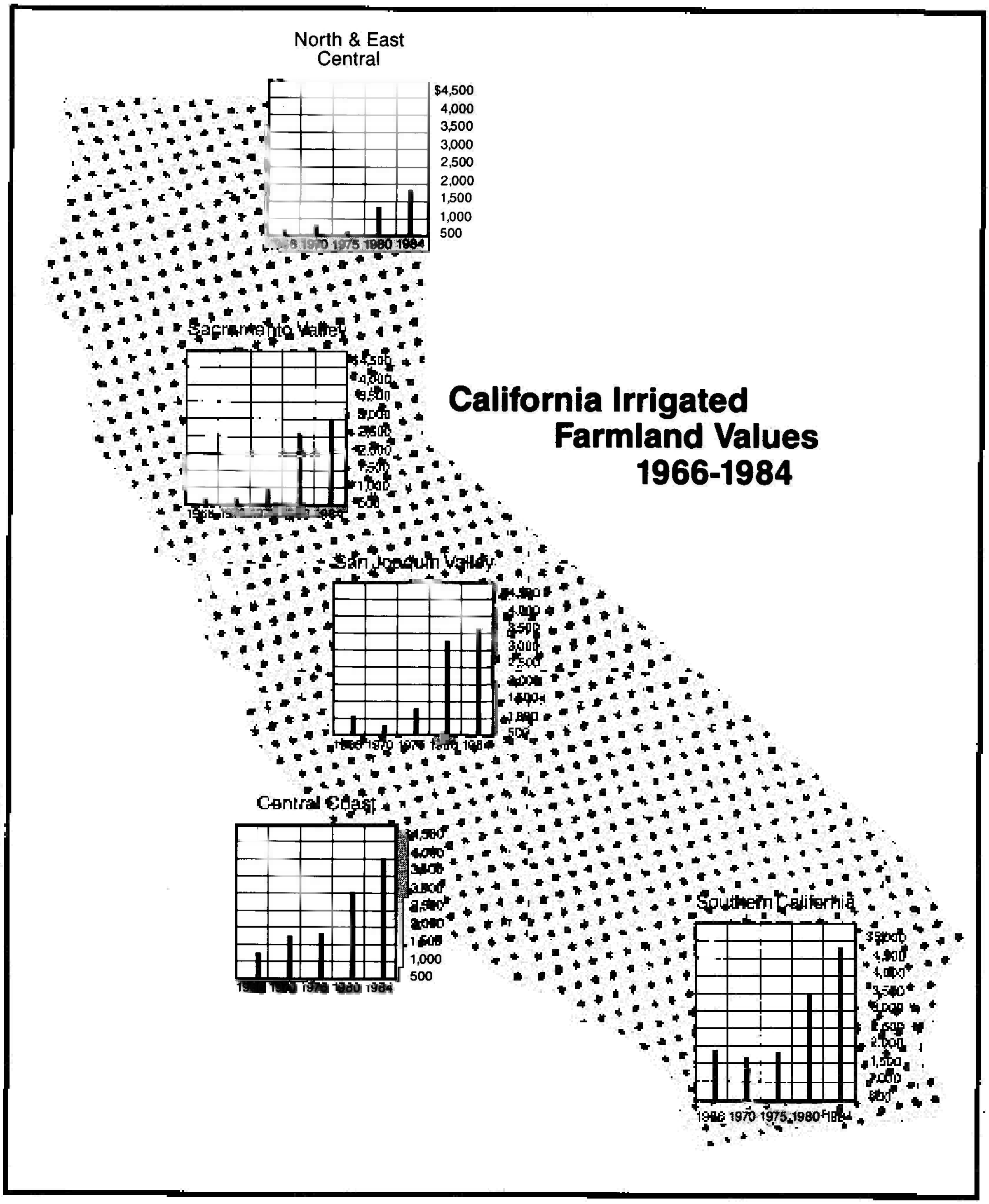
The Land Price Spiral

"Conversion is as much an economic process as it is a physical process," remarks Peter Detwiler, senior consultant to the Local Government Committee of the California state Senate. Central to the process of conversion is the speculation-fueled increase in the price of land, often occurring far out in the countryside.[35]

When the price of land climbs above the value of the land for agriculture alone, it becomes difficult for would-be farmers to acquire land and for existing farmers to expand their operations. Eventually, some owners will sell to developers, causing prices to take another jump — and so the cycle goes.

In California, the 1984 price of irrigated farmland averaged just over $3,500 an acre.[36] In the valuable coastal strip, where the soil can yield two or three high-value crops a year, the cost of agricultural land may exceed $20,000 an acre; established vineyards may go for $30,000 an acre.[37] Prices much above that signal conversion. When farmland prices reach $250,000 an acre, as has happened in Orange County,[38] it's fair to say that the land has been, for all practical purposes, already converted. The 24 California counties included in Standard Metropolitan Statistical Areas also yield almost two-thirds of the state agricultural production. In the urbanized areas of these counties, farmland prices correlate better with population density, changes in that density, and the speculative value than with the inherent productivity of the land.[39] It also happens that many of California's cities were built on or adjacent to the highest quality farmland. In other words, much of California's most productive agriculture is under serious urban pressure.

In most rural areas the value of land sold by one farmer to another has been increasing steadily since 1960, with a series of large annual increases in the late 1970s. (See map) 1984 and 1985 figures, however, show a drop in farmland values throughout the state.[40] In some non-urban areas, a curious ripple effect is driving up land prices far beyond their agricultural value. Farmers displaced from an urbanized area and eager to get back on the land, are able to pay accordingly, bidding up farmland prices in more rural regions. Thus, dedicated farmers may inadvertently hasten the next cycle of farmland loss. In Southern California, for example, people who sold their acreage in Orange County bid up farmland prices in Ventura County.[41]



SOURCE: USDA Economic Research Service, 1966-1984.

Critical Mass

Agriculture depends on a network of services, and in turn sustains that network: feed stores, equipment suppliers, canneries, production associations, banks and much more. When farming diminishes in a region, demand for these services also dwindles. Eventually, the system falls below a "critical mass", the point at which there is no longer enough agriculture to support the services agriculture needs. This has been a concern for dairy managers in southern Sonoma and northwest Marin counties, for Sonoma County apple growers, and indeed in conversion-threatened regions throughout the state.

The Marin/Sonoma dairying area or "milkshed" is not in immediate trouble, but with the intense population pressures in the Bay Area, the local dairy industry is concerned. The critical point has already been reached, however, in Glenn County, which produces about one fourth as much milk as the Marin-Sonoma lands do. And the dairy industry already has collapsed in the southern Santa Clara Valley, the San Luis Obispo-Santa Barbara area, and in northern San Diego County — all areas that once produced a lot of milk.[42]

In the Santa Clara Valley, no longer is there enough producing acreage to support the local canneries. Many plants have closed; the remaining facilities survive partly by processing produce trucked in, at high cost, from outside the area. The owners still find it economical to run these old facilities, but not to modernize them. Costs per can are high.[43]

In areas where the processing industry is in decline, the farmer may be forced to choose his crops according to the plants that are still open, not according to profitability. Later, the farmer may have difficulty finding customers at all.[44]

The Final Step

The final step in the conversion process is the development of the land to non-agricultural uses — urban neighborhoods, rural subdivisions, roads, water projects, etc. This development, while bringing a productive use to the land, can also have detrimental effects on the economic and environmental health of the community, both local and statewide.

The Effects of Conversion

Fiscal Impacts: Some Important Findings

Development is usually considered a boost for the tax base and for the local economy in general. But this is not necessarily the case. The trade of farmland for developed area may be a fiscal loss for local governments and taxpayers. A series of research efforts, beginning with the landmark Foothills Environmental Design Study done for Palo Alto in 1971,[45] reminds us that development brings costs as well as revenues, and that quite often the costs are larger. In general, it is possible to say that, while industrial and commercial development more than pays for itself, residential development is liable to bring a loss.

On the other hand, from a government's point of view, agriculture is a gold mine; it "contribute(s) to the tax base without contributing significantly to costs of services or to student population," as a 1976 study of the Half Moon Bay area stated.[46] This pattern has shown up nationwide: in Loudoun and Clarke counties, Virginia, recent reports show that farms, like other businesses and industries, subsidize residential areas.[47]

Another important finding recurs: it makes better fiscal sense to add housing to existing towns at moderate densities than to scatter the homes around the agricultural countryside. Well-planned close-in developments, being cheaper to serve, can even bring in a net revenue "profit." A 1984 study in Fresno compared the revenue impact of two development plans: one providing 500 units of housing on 139 vacant acres in town; the other offering the same 500 units in "ranchettes" on 1,500 acres of cropland outside the city limits. The researchers concluded that the in-town development would bring in a net gain of $39,874 to public agencies in the first year after its completion; the further-out version would have a net cost of $68,483.[48]

It is more difficult to estimate the effect of farmland conversion on the private economy. Undeniably, even as one economic mainstay is lost, new economic activity is gained.

The Fresno study also compared the economic effects of building the 500 units in town and out among the farms. Both, of course, brought some economic benefit; but the exurban development also canceled out crop value estimated at $1.5 million a year and the equivalent of 24 jobs. So the in-town development made better economic sense.[49]

Loss of Wildlife, Scenery, Wetlands

Most agricultural land meets other needs of the state and its people. As scenery, it is pleasant, interesting and subtly varied. Farmland separates and frames the towns and cities, making them that much more attractive. Cropland and ranchland also provide wildlife habitat. In many areas, winter-flooded fields become seasonal wetlands of great value to waterfowl. When farmland is converted, these values are lost.

Other Ill Effects

The conversion of farmland tends to bring an increase in environmental problems: air pollution from automobiles and industry, increased flooding, and (in some cases) the ill effects of a sprawling development style. This is not to say that agriculture doesn't create environmental problems. Nonetheless, the trade of farms for suburbs is much more likely to be environmentally damaging. For instance, when hilly farm or ranchland is converted, one by-product is soil erosion — a problem of note especially in the Sierra Nevada foothills.[50]

Weakening of Statewide Agriculture

One effect of land conversion, however, stands out: the loss of agricultural production capacity in the nation's leading farm state. Urban growth centers are located chiefly on rich soils and disproportionately along the coast, where the capabilities of the land are unique. The land converted there tends to be some of the best in California and, indeed, in the United States.

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The Crucial Coast

"California's most remarkable farmland lies in the narrow strip along its coast. There, temperatures moderated by the ocean seldom drop below freezing or rise above 80 degrees Farhenheit. In this temperate zone, vegetables can be raised throughout the winter and many crops can be harvested two, three and occasionally four times a year." The coastal belt yields an impressive variety of foodstuffs, and accounts for all of California's commercial output of some crops — artichokes and Brussels sprouts, for example. Santa Barbara County is representative: About half the crops grown in the county are grown because of the coastal "climatic advantage."

In 1980, California had in this maritime belt approximately 500,000 acres of irrigated cropland, just over 5% of the state's total stock of such land.[4] But this same coastal region contained more than 1.3 million acres of urban land — 41% of the urbanized area of the state.[5]

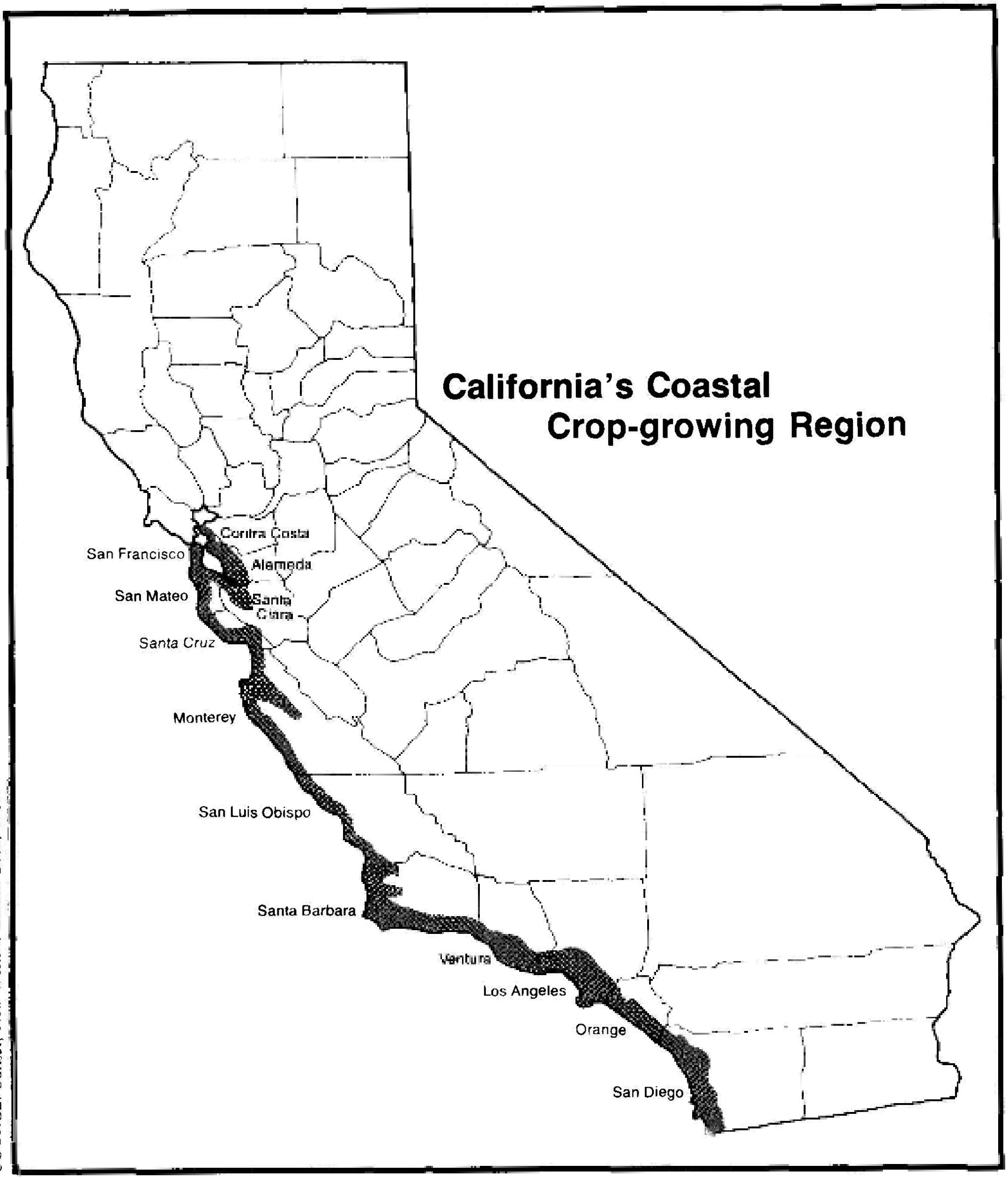
The productive coastal area runs from Half Moon Bay in San Mateo County in the north to San Diego County and the Mexican border in the south. Also receiving significant ocean influence are the plains along San Francisco Bay in Alameda, Santa Clara and San Mateo counties,[6] and the lands along the Suisun and San Pablo bays in Contra Costa and Solano counties. In Sonoma and Napa counties, a lesser coastal influence helps to create the specialized climate that, in combination with rich volcanic soil, makes this a premium wine-grape growing region.[7]

Among the notable coastal crops are apples, artichokes, avocados, broccoli, Brussels sprouts, cabbage, cauliflower, celery, Chinese vegetables, cucumbers, flowers and flower seeds, lemons, lettuce, lima beans, mushrooms, ornamental plants, peas, peppers, raspberries, strawberries, summer squash, tomatoes and wine grapes.[8]

Parts of the San Joaquin Valley can grow some of these crops in the cooler months, but most inland fields do not approach the per-acre production of the coast. In Fresno County, tomatoes yield an average value of $1,700 per acre per year; lettuce brings in $1,983; and strawberries produce $6,387. Coastal Ventura County tomatoes, by contrast, bring in $6,146 per acre per year; Santa Cruz County lettuce yields $4,483 per acre; and Santa Cruz strawberries yield $19,101.[9] The Imperial Valley also grows some winter vegetables, but both acreage and variety are limited.[10]

All along the coast, farmers are able to fill special niches in the market:

- San Diego growers plan their harvest to bring in fresh tomatoes at Christmas.[11]
- Santa Barbara and Ventura lemons and avocados are premium because they can be left on the tree to ripen fully in the warm fall months.[12]
- The Lompoc-Santa Maria area of northern Santa Barbara County produces 80% of the nation's flower seeds.[13]
- In 1983, Monterey County produced 32% of the nation's lettuce — more than one million tons.[14]
- The Central Coast, especially Monterey County, is one of the best artichoke regions in the world. Attempts to grow this crop farther north along the coast, above San Francisco where temperatures are somewhat cooler, have failed.[15]
- Seventy-five percent of the nation's Brussels sprouts are grown in the coastal strip between Watsonville in Santa Cruz County and Half Moon Bay in San Mateo County.[16]



SOURCE: Sunset, *New Western Garden Book*, 1979.

The California Coast's Competition

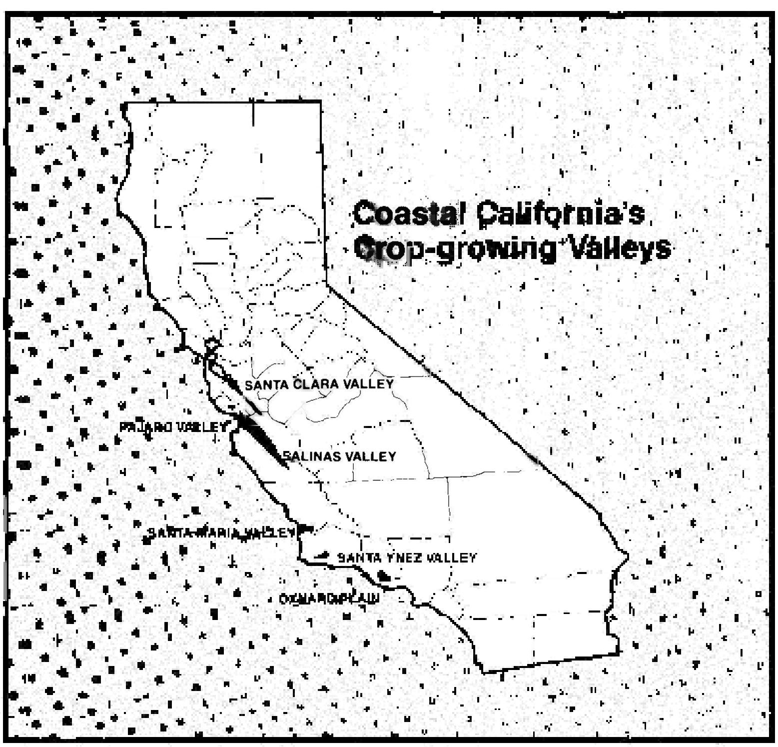
Is the California coast unique in the United States? Not quite. Two other regions yield a somewhat comparable range of crops, including winter vegetables.

In southern Florida, the warm, humid climate allows year-round crop production both on the coast and inland. Most crops are harvested twice a year. Conversion is a threat to these lands also as the southern Florida population continues to boom. Current winter vegetable acreage: about 164,000.[17]

Winter vegetables are grown in two parts of Texas — the small "Winter Garden" region west of San Antonio and the Lower Rio Grande Valley, a stronger and more consistent producer. The four Lower Rio Grande counties grow many of the same crops as the California coastal areas. But hot summers make double-cropping rare. Winter vegetable acreage: about 88,000.[18]

Three points should be noted here. First, the Florida and Texas growing areas combined total about 252,000 acres, little over half the winter vegetable acreage on the California coast. Second, the California coast grows crops that the other regions do not; the reverse is not true. Finally, judging by the last 15 years, the Florida and Texas growing areas are more susceptible than the California areas to damaging weather extremes, primarily freezes.

Mexico also produces winter vegetables for U.S. markets. While shipments of Mexico's agricultural products are likely to continue, California's coastal cropland still produces the majority of winter vegetables for domestic consumption.



SOURCE: California Department of Water Resources. *Bulletin 160-83.*

Rapid Conversion on the Coast

The California coastal strip is one of the most urbanized — and most rapidly urbanizing — regions of the state. How is this development affecting agriculture? To answer that and other questions concerning coastal agriculture, the American Farmland Trust undertook a study using climate data developed by University of California Cooperative Extension for the Sunset *New Western Garden Book* and historic land use data compiled by the state Department of Water Resources.[19]

In 1960, there were 1.3 acres of urban land for each acre of irrigated cropland in the coastal strip; by 1980, the proportion had shifted to almost three to one.[20] Nonetheless, there has been room on the coast, so far, both for irrigated agriculture and for expanding cities. Since the late 1950s, there has been a net increase of nearly 500,000 acres of urban land along the coastline while the farmland has decreased by 125,000 acres.[21] This suggests that urbanization has taken place on other-than-agricultural lands and/or that agriculture has found new lands to bring under irrigation to balance the acreage lost to urban growth. The latter explanation is closer to reality.

Change in California Land Use
— Coastal Counties —

Coastal Counties	Land Use Acreage by Time Periods				County Change	
	1955-64		1977-82		1950s-1980s	
	Urban	Agricultural	Urban	Agricultural	Urban	Agricultural
Alameda	44,000	42,000	83,000	3,000	39,000	(39,000)
Santa Clara	70,000	79,000	100,000	6,000	30,000	(73,000)
San Mateo	60,000	8,000	81,930	5,650	21,930	(2,350)
Santa Cruz	13,400	16,620	26,006	23,090	12,606	6,470
Monterey	27,915	114,000	39,176	156,975	11,261	42,975
San Luis Obispo	10,200	24,685	21,570	28,250	11,370	3,565
Santa Barbara	23,870	56,675	57,740	65,880	33,870	9,205
Ventura	26,490	76,630	51,197	68,950	24,707	(7,680)
Los Angeles	332,500	19,200	365,320	3,310	32,820	(15,890)
Orange	140,590	101,920	225,956	27,310	85,366	(74,610)
San Diego	89,520	83,740	258,240	108,870	168,720	25,130
TOTALS	838,485	623,450	1,310,135	498,265	471,650	(125,185)

Data are land acres. The coastal area used for this analysis represents the zone influenced by the Pacific Ocean and excludes the Delta region.

All data represent land acres, based on land use studies conducted by the Department of Water Resources. Data for Alameda and Santa Clara Counties are derived from 1955-82 *Agricultural Commissioner's Reports*, DWR data, aerial photographs and Association of Bay Area Governments 1960-85 data.

(NOTE: Numbers in parenthesis represent loss.)

Uneven Shift in Land Use

Urban growth is not avoiding irrigated cropland. Rather, land formerly dry-cropped or grazed has been brought under irrigation fast enough to make up for losses to conversion. We haven't "created" new agricultural land — merely shifted it from one farm use to another. A county-by-county survey shows that this replacement has occurred unevenly.

For example, in northern Santa Barbara County, in the Santa Maria Valley, the urban area increased by 10,000 acres from 1959 to 1977, while cropland expanded by 5,000 acres.[22] Local agricultural experts say the urban development has taken place chiefly on previously farmed land; to produce a net gain in irrigated acreage, extensive areas of previously fallow (and lower quality) land were put under cultivation. [23] However, on the Oxnard Plain of Ventura County, one of the state's most fertile growing areas with soil as deep as 40 feet, 15,000 acres were converted to urban development from 1961 to 1980. A review of land use maps from 1961 and 1980 shows that this growth occurred almost exclusively at the expense of irrigated cropland.[24]

In Los Angeles, Orange, Ventura and all the Bay Area coastal counties, land lost to urbanization has not been replaced locally. In Los Angeles, Orange and Ventura, a 143,000-acre increase in urban area between 1960 and 1980 was accompanied by a 98,000-acre decrease in irrigated land. On the fertile plain surrounding San Francisco Bay in San Mateo, Santa Clara and Alameda counties, only remnants of the extensive original farm belt remain.[25]

As if in compensation, the Central Coast counties — Santa Cruz, Monterey, San Luis Obispo and Santa Barbara — have more than replaced their losses. In this region, irrigated cropland in the coastal strip has had a net expansion of over 60,000 acres, even though urban acreage also has increased by 70,000 acres. In San Diego County, too, both farms and cities have been adding acreage. During the 1960-1980 period the county's urban area grew by 170,000 acres — while its agriculture managed a net gain of 25,000 acres.[26]

How Much More Coastal Farmland?

Will Central Coast agriculture continue to bring enough land into service to counterbalance urbanization all along the coastal strip? Or will these counties follow the path of the longer-urbanized regions that already have reached the cropland frontier?

In Santa Barbara, San Luis Obispo and Monterey counties, local farm advisors report, some fallow areas remain that could be brought into year-round crop production. However, these are almost all hilly lands, of lesser quality than the alluvial valley floors, and also highly erodible.[27] In Monterey County, for instance, only terracing would bring in more land, at great expense. In Santa Barbara, water is the limiting factor; dry-farmed hillside crops such as avocados and grapes could still be expanded or planted more densely, though at high risk of erosion.[28]

The county with the most impressive available acreage is San Diego. The area has 60,000 acres of soils in Soil Conservation Service capability classes I-IV, of which only 12,000 to 15,000 are now farmed. In part, this reflects an economic decision to keep some land out of production in the face of competition from inexpensive Mexican produce. [29] The more fundamental constraint, however, is the price of water — as high as $250 an acre-foot, prohibitive for most agriculture.[30] The pressure to convert is so high, moreover, that little potential farmland is sold for farming purposes. According to a local farm leader, farmland parcels that change hands usually go to speculators or developers.[31]

The Last 10,000 Acres

AFT's county-by-county study reveals this startling fact: *California has less than 10,000 acres of high quality coastally influenced land, with available and affordable water supplies, that could be put under irrigation.*[32] From this point on, nearly every acre that goes from an intensive agricultural use into a non-agricultural use is a net loss to the system. No county has significant further reserves.

Urban growth in the coastal strip, though somewhat constrained by the regulatory work of the California Coastal Commission, continues. It consumes, on the average, over 20,000 coastal acres a year. Between 1960 and 1980, about 470,000 acres in the coastal strip were urbanized. Comparing this with the 500,000 acres of irrigated cropland now remaining in the region, the potential for rapid loss, no longer masked by offsetting expansion, seems clear.[33]

Notes

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16. Scheuring, 167.
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19. Shafroth, "Coastal Agricultural Lands."
20. Shafroth, "Coastal Agricultural Lands."
21. Shafroth, "Coastal Agricultural Lands."
22. Shafroth, "Coastal Agricultural Lands."
23. Shafroth, "Meeting with George Goodall."
24. Shafroth, "Coastal Agricultural Lands."
25. Shafroth, "Coastal Agricultural Lands."
26. Shafroth, "Coastal Agricultural Lands."
27. Shafroth, "Coastal Agricultural Lands."
28. Turner, "My Data."
29. Turner, "My Data."
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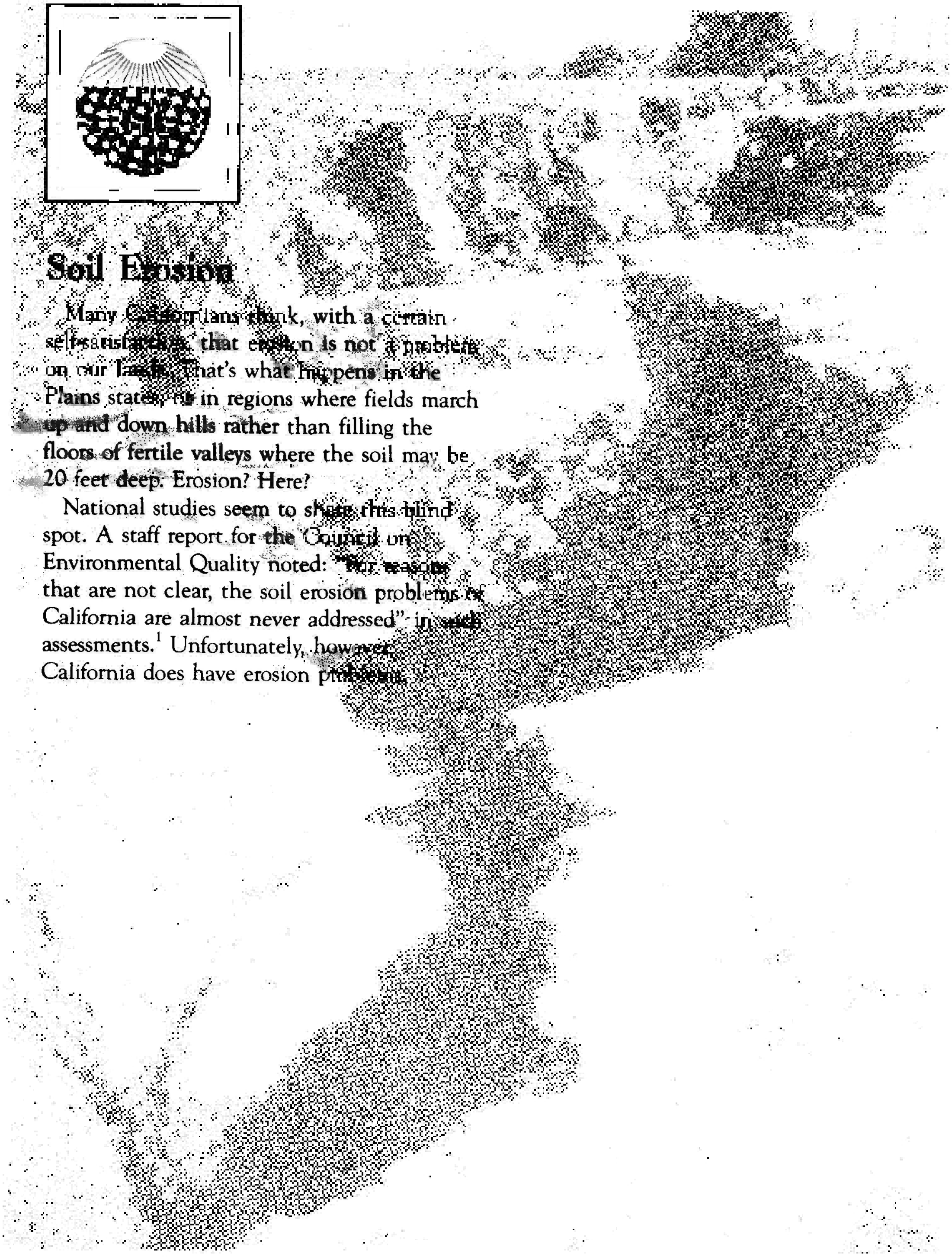
31. Turner, "My Data."
32. Shafroth, "Coastal Agricultural Lands."
33. Shafroth, "Coastal Agricultural Lands."



Soil Erosion

Many Californians think, with a certain self-satisfaction, that erosion is not a problem on our lands. That's what happens in the Plains states, or in regions where fields march up and down hills rather than filling the floors of fertile valleys where the soil may be 20 feet deep. Erosion? Here?

National studies seem to share this blind spot. A staff report for the Council on Environmental Quality noted: "For reasons that are not clear, the soil erosion problems of California are almost never addressed" in such assessments.[1] Unfortunately, however, California does have erosion problems.

What is Erosion?

Soil erosion is a natural process. Erosion on land covered by vegetation is probably no more than one inch every 100 years, a loss normally offset by the formation of new soil. However, continuous intensive cultivation of cropland can greatly accelerate this natural process, causing severe water and wind erosion. So can overgrazing of rangeland.

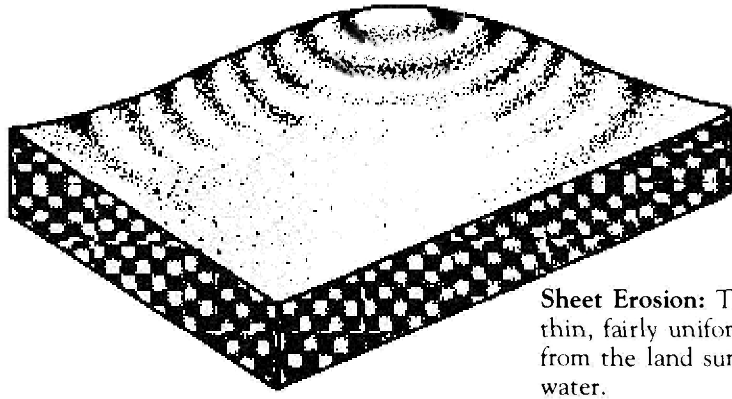
Eroded land is less fertile and produces crops at higher cost. The eroded soil becomes sediment in streams, a form of water pollution, damaging rivers, lakes, reservoirs and water systems.

Water-induced erosion is of four types: sheet, rill, gully and channel. Sheet erosion removes imperceptibly thin layers of soil. Loss of just one-eighth of an inch in a year translates to more than 20 tons of soil per acre — an amount four times greater than the rate at which new soil is generally assumed to be formed. Rill erosion occurs when water from rain or melting snow creates small channels. As the run-off on a field increases in velocity, deeper rills form and more soil is carried off. Gully erosion is a severe form of rill erosion. When water is still more concentrated in streams and rivers, channel or stream-bank erosion occurs. Wind erosion can be extreme where plowed fields are unprotected by groundcover, where soil is not held by plant roots, and in dry climates or during droughts.

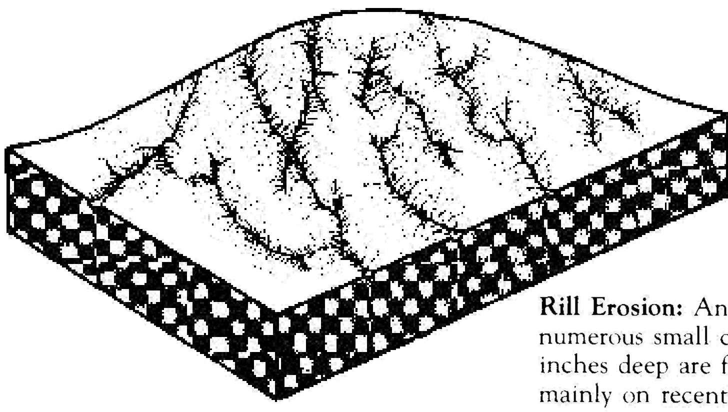
Extent of Erosion

In the United States, 421 million acres are used for crop or hay production. According to the 1982 SCS National Resource Inventory, the annual amount of sheet and rill erosion occurring on this land is approximately 1.8 billion tons; wind erosion takes another 1.2 billion tons a year. The damage is not evenly distributed; about half of the sheet and rill erosion occurs on just 10% of the land. Wind erosion is concentrated primarily in the Plains and Rocky Mountain states.[2]

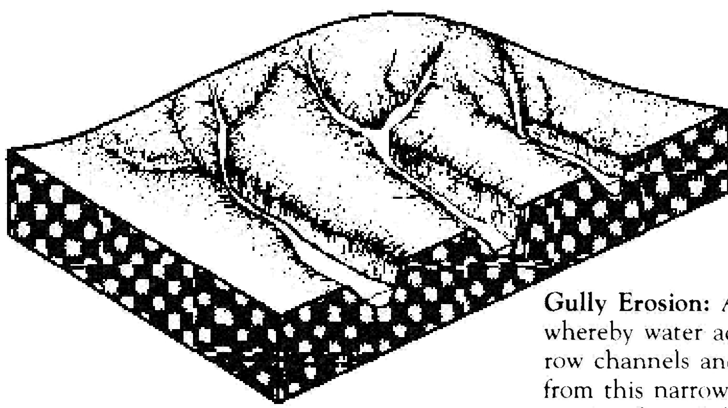
Types of Soil Erosion



Sheet Erosion: The removal of a thin, fairly uniform layer of soil from the land surface by runoff water.



Rill Erosion: An erosion in which numerous small channels several inches deep are formed—occurs mainly on recently cultivated soils.



Gully Erosion: An erosion process whereby water accumulates in narrow channels and removes the soil from this narrow area to a depth ranging from 1 foot to as much as 75 feet.

SOURCE: American Farmland Trust, Soil Conservation Society of America.

Losses in California

How fast is California losing topsoil? Not as rapidly as, say, Iowa — but certainly faster than is generally known.

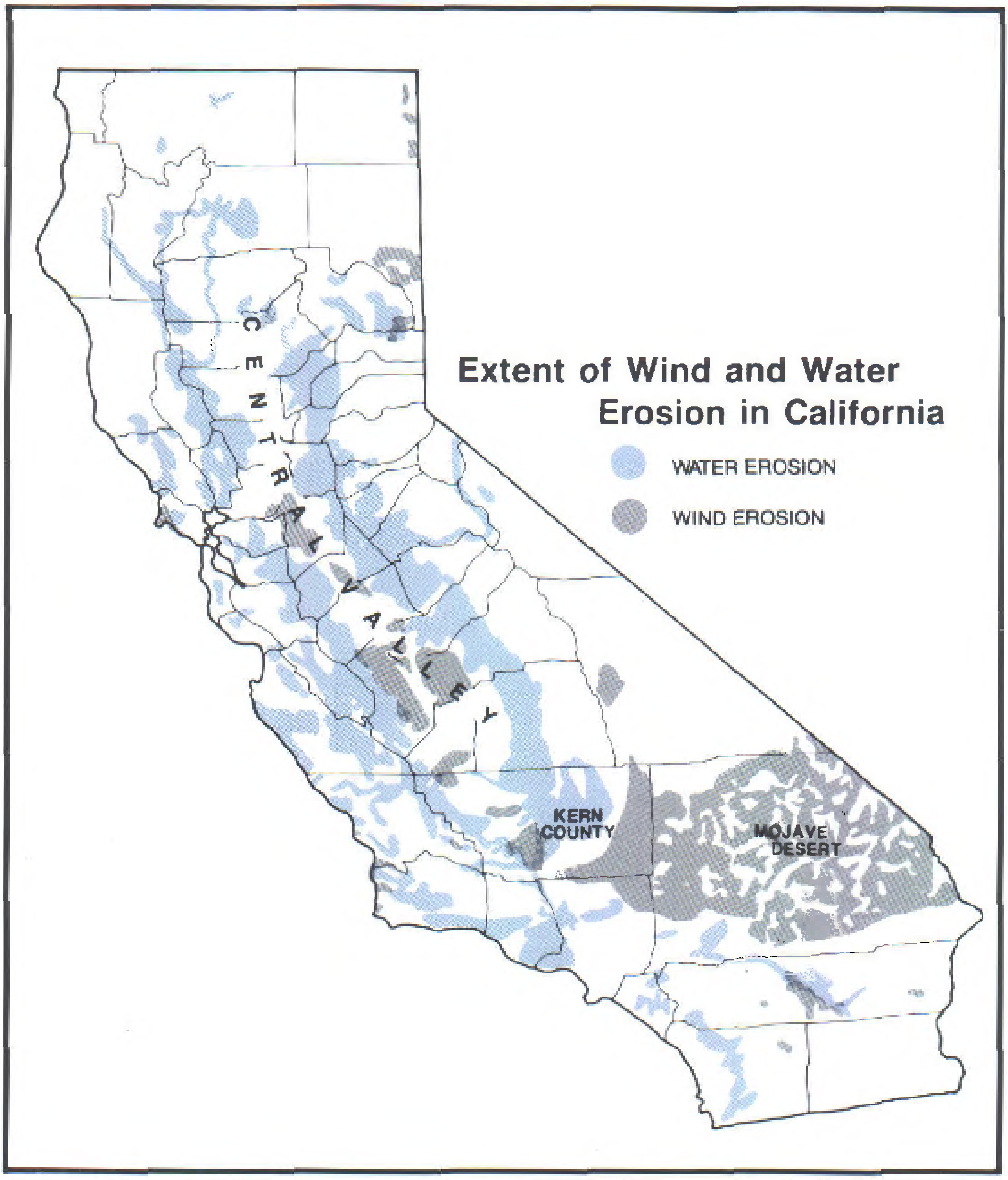
The Soil Conservation Service says the state's rural lands lose about 256 million tons of soil a year. Of the state's cropland, approximately 1,785,000 acres are shedding soil faster than nature can replace it, due to wind, water, or both. At least 900,000 acres of non-irrigated cropland — fully half of that land type — suffer excessive erosion, greater than five tons per acre per year. Thirty-five percent of the state's privately-owned grazing land is also eroding excessively.[3] The following is an examination of these problems by land type:

Irrigated cropland: Mostly flat, this land would not seem very prone to sheet and rill erosion. The SCS, however, has found these problems on 873,500 acres.[4] In addition, very gently sloping land can and does erode if irrigation is excessive.[5] Such "irrigation-induced erosion" is occurring on 1.2 million acres.[6] Also, irrigation ditches and furrows can act as conduits for winter storm runoff, causing further soil loss.[7] Another category is channel or stream-bank erosion: almost 2,800 miles of streams that run through irrigated cropland are eating away at their banks.[8] Wind erosion is also surprisingly common on irrigated cropland, occurring, in fact, on 1.3 million acres. (The SCS estimates that about a quarter of soil losses due to wind occur on such land.)[9]

Dry-farmed cropland: This mostly hilly land is naturally vulnerable to erosion by water. It is made more so by the widespread cultural practice called "weed-free non-tillage" in which the ground is disced, sprayed with herbicides, and left bare of vegetation for months at a time. (Besides open fields, the soil between trees or grapevines is often so treated.)[10] Of 1,770,700 acres of non-irrigated cropland, 912,000 or 51.5% are suffering from sheet, rill and/or gully erosion.[11]

Grazing land: At least 7 million acres of privately-owned grazing land, more than a third of the total, have thinning soil.[12] Publicly-owned lands are doing little better. In 1975, the federal Bureau of Land Management acknowledged that, of the 10 million acres of range it manages in the state, only 12% was in acceptable condition.[13] The cause of most range erosion is overgrazing — asking the land to support more animals than its carrying capacity. (One problem the range manager faces is that the capacity of the land changes from year to year according to rainfall; herds cannot shrink or grow on the same short notice.)[14]

Erosion in watershed areas is a vicious circle. Eroded hillsides absorb less water than undisturbed ones, increasing runoff; the lost soil becomes sediment in streambeds, causing streams to meander and undercut their banks, dislodging still more soil. The effects can extend far downstream.[15]


Extent of Wind and Water Erosion in California
WATER EROSION
WIND EROSION
CENTRAL VALLEY
KERN COUNTY
MOJAVE DESERT

Erosion by Region

Coastal mountains and valleys

The grazing land and the hilly cropland in the mountains between the Central Valley and the Pacific Ocean are undergoing marked erosion, mostly by water. In 12 of the 20 farm counties near the coast, more than half of the dry-farmed land is losing excessive amounts of soil to sheet, rill and gully erosion. (The counties, north to south: Sonoma, Napa, Marin, Contra Costa, Alameda, San Mateo, San Benito, Monterey, San Luis Obispo, Santa Barbara, Ventura and Orange.) In several counties — Alameda, Monterey, San Benito, and Ventura — more than half of the grazing land is also rapidly eroding.[16]

These problems are worst in the Central Coast counties. Gullies four feet deep have been seen in some avocado orchards in the Santa Barbara area.[17] The most startling figures come from Monterey County, where 71% of the rangeland — over half a million acres — is eroding excessively. And of 114,500 acres of dry-farmed cropland, all are losing soil faster than it can be replaced.[18] If erosion continues at these rates, one SCS official has stated, "all the productive topsoil will be gone in another 60 to 80 years."[19] In the Salinas Valley, the agricultural heartland of the county, the State Water Resources Control Board has noted severe erosion even on moderately sloping land where silty, sandy soils are planted to grapes.[20]

Central Valley

In the Central Valley, water erosion on the flat valley floor is minimal. Wind erosion, however, is significant there: Fresno, Kern, and San Joaquin counties each have about 250,000 acres of irrigated cropland affected.[21] The most obvious erosion in the region occurs in the foothill zones on either side of the trough. According to a 1979 survey conducted by the Department of Conservation, over 12% of the cropland in the Central Valley region from Oroville south has erosion problems; the larger part of that orchard land is in the Sierra foothills.[22] In the hills east and southeast of Fresno, newly planted orchards and dry-farms using "weed-free non-tillage" systems have lost as much as 400 tons per acre from a single heavy rainstorm.[23]

Kern County

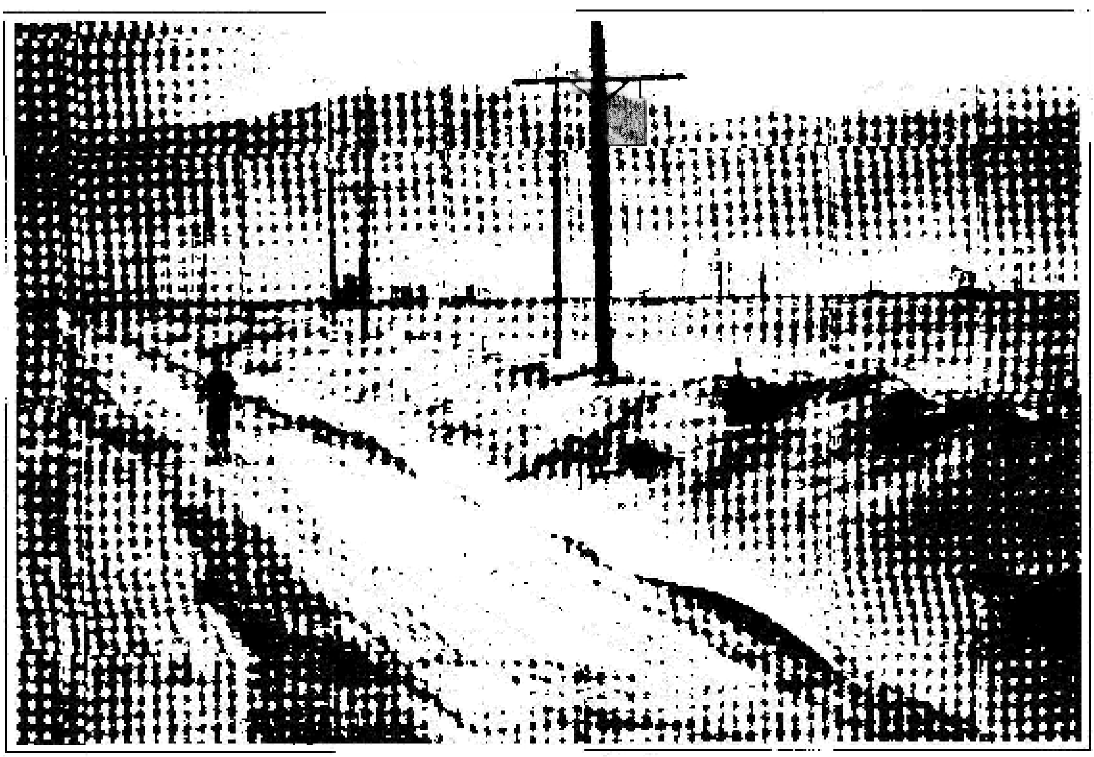
Kern County stands out as an erosion hot spot. Here the SCS County Resources Inventory found 17,900 acres of cropland and 526,000 acres of grazing land with water erosion; 250,000 acres of cropland and 446,000 acres of grazing land have wind erosion problems. (Many acres, of course, have both — the figures cannot be added to reach an erosion total.)[24] The picture is slightly complicated by the fact that Kern County sprawls across the southern Sierra to include a slice of the Mojave Desert.

In December 1977 a major windstorm hit the Bakersfield area. It did an estimated $2.5 million of damage to crops by burying them, sandblasting them and uncovering seed.[25] Of greater long-term importance, the storm took as much as two feet of topsoil off plowed but unplanted fields.[26] And it scoured soil from 147,000 acres of grazing land in the Sierra foothills at a rate estimated at 167 tons per acre.[27] The nutrient loss to grazing land has been pegged at $24 million.[28] Total estimated soil loss from the storm: 50 million tons.[29]

The Desert

Of the 3 million acres of agricultural land in California subject to wind erosion, at least half, probably more, lie in the Mojave and Colorado deserts and other arid lands east of the Sierra-Cascade crest. (Uncertainty comes from the fact that some large counties are only partly in the desert.) San Bernardino County alone has 600,000 acres of wind-eroding land.[30]

Irrigated croplands in the desert regions, ranging from small oases to the green expanse of the Imperial Valley, lose some soil to wind; but the bulk of the acreage damaged is grazing land, naturally vulnerable in this dry climate and rendered more so by overgrazing and off-road vehicle traffic.[31] SCS figures understate the problem by omitting the government-owned rangeland that predominates in the desert counties — and which has its own erosion problems. Based on a questionnaire submitted to Resource Conservation Districts, the Department of Conservation estimates that more than seven million acres of range suffer from wind erosion in southeastern California alone.[32]



Effects of Erosion

Soil erosion causes two general types of damage. Onsite, it can reduce the productivity of land, labor and capital. Offsite damages consist primarily of accelerated runoff carrying sediment, fertilizer nutrients and pesticides into bodies of water or other areas where they may do harm.

Onsite Impacts

Erosion degrades the physical, chemical and biological characteristics of the top layer of soil and reduces the depth of the plant-rooting zone. The gradual selective removal of organic matter and finer soil particles from an eroding surface diminishes a soil's capacity to absorb and retain water and nutrients in forms plants can utilize. As the soil absorbs less water, runoff increases and further erosion occurs. Then the accompanying decline of productivity must be offset by adding costly plant nutrients or organic matter to the soil. "By removing that top layer," says Richard Cruse, professor of agronomy at Iowa State University, "we're removing the cream. It's got the most nutrient matter, the best soil structure for aeration, moisture, and temperature."[33] Eventually erosion forces plants to root in subsoil materials that usually are not as favorable to growth. Eroded lands become more expensive to farm. More materials and energy go into them for less result.[34]

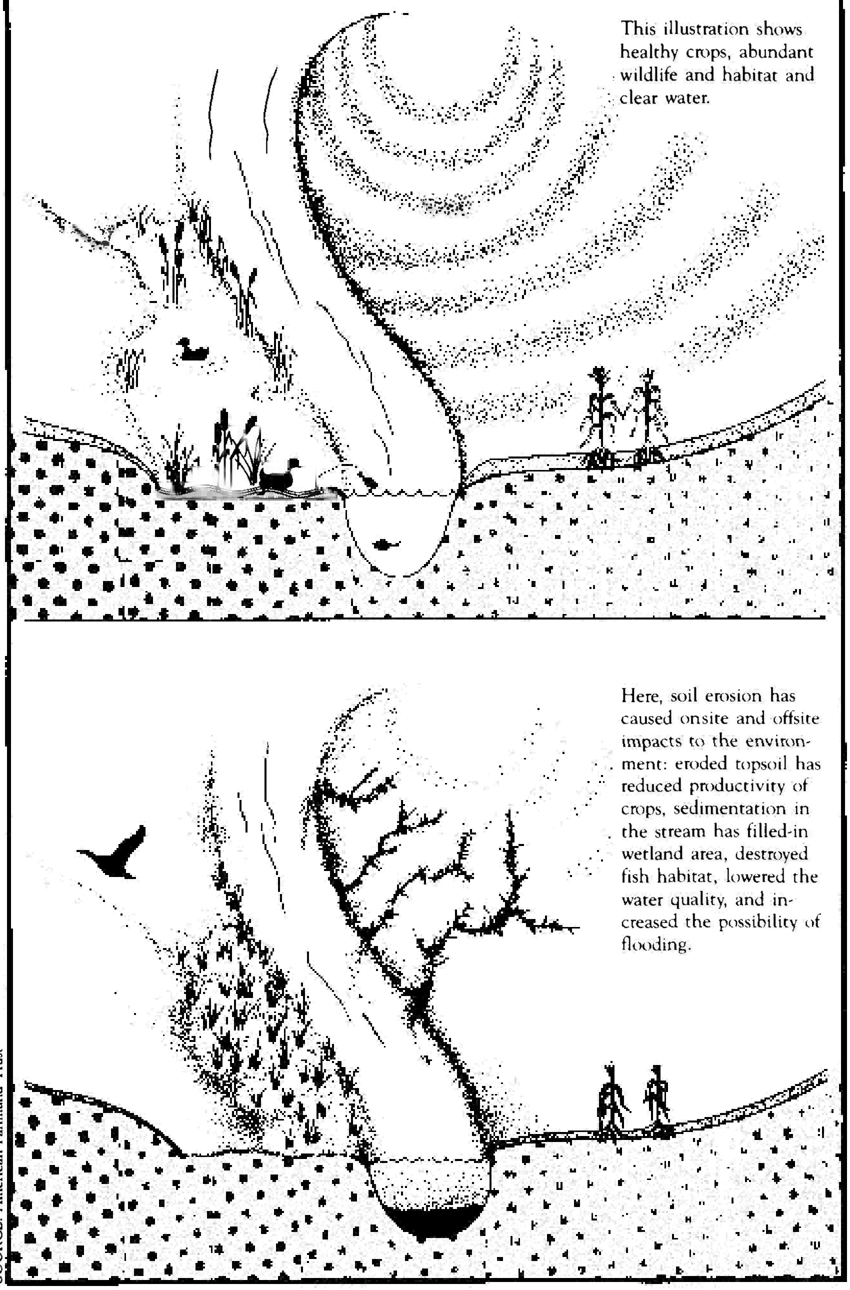
Attempts have been made to put a price on soil loss. The General Accounting Office, estimating what it costs to replace lost soil nutrients with fertilizer and soil additives, has assigned a value of 25 cents per ton to eroded soil.[35] The nutrient loss to rangeland near Bakersfield in the 1977 dust storm was estimated at about $1.00 per ton of soil removed.[36] Another USDA study indicates that water erosion in the hills west of the San Joaquin Valley "has reduced forage consumption by 5 percent annually, resulting in an annual loss of over $1 million in 1977 dollars."[37]

Offsite Impacts

Eroded soil does not disappear; it becomes sediment somewhere else, most often in bodies of water. According to one frequently cited estimate, about 2.1 trillion tons of suspended sediment are discharged into receiving waters in the United States annually. Cropland erosion is believed to contribute about 40%, and streambank erosion 26%, of the sediment discharged.[38] Sedimentation clogs streams, irrigation canals and drainage channels, causes deterioration of aquatic habitats, muddies recreational waters, decreases water storage capacity in lakes and reservoirs, and increases water treatment costs.[39] Sediment from croplands is of special concern because soil grains can carry attached particles of nutrients and pesticides into streams.[40]

Sediment also increases flood damage. Clogged streams have less room for water and overflow more readily; also, the mud that settles from turbid floodwater adds to the damage done. Sediment washed down a slope or onto a floodplain can smother newly germinating crops. It is a curious fact, too, that sediment deposited in flood areas is typically less fertile, as soil, than the original topsoil it covers.[41] A recent Conservation Foundation report places the estimated costs of offsite damages from soil erosion nationwide at $3 billion to $3.5 billion a year; at least $1 billion of that can be traced to erosion on agricultural land.[42]

Impacts of Soil Erosion



This illustration shows healthy crops, abundant wildlife and habitat and clear water.

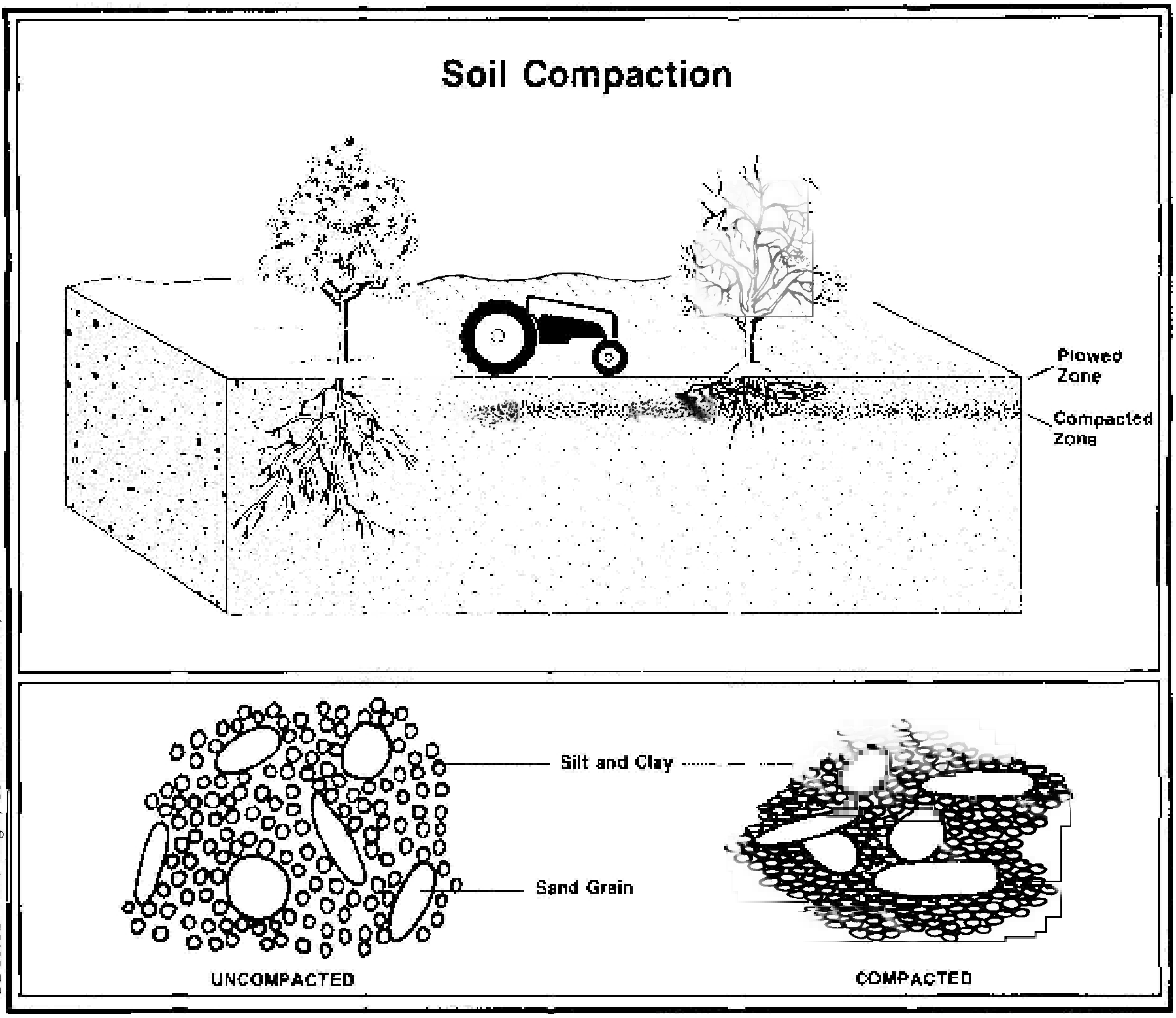
Here, soil erosion has caused onsite and offsite impacts to the environment: eroded topsoil has reduced productivity of crops, sedimentation in the stream has filled-in wetland area, destroyed fish habitat, lowered the water quality, and increased the possibility of flooding.

SOURCE: American Farmland Trust

Soil Compaction

When heavy machines pass over wet soils, the ground compresses, losing some of the tiny pores that normally make up as much as half of its volume. Water and air move less easily through compacted soils, and roots have difficulty pushing through them. Weak root structures make plants less vigorous and less productive.[43] Researchers have documented yield drops for corn, cotton and alfalfa hay growing in compacted soils.[44] Not all soils are equally vulnerable. Soils containing a lot of organic matter don't compress so easily. But most California soils are highly mineral, containing less than 3% organic matter, and pack down readily.[45]

With the trend toward more mechanized farming practices and heavier equipment, compaction increases. During harvest, wheels can pass over 75% of the area of a field.[46]



SOURCE: Mike Singer, University of California, Davis

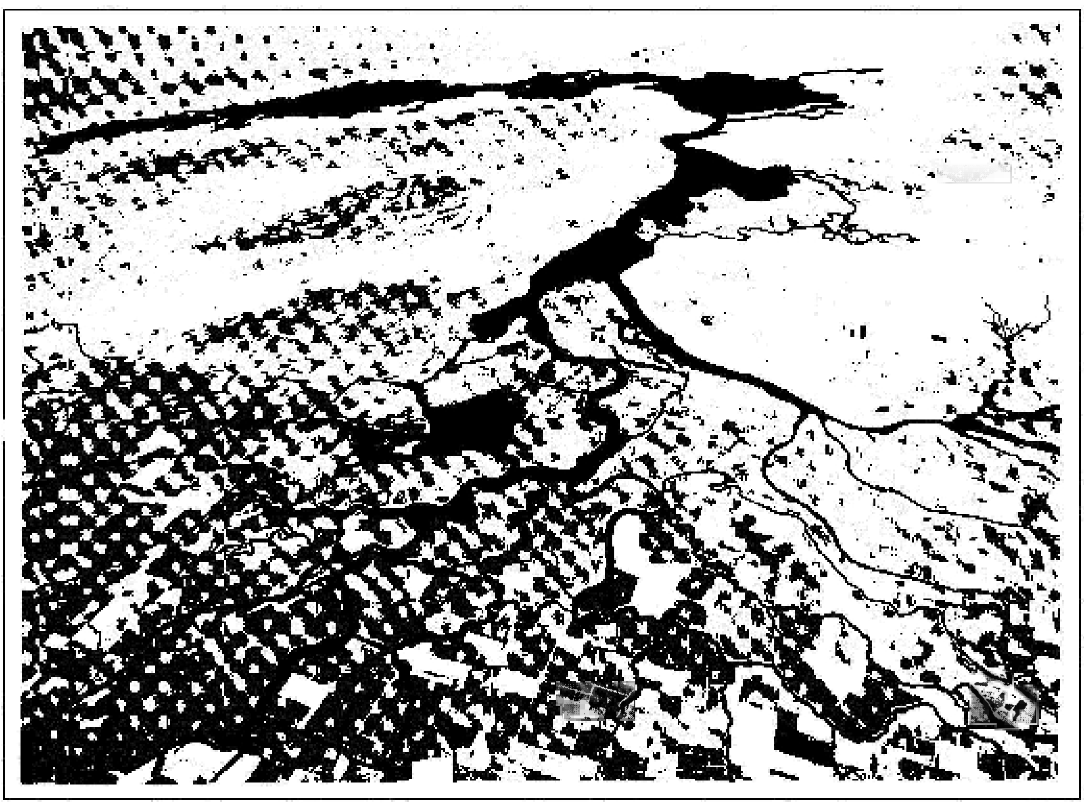
(Growers of certain crops — notably rice, tomatoes, walnuts and sugar beets — use such equipment more than others.)[47] Compaction also occurs on some grazing land wherever herds mill around on small areas. Since compacted ground absorbs less water, the main effect is an increase in runoff and erosion.[48]

The Department of Conservation estimated in 1979, that 2,556,000 acres of California cropland and grazing land are affected.[49] The condition is most widespread in a strip running up the west side of the Central Valley, with a special concentration in Yolo and Colusa counties.[50] Thirty-one percent of the farmland in the Central Coast region is affected, the problem being centered in eastern San Luis Obispo County and adjacent parts of Monterey County. In southeastern California, 24% of the cropland is affected — notably the Imperial Valley and the Palo Verde Valley, where almost all the land is compacted to some extent.[51]

One scientist estimates that two million acres of California land are yielding less because of compaction. According to another report, reducing the vehicle traffic that leads to compaction would extend the life of alfalfa plantings, with an annual savings of more than $20 million to California growers.[52]

The Delta: A Particular Problem

One agricultural region has a unique and intractable problem: the Sacramento-San Joaquin Delta, the rich triangle where many rivers pour into the inland edge of the San



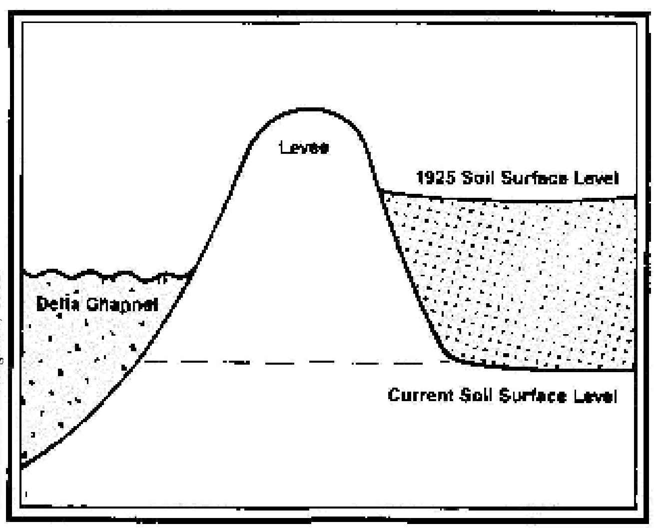
Francisco Bay estuarine system. Before the late 19th century, the Delta was a vast interior wetland. For thousands of years dead marsh-plants accumulated underwater, where, because of the lack of oxygen, they did not fully decompose but formed a layer of organic peat.

Peat soils are rich, and as settlement proceeded farmers began to dike off the Delta, first at the edges, then right through the middle, until what had been a marsh became a patchwork of diked-off islands separated by deep river channels.[53] Peat, however, decomposes when exposed to the air. The decomposition that it did not undergo while underwater now proceeds; the organic matter oxidizes; and the soil seems almost to evaporate. (For years, Delta farmers hastened the process by burning the surface layer every several years for weed control.)[54]

As the peat has disappeared, the level of the land behind the dikes has dropped. Scientists at the University of California at Davis, who have tracked the problem for more than 60 years, have documented a steady loss of between one and three inches a year, depending on location.[55] The ground surface, once at sea level, now lies 10 to 20 feet below the level of the surrounding water.[56] On some islands, 25 feet of peat soils remain.[57] As the fields sink, the surrounding water puts increasing pressure on the aging levees that protect the islands. Levee breaks are becoming more and more frequent and expensive to repair. Several islands have already been abandoned, becoming open water.[58]

Others may follow. How many, and how soon, depends on many factors; a major state or federal effort to stabilize the Delta would change the outlook. Lacking such a program, the Department of Water Resources reports, 21 islands totaling 147,000 acres would eventually have a "high or significant" chance of flooding and remaining flooded, because the cost of reclaiming them would be greater than the local farm districts could bear.[59] Even with a major reconstruction project, the DWR suggests, "a long run view suggests that some permanent flooding may be inevitable."[60]

Soil Oxidation in the Delta



SOURCE: California Department of Water Resources. *Delta Levees Investigation*, 1982.

As the soil has disappeared (oxidized), the level of the land has dropped. The ground surface, once at sea level, now lies ten, fifteen, even twenty feet below the level of the surrounding water.

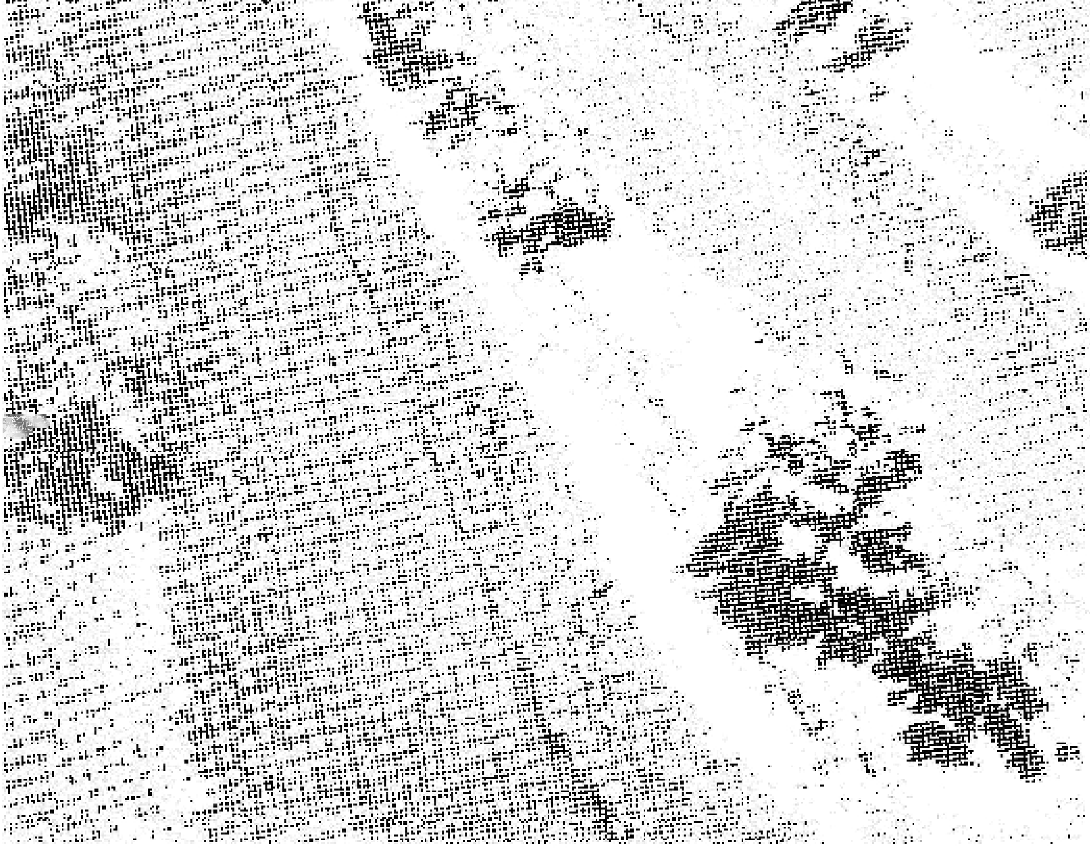
Notes

1. George L. Baker, "Every Day California Loses Vital Topsoil," *Sacramento Bee*,Nov. 10, 1980, p. A-6.
2. U.S.D.A. Soil Conservation Service (SCS), 1982 National Resources Inventory (NRI).
3. U.S.D.A. Soil Conservation Service (SCS), *California Multiyear Plan* (Davis, 1984), pp. 4-1, 4-2, 4-3.
4. SCS, *Multiyear Plan*, p. 4-3.
5. SCS, *Guide for County Resources Inventory* (Davis, 1982), p. 4.
6. SCS, *Multiyear Plan*, p. 4-3.
7. SCS, *Guide*, p. c-5; California Department of Conservation, California Soils: An Assessment (Sacramento, 1979), p. III-18.
8. SCS, *Multiyear Plan*, p. 4-3.
9. SCS, *Multiyear Plan*, pp. 4-3 and 4-5.
10. DOC, *California Soils: An Assessment* (Sacramento, 1979), pp. I-13, III-13, III-18; see also Peter Steinhart, "The Edge Gets Thinner," *Audubon*, November 1983, p. 102.
11. SCS, *Multiyear Plan*, p. 4-3.
12. SCS, *Multiyear Plan*, p. 4-3.
13. George L. Baker, "Death of Our Farmland," *Sacramento Bee*, Nov. 9, 1980, p. A-1.
14. DOC, *California Soils*, p. III-69.
15. D.N. Swanston and C.T. Dyrness, "Stability of Steep Land," *Journal of Forestry* 71:5, May 1973. (Reprint consulted lacks page numbers.) See also DOC, *California Soils*, pp. III-28 through III-34.
16. SCS, *County Resources Inventory: Summary Statistics for Areas of Concern* (Davis: SCS, 1983).
17. DOC, *California Soils*, p. III-19. Ultimate source is State Water Resources Control Board.
18. SCS, *County Resources Inventory*.
19. George L. Baker, "Every Day California Loses Vital Topsoil," *Sacramento Bee*,Nov. 10, 1980, p. a-6.
20. DOC, *California Soils*, p. III-19.
21. SCS, *County Resources Inventory*.
22. DOC, *California Soils*, p. III-18.
23. DOC, *California Soils*, p. III-13. (Original source State Water Resources Control Board.)
24. SCS, *County Resources Inventory*.
25. DOC, *California Soils*, p. I-13.
26. Peter Steinhart, "The Edge Gets Thinner," *Audubon*, November 1983, p. 96.
27. DOC, *California Soils*, pp.I-13 and III-41. Ultimate source is U.S. Geological Survey.
28. DOC, *California Soils*, p. I-13.
29. Steinhart, "The Edge Gets Thinner," p. 96.
30. SCS, *County Resources Inventory*.
31. DOC, *California Soils*, pp. I-16, III-37.
32. DOC, *California Soils*, pp. III-39, III-71.
33. Steinhart, "The Edge Gets Thinner," p. 98.
34. Lester Brown, "Global Loss of Topsoil," in *Journal of Soil and Water Conservation*, May-June 1984, p. 165. See also note 33.
35. Baker, "Every Day," p. 2.

36. DOC, *California Soils*, p. I-13.
37. DOC, *California Soils*, p. III-22 and Appendix B.
38. SCS, 1982 NRI.
39. Edwin H. Clark, II, "The Off-Site Costs of Soil Erosion," *Journal of Soil and WaterConservation*, January-February 1985, pp. 19-22.
40. Steinhart, "The Edge Gets Thinner," p. 97.
41. Clark, "Off-Site Costs," pp. 21-22.
42. Clark, "Off-Site Costs," p. 22.
43. Steinhart, "The Edge Gets Thinner," p. 108
44. DOC, *California Soils*, pp. III-56, III-57 and Appendix B.
45. DOC, *California Soils*, III-53.
46. DOC, *California Soils*, III-57 and Appendix B.
47. DOC, *California Soils*, pp. III-55 and III-72.
48. DOC, *California Soils*, pp. III-21 and III-56.
49. DOC, *California Soils*, p. III-56.
50. DOC, *California Soils*, p. III-75.
51. DOC, *California Soils*, p. III-72, p. III-55.
52. DOC, *California Soils*, pp. III-56, III-57 and Appendix B.
53. Walter W. Weir, "Subsidence of Peat Lands of the Sacramento-San Joaquin Delta, California," Hilgardia, June, 1950, pp. 37-42.
54. Weir, "Subsidence," pp. 50-53.
55. Weir, "Subsidence," p. 42; DWR, *Delta Levees Investigation* (Sacramento, 1982), p. 36.
56. DWR, *Delta Levees*, p. 5.
57. DWR, *Delta Levees*, p. 36.
58. DWR, *Delta Levees*, p. 1.
59. DWR, *Delta Levees*, pp. 16, 32, 153-154.
60. DWR, *Delta Levees*, p. 3.

Soil Salinity and Farm Drainage Problems

On large areas of California farmland, salty water is accumulating in the soil. Hundreds of thousands of acres, especially in the San Joaquin Valley, are in danger of going out of production because of salt buildup in the soil — which slows plant growth or makes it impossible — and high brackish water tables.

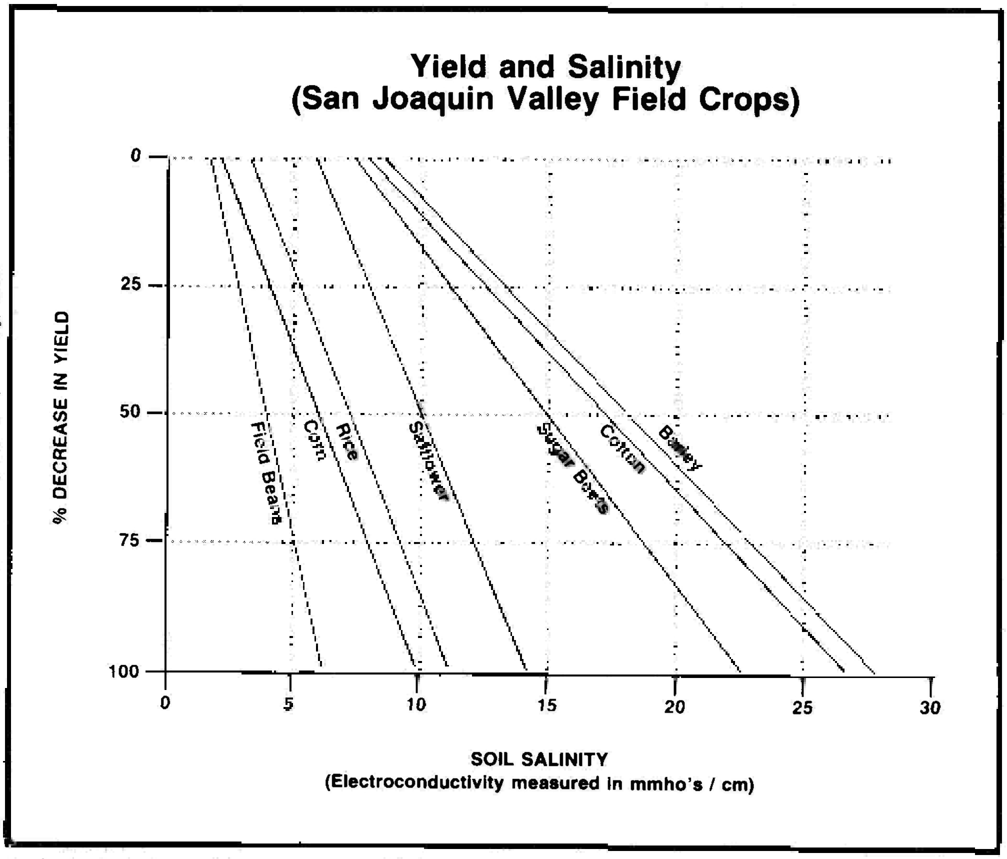


Pervasive Problem

All soils contain salts — sodium chloride (common table salt) and other, related chemicals. In regions with wet climates, rainfall sinking through the ground dissolves the salt from the soil and carries it below the root zone — a process called "leaching." Where rainfall is low, however, as in the regions that yield the bulk of California's agricultural products, such leaching is slight.

The soil itself is not the only source of salt. Some is added as a component of fertilizers and other soil amendments. A great deal is brought in with irrigation water. (All water, like all soil, contains some salt; water taken from the Delta, for instance, contains 350 pounds per acre-foot.)[1] When fields are irrigated, most of the water is used by plants or lost to evaporation. The salt stays behind.

All crops are affected, in some degree, by excessive soil salinity. Among the most sensitive plants are beans, carrots, onions and various fruit trees. Corn, broccoli and alfalfa are three moderately affected crops; cotton and barley are among the most resistant. When there is too much salt in the root zone, yields drop; at still higher concentrations, plants will not grow.[2]



SOURCE: San Joaquin Valley Interagency Drainage Program, *Agricultural Drainage and Salt Management in the San Joaquin Valley*, 1979.

As the level of salt in soil increases, crop yields decrease. Some crops are more tolerant than others to high concentrations of salt. Barley, cotton and sugar beets show no losses in yields at levels where field beans cannot survive.

Various methods are used to keep salt at levels acceptable for farming. The key, in low-rainfall areas, is artificial leaching. In addition to the water needed by the plants, the irrigator applies an extra quantity (about 20%) — the "leaching requirement" — to percolate down through the soil, dissolve the salt and carry it below the root zone.[3] Where drainage is poor, however, the leaching water cannot sink freely through the subsoil; it is here that the real salinity problem begins.

In some areas (notably the Imperial Valley), fine-textured soils resist the passage of water; the ground tends to become waterlogged and salt cannot be leached.[4] In other cases, a layer of clay below the surface of the ground acts as a barrier. Percolating water is trapped above the impermeable layer, forming a "perched" water table, typically very salty. With continued influx from above, the underground pool grows and rises toward the soil surface. When the water table approaches the root zone, water is drawn upward by capillary action and evaporates from the surface, leaving its salt behind where it does the most harm.[5]

When the saline water-line reaches four to five feet below the surface, yields drop 10% or more.[6] A change in cropping patterns may occur as shallow-rooted and salt-tolerant crops are planted. If the water table continues to rise, it becomes impossible for crops to grow at all.[7]

How much land is now affected by salinity? The Soil Conservation Service estimates that 1.6 million acres of irrigated land in California have salinity problems because of poor drainage or a high groundwater table. Another 2.9 million acres have a problem due to naturally saline or alkaline — "sodic" — soils. Some of the 2.9 million acres presumably have poor drainage, too, but the statistics do not indicate how much.[8]

The drainage-related salinity problem is increasing. By the year 2000, estimates the SCS, the acreage showing some sign of salt drainage troubles — either declining yields of salt-sensitive crops or widespread replanting to salt-tolerant ones — will increase by almost half, reaching 2.3 million acres.[9]

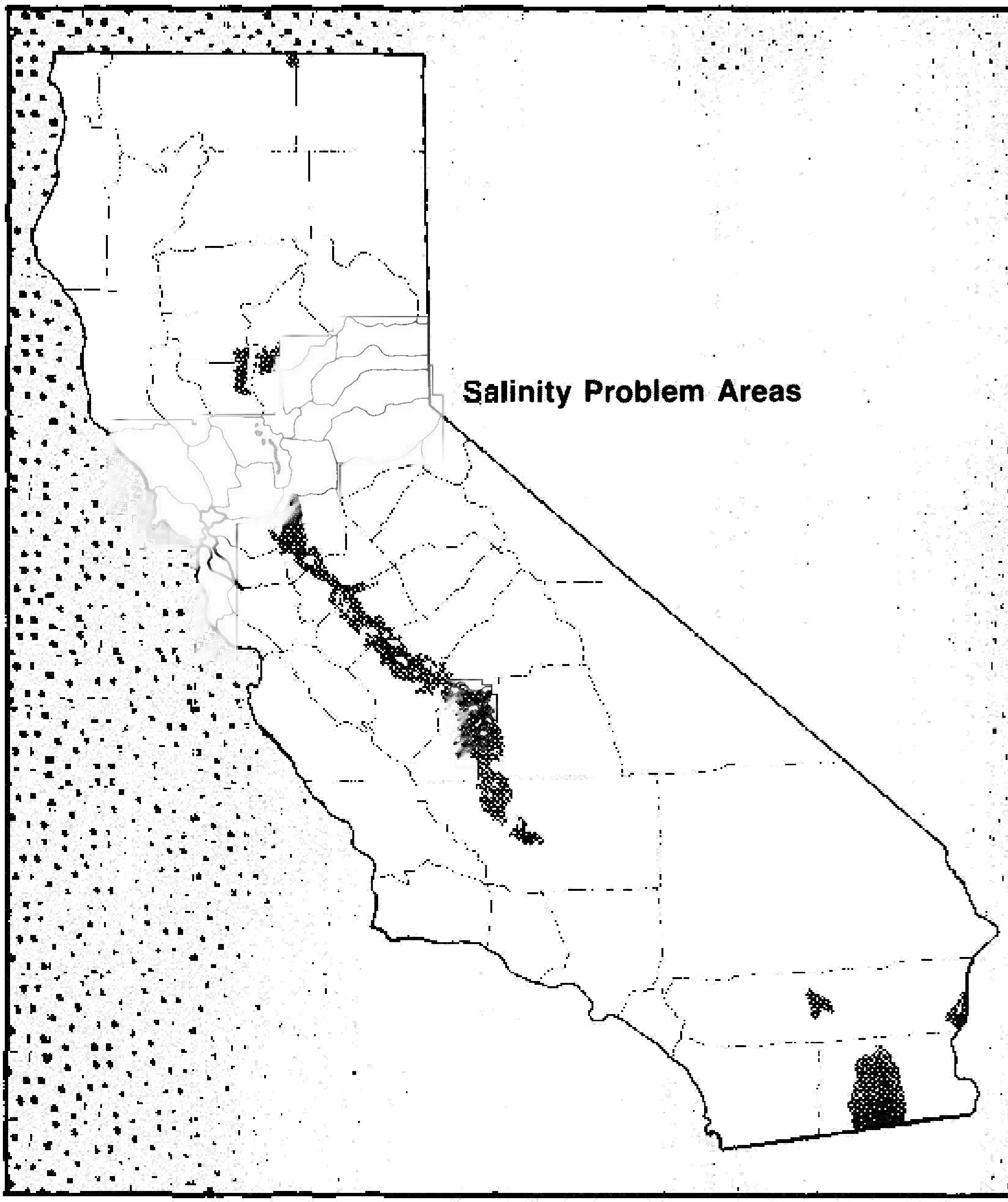
The Affected Regions

Imperial and Coachella Valleys

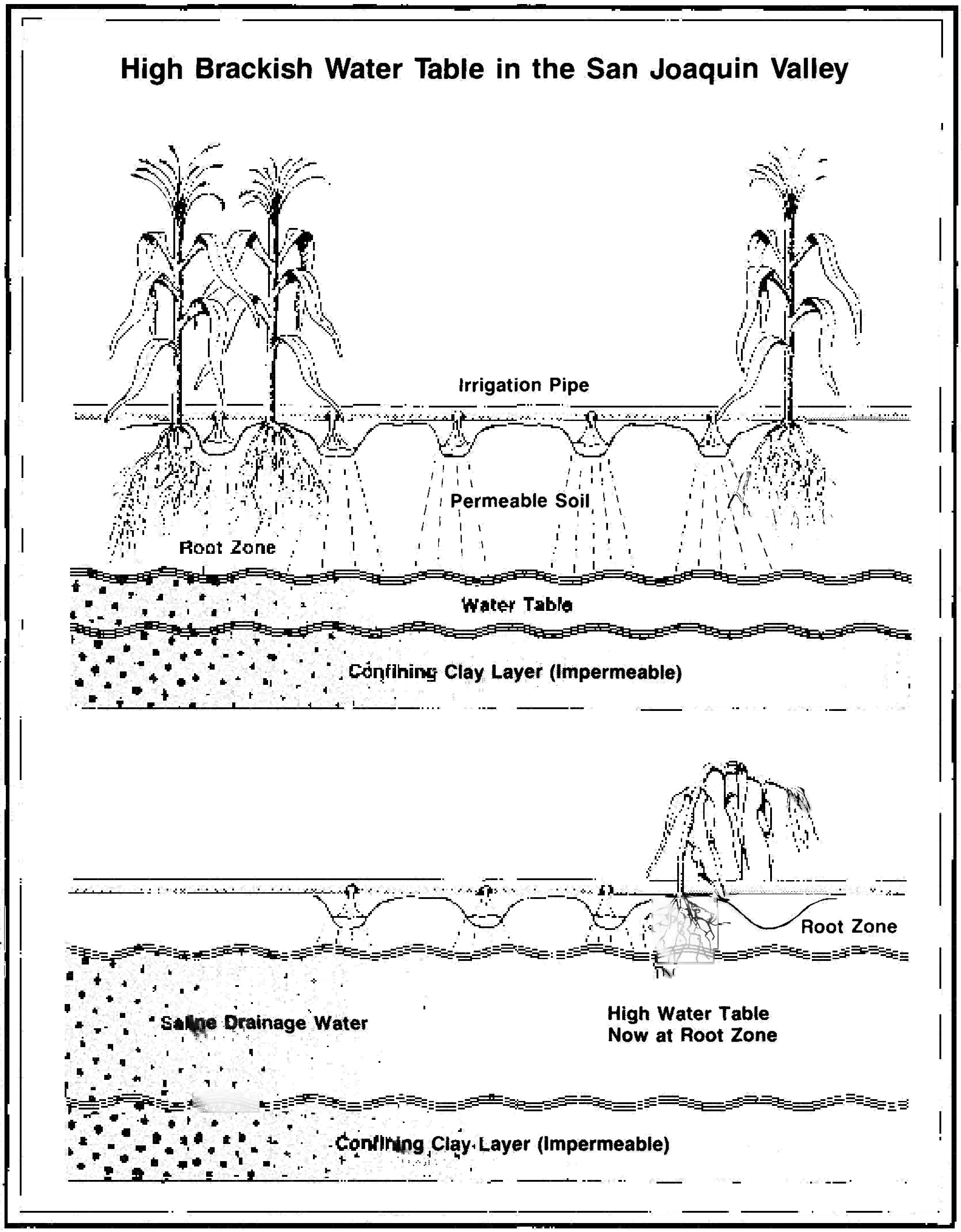
One of the affected regions is the lowland trough east of San Diego that contains the Coachella Valley to the north, the Imperial Valley to the south, and in the middle the desert lake called the Salton Sea. Here there is almost no leaching by rainfall. Soils are not exceptionally salty, but the water applied to them is, flowing from the Colorado River, the most saline major water source in the state.

The Imperial Valley's fine-grained, heavy soils are hard to drain. As early as 1920, a buildup of salty water in the soil was threatening productivity. After trying unsuccessfully for 20 years to deal with the problem, the SCS helped to develop an expensive but effective solution: the installation of a vast underground network of perforated pipes, called tile drains, to carry the brine away.[10] Ninety percent of the Imperial Valley is now so drained.[11] In the Coachella Valley, similar drainage problems have also been remedied by subsurface drains.[12]

Though the situation seems to be under control, the management of salt drainage in the Imperial and Coachella valleys remains a complex problem. An increasingly saline Colorado River could lead to renewed salt buildup in the two valleys.[13] The lower river is expected to become, by the year 2000, a third again as salty as it is today.



SOURCE: Soil Conservation Service, 1982



SOURCE: University of California Cooperative Extension, California Agriculture, October 1984.

Irrigation water percolates through the soil where it accumulates salts. Eventually, it meets the water table which is higher than normal due to an impermeable layer of clay. Additional water flows in from up-slope causing the water table to rise even farther. Eventually, the now saline (brackish) water table rises to within 5 to 10 feet of the surface where it intrudes in the plant's root zone. Few plants can survive in this situation.

The San Joaquin Valley

Rising water tables are a concern for about one-third of all irrigated land in the San Joaquin Valley.[15] No easy solution has yet been found. Along one side of the valley, from the lowest part westward, layers of impermeable clay lie below the surface, typically about 40 feet down.[16] Prolonged irrigation brings groundwater trapped above the barrier toward the soil surface. According to the Department of Water Resources, water is now within 20 feet of the surface on 1,580,000 acres, and within five feet of the surface, the critical level, on 650,000 acres.[17] The acute problem area is expected to exceed one million acres within the next 50 years.[18]

Consider the case of the Westlands Water District. This section on the west side of the valley was semi-desert until the late 1960s, when Central Valley Project water began to pour onto the land. Today, more than 260,000 acres in the Westlands have water less than 20 feet below the surface;[19] on 151,000 acres, the water table is less than 10 feet down.[20] And the critical five-foot level has been reached on 45,000 acres.[21]

The solution, at first glance, is the same as in the Imperial/Coachella region: install subsurface drains. But some special problems complicate the situation. (See **Other Impacts** section.)

Impacts: Reduced Productivity

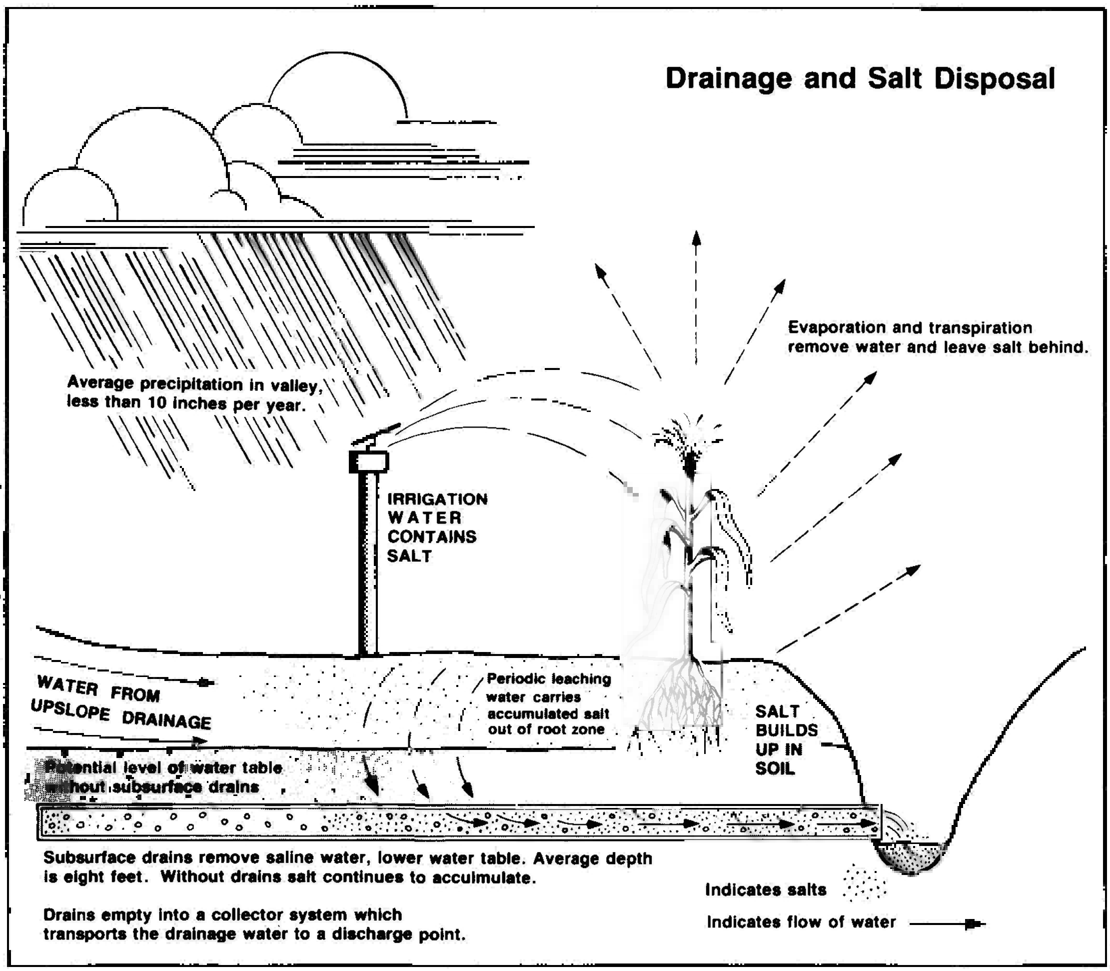
Saline drainage water problems already are cutting crop yields markedly in California, with greater reductions likely unless action is taken. In 1979, lost production statewide was estimated at over $30 million a year.[22] In 1982, Westlands alone estimated losses at $17 million,[23] with reductions of more than $200 per acre on the critical acres.[24] The 1979 report of the state-federal Interagency Drainage Program projected annual crop losses of more than $300 million statewide by the year 2000.[25]

The worst possible impact, of course, is for land to go out of irrigated production completely. While there are no reliable statewide statistics, it is clear some land is fallow today because of salt problems, and much more is threatened. The Kern County Farm Advisor says that 10,000 acres had been retired in that county by 1982.[26] In the Tulare Lake Basin, 17,000 acres are expected to go out eventually if the problem is not solved.[27] In a 37,000 acre problem area in Kings County, a 1983 SCS study predicted, about 27,000 acres of cotton and barley land will revert to native vegetation and pasture by 2025 — unless corrective action is taken. Production loss: at least $12 million. And cotton and barley are among the least sensitive of crops.[28] The U.C. Cooperative Extension estimates that 100,000 acres could be lost by 1990 if solutions are not found.[29]

Other Impacts

The solutions to farm drainage problems produce certain costs and impacts of their own, sometimes in areas far removed from the salinized fields. Tile drains are expensive to install; the salty water removed from the fields must be disposed of somewhere, at further expense; and in some cases contaminants in the drainwater make its safe disposal all the more difficult.

The tile drain idea in outline is simple. Trenches are dug and a system of perforated pipes is laid six to 10 feet below ground. (Early drains were made of clay tile; today they are commonly plastic.) When soil water rises to the level of the drains, it flows through them to larger collector pipes, which in turn lead to an underground sump. From the sump, the water is pumped to the surface for discharge.[30]



SOURCE: U.S. Bureau of Reclamation, *Drainage and Salt Disposal Information Bulletin*, 1981

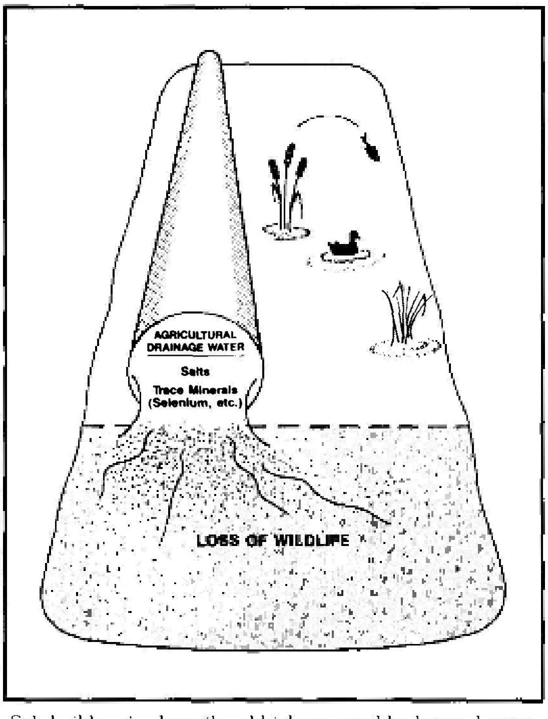
As the irrigation water percolates through the soil, it accumulates salts. The subsurface tile drains remove the saline water before it reaches the water table.

Where to discharge is the next issue. Some drainage waters, only mildly saline, can be reused; others cannot.[31] In the Coachella and Imperial valleys, disposal is relatively simple: drainwater flows into the New and Alamo rivers and thence into the Salton Sea. There are some unplanned effects, though. One is the growing salinity of the sea, itself a valuable resource for recreation. As salt drains into it (five million tons a year) it may become too saline to support fish and the sport fishing industry that depends on them.[32] A second problem is that the sea, swelled by agricultural drainage, has been rising and now is flooding some adjacent properties. It is hoped that valley farmers can cut discharge to the lake by lining canals to cut leakage and by refining irrigation practices, saving water while still applying enough to leach the salt from the soil.[33] However, such action, reducing the sea's intake of water but not its intake of salt, will make it even more saline.[34]

In the San Joaquin Valley, solutions to the drainage problem cause numerous impacts. Agricultural wastewater from 82,000 acres is being discharged into the Kings and San Joaquin rivers,[35] but water quality standards put a limit on river discharges.[36] Other solutions are more complex. One option is to put the drainage water in ponds and let it evaporate. (Such ponds are already serving some 87,000 acres in the Tulare Basin.)[37] Ponding requires a lot of land. Since little non-agricultural land is available for ponds, some cropland must be sacrificed. Estimates vary but the consensus seems to be that 15% to 20% of cropland in areas served by ponds would have to be devoted to them.[38] In 1979, the land requirement for a valley-wide system was estimated at 100,000 acres in the year 2000,[39] growing ultimately to 188,000 acres.[40]

Another solution would be to drain the wastewater via a massive canal to the inner end of San Francisco Bay. This Valley Drain, also known as the San Luis Drain, would be 290 miles long, beginning near the southern tip of the valley and ending at Suisun Bay, the middle link in the San Francisco Bay-Delta estuarine system.[41] An 82-mile portion of this ditch has been completed, ending not at the Bay but at Kesterson Reservoir north of Los Banos [42] and serving just 42,000 acres of land in the Westlands Water District.[43] For various reasons, including its expense and fears that the salty effluent might upset the delicate balance of salt and fresh water in the Bay-Delta system, the project has been controversial and has not moved forward.[44] A more ambitious variation on the same plan

Impacts of Saline Drainage Water



SOURCE: American Farmland Trust

Salt build-up in the soil and high water tables lower the productivity on California cropland. When the salts and other minerals (selenium) leave the farm in the drainage water, rivers and other water bodies can be polluted causing loss of wildlife and decrease in water quality.

would pump the water across the coast ranges and discharge it into the ocean at Monterey Bay or at Estero Bay near San Luis Obispo.[45] Other alternatives, including desalinization of the drainage water and its use in power plant cooling, have been explored but are not yet large-scale solutions.

The Kesterson Dilemma

In some areas, the disposal problem is especially difficult because the drainage water contains not only salt but also potentially toxic substances leached from the soil. This aspect of the salt drainage problem, only recently understood, has caused a rethinking of the issue and a reassessment — upward — of the costs of solving it.

Soils in parts of the San Joaquin Valley, mostly on the west side, contain trace minerals including boron, chromium, arsenic, mercury, nickel and selenium.[53] Several of these are known or suspected to be poisonous when concentrated; all are picked up from the soil by drainage water. Of special current concern is selenium. Though a necessary trace element for plant growth, selenium in large quantities is both a toxin and a mutagen.[54]

It was at Kesterson Reservoir, current terminus of the incomplete San Luis Drain, that these problems first made news. In Kesterson, evaporation produces a brine rich in selenium and other suspect elements.[55] In 1983, the Fish and Wildlife Service documented deaths and deformities in waterfowl there.[56] The Kesterson ponds, never designed as the final destination of the water, are not lined; water has been escaping,[57] and there is fear of contamination in local groundwater and elsewhere.[58] Concern about this leakage has prompted the Department of the Interior to order a shutdown of disposal at Kesterson after the 1985 harvest.

Meanwhile, the search for solutions goes on. One option — to clean up past contamination and double-line the Kesterson ponds for continued use — would cost at least $500 million.[59] About 250,000 acres of soils are thought to contain the potentially toxic minerals. It has been suggested that the most economical way of solving the toxic drainage problem would be to buy the high-risk land, for $650 million to $875 million, and retire it from production.[60]

No Cheap Way Out

All of these options are expensive. Tiling fields costs $400 to $800 per acre. Farmers tend not to make this investment until the problem becomes acute; only about 10% of the afflicted farmland on the west side of the San Joaquin Valley now has drains installed.[46] Use of the Salton Sea as a drainage sump has economic costs. Damage caused to adjacent properties by rising water has been in the millions of dollars and legal actions against the Imperial Irrigation District have resulted. The sport fishery of the sea, which may disappear if the water becomes more saline, also has an economic value.[47]

Evaporation pond costs vary. Ponds that are unlined or lined only with clay are the least expensive; even these may cost $100 to $150 for each acre they serve. If the effluent contains toxic substances, the ponds may have to be double-lined with impermeable materials and equipped with leak-detection systems; the expense would be prohibitive.[48] The U. S. Bureau of Reclamation estimates the cost of building unlined or clay-lined ponds for all problem areas in the valley at between $1 billion and $4 billion; the cost of the same ponds, double-lined, would be $13 billion.[49]

Completing the San Luis Drain, recently estimated to cost about $1 billion, might reach $4 billion.[50] The other canal alternative, to send water over the coast ranges to the sea, would cost an estimated $5 billion before water began to flow; once built, the energy cost of pumping would be great.[51] A final option — processing the water to remove the salt — would require an estimated $4 billion to launch.[52] Since it no longer seems much more expensive than the other possibilities, desalting may get more attention.

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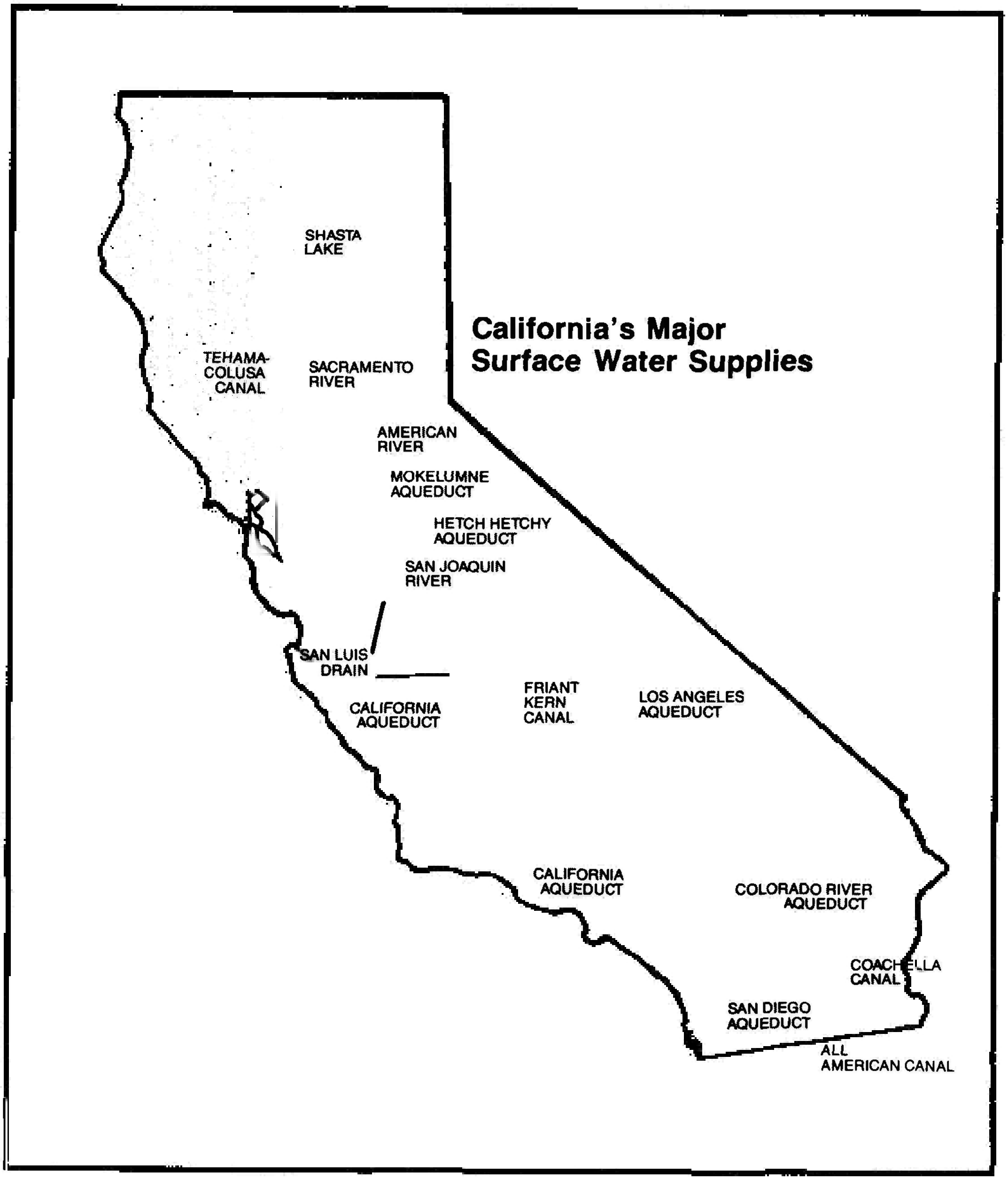
Agricultural Water Supply

In its use of water, California is more a farm state than an urban state. Agriculture currently uses approximately 83% of the state's developed water supply: 28 million acre-feet in a hypothetical "average" year. (An acre-foot contains 326,000 gallons.) Some of its most productive land is in regions that get less than 10 inches of rain a year; yet on these lands we grow crops that require an average of two or three feet of water a year. Some crops need 30 feet of water.

About 75% of California's water comes directly from rivers and lakes, by way of the major governmental water projects. The remainder is groundwater.[3] Since the development of California water began, agriculture's share expanded [illegible] new water projects [illegible] have come under irrigation. In [illegible] 3 million;[4] by 19[illegible] million.[5] The price [illegible] most farmers, water [illegible] list of the costs of doing business.

However, the days of steady expansion of surface water supplies appear to be over, [illegible] are on the way up. New [illegible] ducts are increasingly expensive to build. Meanwhile, groundwater levels are declining in large areas; as water tables drop, pumping costs increase and groundwater becomes more expensive.



SOURCE: Western Water Foundation

Surface Water Supplies

In a typical rainfall year, about a third of the water that runs from the mountains of California (or enters the state in rivers) is diverted to farms and cities.[7] More than half the developed supply comes from the vast watershed of the Central Valley: from the Sacramento, the San Joaquin, the Kings, the Kern rivers and their tributaries. About one-sixth comes from the Colorado. The remainder comes from the east slopes of the Sierra and from various coastal streams.[8]

The biggest single water supplier is the Bureau of Reclamation's Central Valley Project with a 1980 yield of 7.1 million acre-feet. Most of that water goes to agriculture. The core of the project is Shasta Dam on the upper Sacramento; additional dams tap many other rivers. The Bureau of Reclamation also operates the reservoirs on the lower Colorado from which just under 4 million acre feet are diverted, via the All-American and Coachella canals, to the Imperial and Coachella valleys:[9] Other federal water projects scattered around the state contribute another 1.1 million acre-feet to the supply.[10] Total federal surface water: 12.2 million acre-feet.[11]

The smaller State Water Project (SWP) has fewer reservoirs (its one major dam is on the Feather River above Oroville) but longer aqueducts. It is designed partly to serve urban areas, and much of the water it captures is pumped south over the Tehachapi Mountains to the Metropolitan Water District of Southern California. Current yield: 2.3 million acre-feet.[12] The remaining 11 million acre-feet of surface supply is provided by local water districts or taken directly from streams by riparian landowners.[13]

The Rising Cost

The cost of water from these facilities varies tremendously. Recently developed sources generally are much more expensive than older ones; water costs also tend to rise from north to south. The average agricultural water price in Shasta County is $5 per acre-foot; in Kern County it is $31; and in San Diego County it is $145.[14]

In 1985, charges to contractors for the Central Valley Project run from $3.50 to $15 per acre-foot. State Water Project rates for agriculture are higher; in 1985 they range from $34 to $73, with an average of $51.[15]

The cost of water from existing projects will be rising. Central Valley Project rates will go up as contracts expire and are renegotiated in the 1990s, doubling or tripling in most areas by the turn of the century (but remaining below $20). State prices are taking a similar leap in the 1980s; the acre-foot price charged the Kern County Water Agency, for instance, will jump from $29 (1980) to $120 by 1990.[16]

Any *new* waterworks that are built will deliver water at much higher cost than older ones. The best dam sites are already developed; construction costs tend to climb much faster than inflation; and federal funding is drying up. Higher interest rates have also contributed to the price spiral.[17]

It cost the state $37 (in 1980 dollars) to create each acre-foot of perennial annual yield from Lake Oroville, the first SWP reservoir. An acre-foot of yield from the Cottonwood Creek Project in the northern Sacramento Valley, the project most likely to be constructed next, will cost more than $200 per acre-foot to develop.[18]

The recent proposal for the Cross-Delta Facility, a channel to move project water more efficiently from north to south through the Sacramento-San Joaquin Delta, would have made 400,000 acre-feet a year available, at a cost of $180 million — $450 per acre-foot of yield.[19] To recover its investment and pay other costs incurred in moving the water south, the state would have had to collect $167 per acre-foot for this water from agricultural users.[20] (Because of the practice of "average pricing," by which new, expensive supplies are pooled with previously developed, cheaper water, the actual price for any given contractor would be less than that.) An earlier, more elaborate idea for Delta transfer, the Peripheral Canal, would have cost at least $868 million.[21]

There are other examples, but the pattern is clear: prices for surface water are on the way up, and if steps are taken to expand supply, the average cost will climb still faster.

The Kern County Shortfall

The State Water Project has a reliable annual yield of 2.3 million acre-feet; but when it was launched its planners were confident of rapid expansion beyond that point. In fact, the state signed contracts with agricultural and urban water districts promising a steady increase in deliveries, reaching 4.1 million acre-feet by the year 1990.[22] However, the SWP has not grown as planned, and clearly will not be adding much capacity soon. Moreover, its yield is expected to drop somewhat as local water use increases in the areas from which it draws.[23]

To this point, the shortfall has not mattered. The urban areas served by the project have added population more slowly than predicted; the water the cities don't need has been given to the farms, and no one has been shorted.

The state's largest urban water customer, by far, is the Metropolitan Water District of Southern California, which is now entitled to 1.6 million acre-feet; the largest agricultural contractor is the Kern County Water Agency, currently entitled to just over 800,000 acre-feet.[24] In 1982, the MWD actually took delivery on less than 700,000 acre-feet. The water not needed in the south stayed in the north, giving the Kern County Water Agency its full entitlement for the year.[25]

This situation is due to change. Population growth in Southern California, if slower than once anticipated, continues. Also, the MWD stands to lose a portion of its current supply from the Colorado River (as Arizona increases its diversions from that stream). Expected result: the MWD will draw more of the limited state water, leaving less for other contractors.[26] Add to this the expected decline in project yield, and it appears that agricultural customers, particularly the Kern County Water Agency, could be pinched in some dry years.

What would be the effects? The Department of Water Resources predicts a slight drop in irrigated acreage at the southern end of the San Joaquin Valley and an increase in the northern part. More grains and less cotton would be planted. The most disturbing result would be still greater use of groundwater and a rise in overdraft.[27]

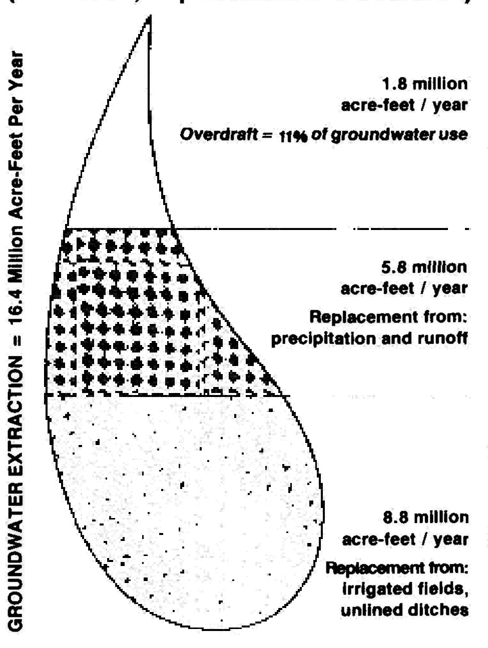
Groundwater

In large parts of California, agriculture depends on groundwater, either solely or in conjunction with surface supply. For groundwater to accumulate in usable quantities, there must be large subterranean beds of sand and gravel. Such beds, called aquifers, underlie about 40% of the state, including most of the cropland areas. The aquifers contain a huge quantity of water: 857 million acre-feet.[28] How much of this water could be extracted is not known; estimates run as high as 500 million acre-feet.[29]

California farmers annually pump 16.4 million acre-feet from the state's aquifers; 5.8 million acre-feet flow back into the aquifers from precipitation and runoff — the natural recharge. Another 8.8 million acre-feet sink back from irrigated fields, from unlined transportation ditches, and through deliberate recharge programs. Net effect: a loss to the groundwater stock, or overdraft, of 1.8 million acre-feet a year.[30] Statewide, agriculture is relying on overdraft to meet about 6% of its total needs and 11% of its groundwater needs.[31]

Because water is already stored in the aquifers, this overdraft can go on for many years in most areas without exhausting the supply. The fact remains that agriculture is maintaining its annual water income by drawing down its water savings. The effects of this situation vary from case to case.

California Agricultural Groundwater
(Extraction, Replacement and Overdraft)



SOURCE: California Department of Water Resources, *Bulletin 160-81.*

Sustained Yield and Conjunctive Use

Used carefully, an aquifer can be part of a water system that delivers a reliable water supply year after year, in flood and in drought. But there must be some control on the amount of water extracted. In some cases, the yield will be limited to the amount replenished each year by natural recharge. In others, where an aqueduct or river provides surface water, the aquifer can be used as a reservoir, storing the excess surface flows of wet years and yielding that surplus back in times of drought. An aquifer and an aqueduct used together — conjunctive use — provide a larger reliable water supply than the same facilities used separately.

From the point of view of conjunctive use, the most valuable resource in an aquifer is not the water it holds but the empty storage space at the top: room enough, in California aquifers today, for 161 million acre-feet.[32] Local water management agencies in California are storing more than 2 million acre-feet of water in aquifers each year.[33]

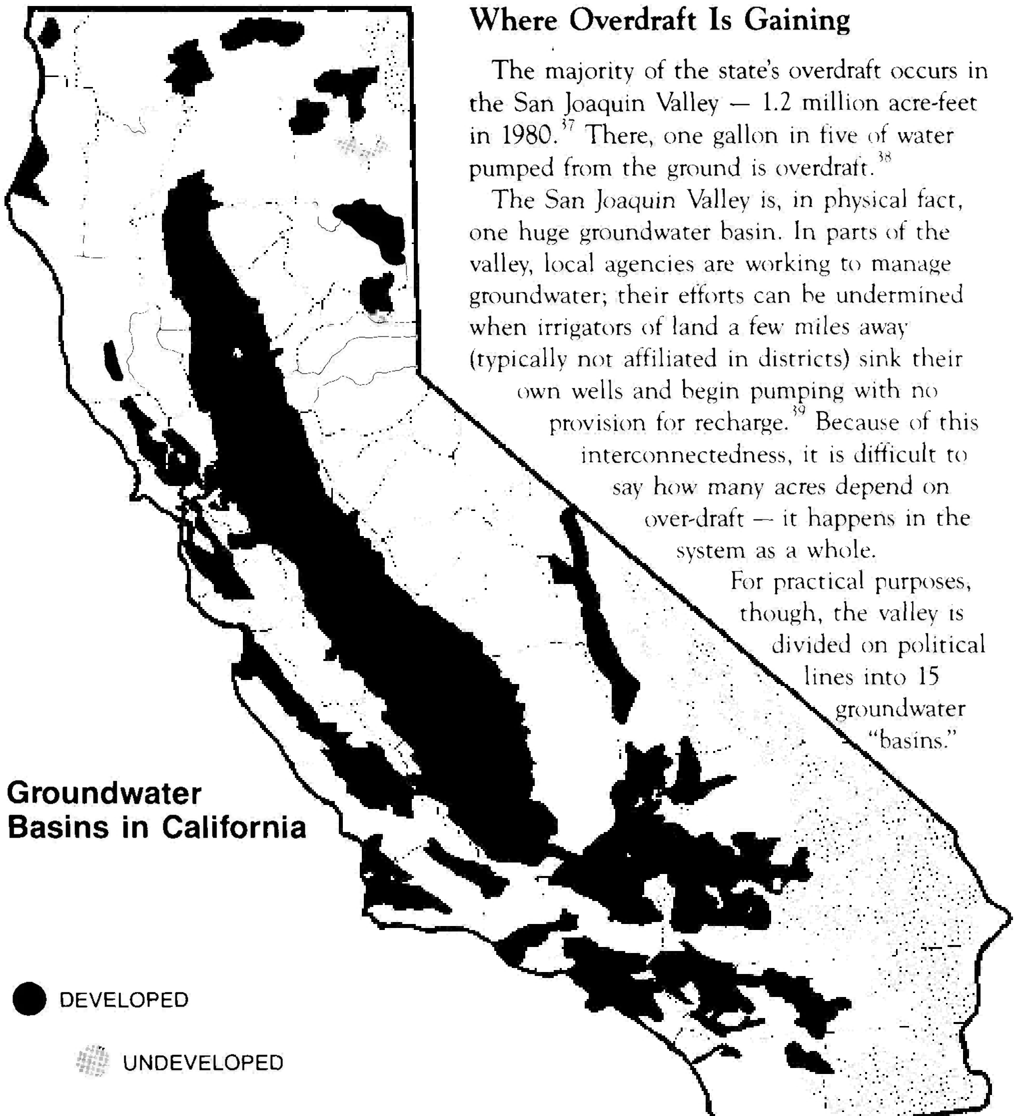
In much of the state, especially in coastal urban areas, aquifers are being managed for sustained yield.[34] At Santa Barbara, for instance, water agencies use groundwater chiefly as a backup: in wet years, they rely on surface streams; during droughts, they draw on their groundwater reserves.[35] Something similar is being attempted in parts of the Central Valley, including for instance the area served by the Madera Irrigation District.[36] However, in vast areas, including much of the San Joaquin Valley, sustained yield management is not in place. Water is being pumped out of aquifers faster than natural and current artificial recharge can replenish it.

Where Overdraft Is Gaining

The majority of the state's overdraft occurs in the San Joaquin Valley — 1.2 million acre-feet in 1980.[37] There, one gallon in five of water pumped from the ground is overdraft.[38]

The San Joaquin Valley is, in physical fact, one huge groundwater basin. In parts of the valley, local agencies are working to manage groundwater; their efforts can be undermined when irrigators of land a few miles away (typically not affiliated in districts) sink their own wells and begin pumping with no provision for recharge.[39] Because of this interconnectedness, it is difficult to say how many acres depend on over-draft — it happens in the system as a whole.

For practical purposes, though, the valley is divided on political lines into 15 groundwater "basins."



SOURCE: State of California, California Water Atlas, 1978

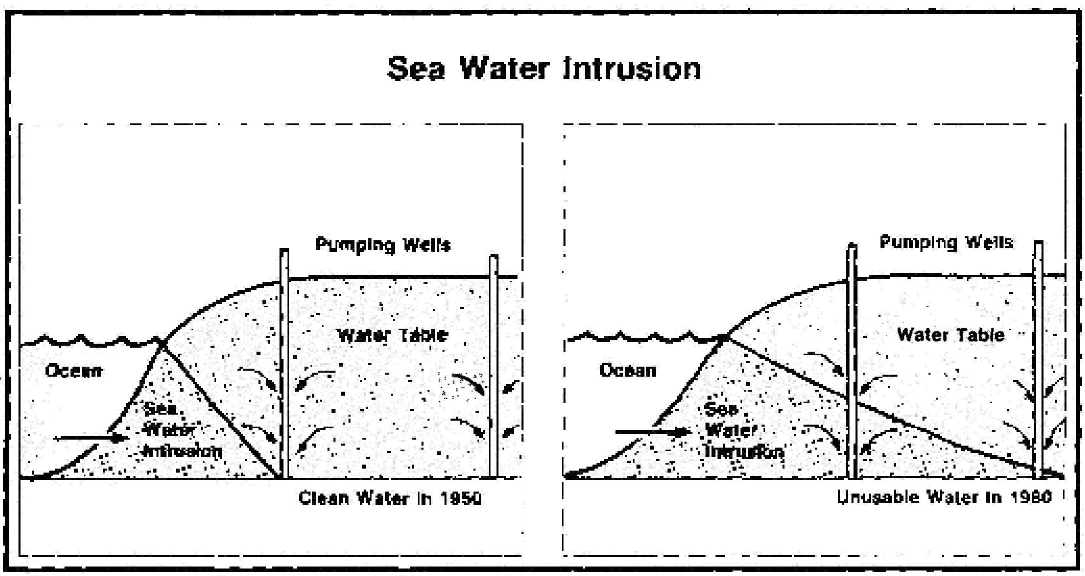
In eight of these basins, DWR reports, overdraft is "critical."[40] More than 2 million acres in these areas are irrigated by groundwater.[41] DWR projects that irrigated acreage in these areas will continue to grow and that overdraft in the valley will increase to 2.4 million acre-feet, or more, by 2010.[42]

Outside the Central Valley, the problem afflicts smaller areas, but often in a more acute form. In some isolated Coast Range groundwater basins, sustained yield management of groundwater is not a possibility: natural recharge is tiny and no source of water for artificial recharge is available. In these cases, the water in the ground is being mined, like a mineral; when it sinks below the level from which it can economically be pumped, irrigated agriculture will end.[43] The largest such area is the Cuyama Valley inland from Santa Barbara, where 13,000 acres are now irrigated.[44]

Sea Water Intrusion

Another special case arises in shoreline areas. If an aquifer next to the ocean is partially emptied, sea water may seep in to fill the void, making the water in wells brackish. Sea water has invaded 14 important coastal basins and is suspected to be in 14 others.[45] Techniques have been developed to head off the intrusion; most involve injecting fresh water into the aquifer or slowing the rate at which water is pumped out. In some areas, the intrusion has been halted or reversed.[46]

Intrusion remains a "critical" problem in the Pajaro and Salinas valleys along the Central Coast and in the Oxnard Plain in Ventura County, all important agricultural areas.[47] Intrusion is also extensive along the northern edge of the San Francisco Bay estuary, in the lower parts of the Petaluma Valley, the Sonoma and Napa valleys, and the Suisun Valley. In these areas, salt water infiltrates



SOURCE: California Department of Water Resources, *Sea Water Intrusion in California*, 1975.

As fresh water is pumped to irrigate crops and service urban areas near the coast, sea water intrudes into the aquifer, leaving it unusable.

from the many tidal channels when summer pumping lowers the level of fresh water in the aquifers.[48]

It is not known how many acres are affected by sea water intrusion. A general idea of the area of concern, however, may be derived by noting how far inland, in each basin, intrusion has been detected and estimating how much land in the basin lies that close, or closer, to the shore. Using this yardstick, it appears that 38,000 acres in the Pajaro and Salinas basins[49] and 20,000 acres in the Oxnard basin[50] may lie in the potential danger zone. Not all this land, of course, is irrigated cropland. The North Bay areas where intrusion has been noted are extensive; in 1975, DWR estimated, very tentatively, that as much as 170,000 acres might be affected. The data, however, are spotty.[51]

The Cost of Overdraft

Why worry about overdraft? Despite the previously mentioned isolated cases, there is no danger that large groundwater basins will "go dry" in the foreseeable future. But extracting water from those basins may become expensive — even prohibitively so — as overdraft goes on.

The key is the energy expense of lifting water from increasing depths. In 1982, pumping costs in the San Joaquin Valley were 20 to 30 cents per acre-foot for each foot of lift. The total cost ranged from about $10 per acre-foot where the water is near the surface to $40 per acre-foot where it lies 400 feet down. In a few areas, lifts already are approaching 800 feet.[52]

Every groundwater basin, economists say, has an optimum level at which the water table should be stabilized — a level that allows for the best combination of present farm income and future energy savings. If overdraft is not curtailed eventually, the water in many California aquifers will sink not only to that point but well below it.[53]

Economist Richard Howitt, in a 1979 study of four of the San Joaquin Valley basins where the DWR calls overdraft "critical," found two contrasting situations. In two basins — Madera and Kings — the optimum level was still three decades or more away; he saw ample time to plan for a slow transition to sustained yield. But in the two other basins studied — Tule and Kaweah — the optimum point would be reached much sooner — by 1991 in Tule, by 1997 in Kaweah. Such calculations depend on various assumptions about energy prices, inflation and other factors; if different assumptions are made, Howitt noted, it might be concluded that Kaweah and Tule had already pumped beyond the optimum point.[54]

If the water level keeps sinking, pumping costs eventually will rise so high that some crops — those requiring the most water per dollar of market value — become unprofitable to grow. Then water use will drop and the water table will stop falling. Sustained yield will have been achieved. But this stable situation will be less satisfactory than the one that might have resulted if overdraft had been stopped sooner. Groundwater will cost much more; some land will not be planted; some crops will not be grown.[55]

Such a situation has another significant drawback. When the water table stabilizes at a very low level, a region loses some of its protection against drought; it is no longer practical to make up for a temporary lack of surface water by extracting more from the ground. (Such pumping helped the San Joaquin Valley ride out the drought of 1976-77 with little harm done.)[56]

In the Central Valley, this unattractive outcome is not imminent — probably 30 years or more away if present trends continue.[57]

Elsewhere, the effects may be apparent sooner. Two agricultural regions where production is expected to decline because of falling groundwater levels and rising energy costs are the Antelope Valley east of Los Angeles and Butte Valley in northeastern Siskiyou County.[58]

The Outlook

California agriculture is not running out of water. But the price of water on the farm, whatever the source, seems sure to rise; additional supplies — whether skimmed from rivers or pumped from the ground — will become increasingly expensive.

Moderate price increases, it is argued in some quarters, might be healthy in certain regions. But very high water prices are unlikely to be welcomed anywhere. High prices limit the range of crops that farmers can afford to grow. They tend, of course, to encourage water conservation; but they tend even more strongly to drive land out of production. When prices are high, economist Howitt notes, farmers often find it more profitable to cut back on irrigated acreage than to invest in conservation measures.[59]

Where urban growth is competing with agriculture for land, high water prices can and do help push farmland over the edge into conversion. This pressure is evident in Ventura County, San Diego County and elsewhere.[60]

The best hope of keeping price increases affordable to farmers would seem to lie in the efficient use of existing water supplies and, most particularly, in the careful management of groundwater. Sooner or later, overdraft will end and California agriculture will be functioning on a secure and relatively fixed water income. The sooner that point is reached, the cheaper water will be and the smaller the amount of land the industry risks losing to profitable use.

Notes

1. California Department of Water Resources (DWR), *The California Water Plan: Projected Use and Available Water Supplies to 2020, Bulletin 160-83* (Sacramento, 1983), p. 168.
2. *California Water Plan*, p. 31.
3. *California Water Plan*, p. 62.
4. Frank H. Bollman, *Regional Shifts since 1980 in the Production of Vegetable, Fruit, and Nut Crops: California and Arizona*, 1979. Unpublished technical paper, prepared for the U. S. Water Resources Council as a contribution to the *National Agricultural Lands Study*.
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6. DWR, *California Water Plan*, p. 139.
7. DWR, *California Water Plan*, p. 176.
8. DWR, *California Water Plan*, pp. 84, 188.
9. DWR, *California Water Plan*, p. 84.
10. DWR, *California Water Plan*, p. 186.
11. DWR, *California Water Plan*, p. 84.
12. DWR, *California Water Plan*, p. 72.
13. DWR, *California Water Plan*, p. 84.
14. DWR, *California Water Plan*, p. 82.
15. DWR, *Management of the California State Water Project, Bulletin 132-84*, (Sacramento, 1984), Tables B-22 and B-5B.
16. DWR, *California Water Plan*, p. 138.
17. DWR, *California Water Plan*, pp. 257-8.
18. DWR, *California Water Plan*, p. 258.
19. David N. Kennedy, DWR, "Plans for Delta Water Transfer," transcript of remarks to the Senate Committee on Agriculture and Water Resources, April 10, 1984, p. 5.
20. Senate Office of Research, *Who Pays and Who Benefits: Water Development in California (Issue Brief)* (Sacramento, 1984), p. 16.
21. DWR, *The California State Water Project — Current Activities and Future Management Plans, Bulletin 132-81*, (Sacramento, 1981), pp. 140-41.
22. DWR, *California Water Plan*, p. 201.
23. DWR, *California Water Plan*, p. 149.
24. DWR, *Management of the California State Water Project, Bulletin 132-83*, pp. 200-201.
25. DWR, *Management of the California State Water Project Bulletin*, *132-83*, pp. 201, 203, 213, 215.
26. Michael Storper and Richard A. Walker, *The Price of Water: Surplus and Subsidy in the California State Water Project* (Berkeley: U.C. Institute of Governmental Studies, 1984), pp. 3-4.
27. DWR, *California Water Plan*, p. 149.
28. DWR, *California Water Plan*, p. 76.
29. DWR, *California Water Plan*, p. 251.
30. DWR, *California Water Plan*, p. 88.
31. Derivation of 6% figure: 1.8 million acre-feet of overdraft (almost all in agricultural areas) divided by 28.0 MAF used by agriculture (see note 1). The 11% figure is derived by dividing the 1.8 MAF of overdraft by the 16.4 MAF of groundwater extracted.

32. DWR, *California Water Plan*, p. 76.
33. Helen J. Peters, *Ground Water Management in California* (American Society of Civil Engineers, 1982), conference preprint 82-035, p. 12.
34. Helen J. Peters, "The Variety of Ground Water Management Strategies in California," DWR, 1982; single sheet document.
35. Helen J. Peters, interview by Will Shafroth, July 27, 1984, transcript (available at American Farmland Trust, Western Field Office), p. 26.
36. Peters, interview by Shafroth, pp. 3, 17.
37. DWR, *California Water Plan*, p. 175.
38. Richard E. Howitt, "Is Overdraft Always Bad?" in *Proceedings of the Twelfth Biennial Conference on Ground Water* (Davis: California Water Resources Center, 1979), p. 50.
39. DWR, *The Hydrologic-Economic Model of the San Joaquin Valley, Bulletin 214*, (Sacramento, 1982), p. 18.
40. DWR, *Ground Water Basins in California Bulletin 118-80*, (Sacramento, 1980), pp. 38-39.
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42. DWR, *California Water Plan*, p. 175.
43. Peters, interview by Shafroth, pp. 7-9.
44. Martha L. Turner, "Memo," June 1985, transmitting information from David Inouye, DWR Southern District.
45. DWR, *Sea-Water Intrusion in California: Inventory of Coastal Ground Water Basins Bulletin 63-5*, (Sacramento, 1975), p. 1.
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47. DWR, *Sea-Water Intrusion*, p. 4.
48. DWR, *Sea-Water Intrusion*, pp. 106-109, 113-114.
49. DWR, *Sea-Water Intrusion*, pp. 173-4, pp. 184-5.
50. DWR, *Sea-Water Intrusion*, pp. 293-4.
51. DWR, *Sea-Water Intrusion*, pp. 106-109, 113-114.
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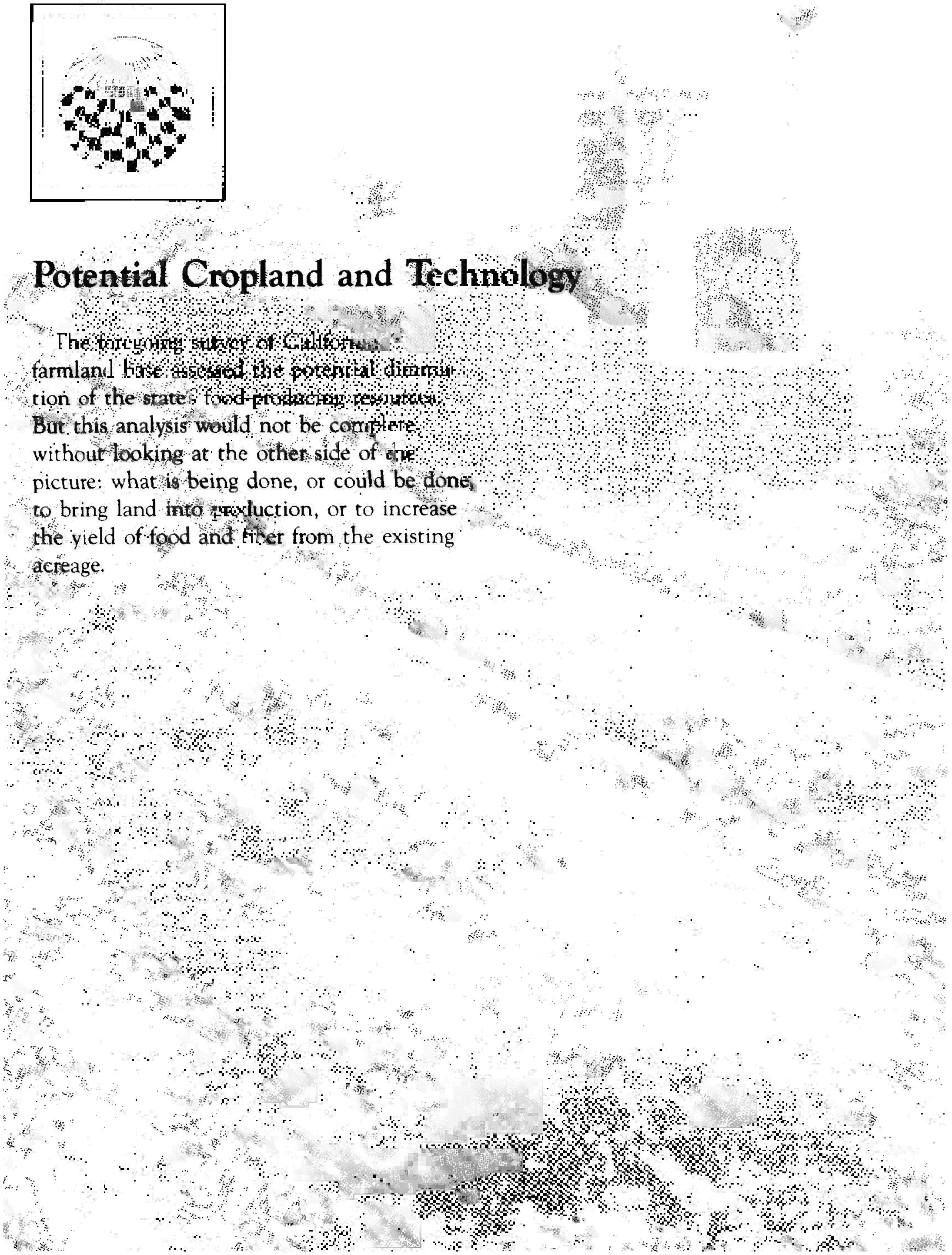
53. Peters, interview by Shafroth, pp. 9-10.
54. Howitt, "Is Overdraft Always Bad?" p. 55.
55. Howitt, "Is Overdraft Always Bad?" p. 55-56.
56. DWR, *California Water Plan*, p. 24.
57. DWR, *California Water Plan*, p. 189.
58. DWR, *California Water Plan*, pp. 131, 200.
59. Howitt, "Is Overdraft Always Bad?" p. 53.
60. Peters, interview by Shafroth, p. 40.



Potential Cropland and Technology

The foregoing survey of California's farmland base assessed the potential diminution of the state's food-producing resources. But this analysis would not be complete without looking at the other side of the picture: what is being done, or could be done, to bring land into production, or to increase the yield of food and fiber from the existing acreage.

Potential Cropland

California's total agricultural land base — all the irrigated cropland, dry-farmed land and range — probably can't expand much. Most land suited for agricultural use already is being used at least for livestock grazing.[1] Most newly irrigated cropland, then, will require a shift from range or dry-farm use.

Irrigated acreage in California expanded repeatedly as water became available, most recently during the 1970s, when the 8.8 million irrigated acres in 1972 jumped to 9.5 million in 1980. Recently, enough land has been put under irrigation to offset losses to conversion, salinity and other factors.[2] But in the future, expansion may be more problematic because of two limiting factors — the inherent fertility of the potential cropland and the availability of water — neither of which is as favorable to irrigating the potential cropland as they were in the past.

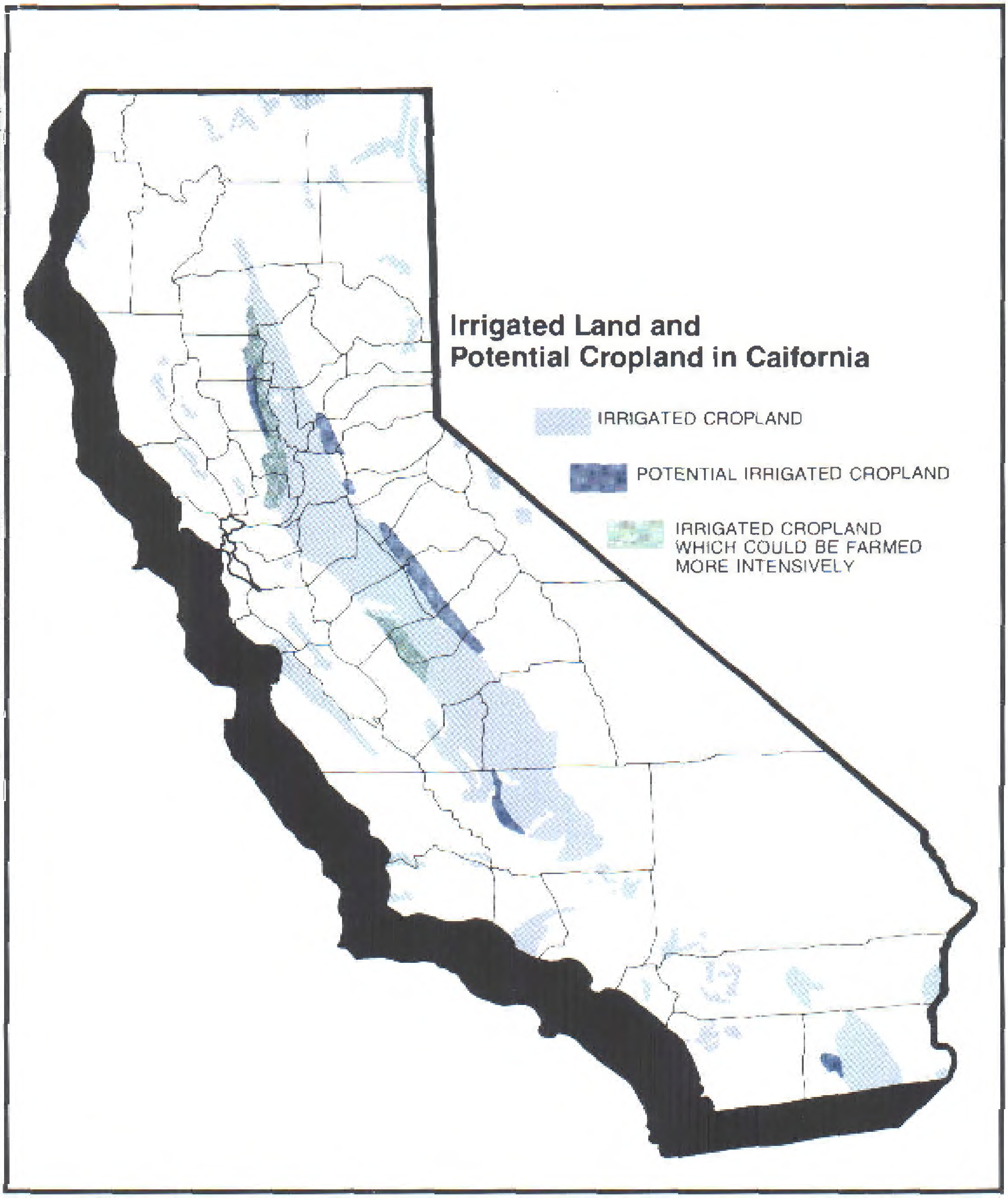
California has 18.7 million acres of land in Soil Capability Classes I-IV, the top half of the eight-class fertility scale. Although crops can be grown on lands poorer than Class IV, especially in the climatically favored coastal belt, these top four soil classes certainly contain the bulk of the state's crop-growing potential. Already 9.5 million acres in these classes are irrigated, leaving 9.2 million acres of good land to which irrigation might theoretically be extended.[3]

Sizeable areas along both sides of the Sacramento Valley could support crop production. In the San Joaquin Valley there is considerable irrigable land along both margins, particularly in Kings and western Kern counties.[4] The Imperial Valley growing area could be expanded by as much as 100,000 acres in the West Mesa district, and the nearby Coachella Valley has 36,000 arable acres still dry.[5] Large parts of the western Mojave Desert are also fertile enough to support irrigated agriculture[6]. The question then becomes: How much of this land can be supplied with water?

One block of good soils — 50,000 acres or so on the west side of the Sacramento Valley — has ready access to water and could be put into production at any time. Current economic conditions are keeping it out of cultivation.[7] Smaller acreages on both sides of the valley will become viable with the completion of two aqueducts, the Folsom South Canal on the east side of the valley and the Tehama-Colusa Canal extension on the west.[8]

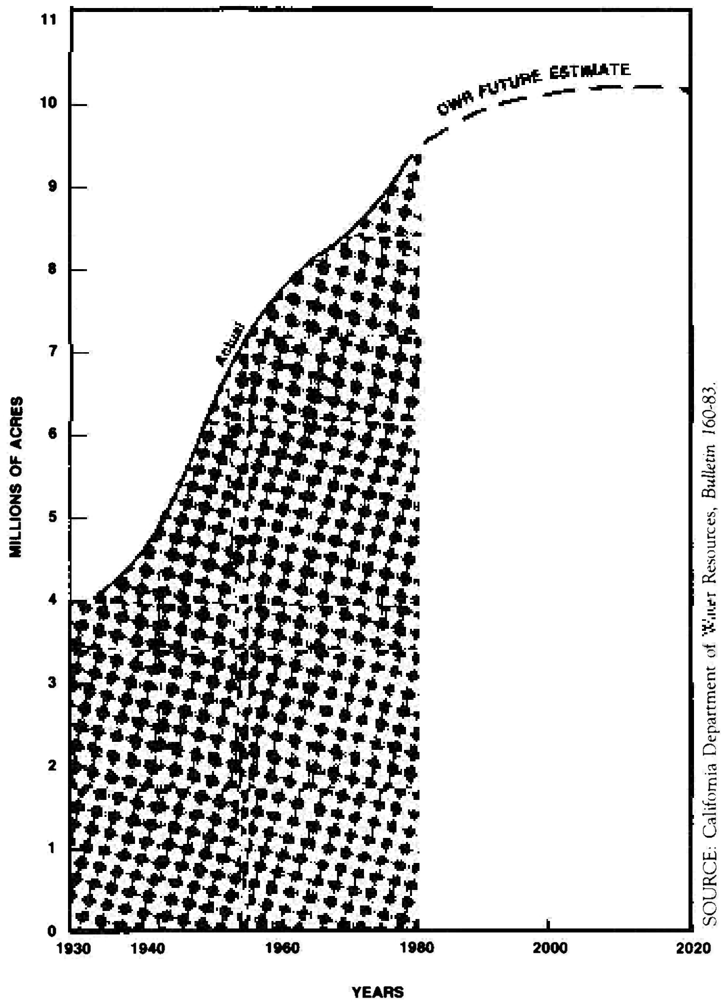
In the San Joaquin Valley, the chances of getting water to much additional land seem dim for the foreseeable future. Groundwater alone cannot sustain much further expansion; most of the land that has groundwater under it at depths from which it is economic to pump already is being farmed. A thin band of land on the east side of the valley from Stockton, south to Madera could be brought into production. Other non-irrigated land must wait for additional surface supplies, but these are not likely soon.[9]

In the Imperial-Coachella region, more efficient irrigation on existing fields could make available some water for use on suitable non-irrigated lands nearby. Agricultural runoff is raising the level of the Salton Sea and flooding adjacent farms. A 1981 Department of Water Resources study suggested that the excess runoff water be conserved and sold to Southern California cities.[10] Critics of this plan want to use the water thus saved to irrigate additional farmland instead.[11]



SOURCE: Irrigated crop land information from California Department of Water Resources, *Bulletin 160-83*. Other information from American Farmland Trust

Change in Irrigated Land and Estimate for Future



Other areas are unlikely to get water, even if major new water projects are built. The expense of moving water to the extensive "irrigable" lands of the Mojave Desert, for instance, seems prohibitive.[12] And, as noted earlier, the coastal areas can expect a maximum of 10,000 acres to be brought into production in the future.

A more detailed inventory of the acreages that could reasonably be put under irrigation has not been made. It appears unlikely, however, that even the most painstaking count would find more than 300,000 acres of such land. Compared to the existing irrigated farmland stock of 9.5 million acres, this seems small indeed — a potential expansion of just over 3%.[13]

Intensification of Use

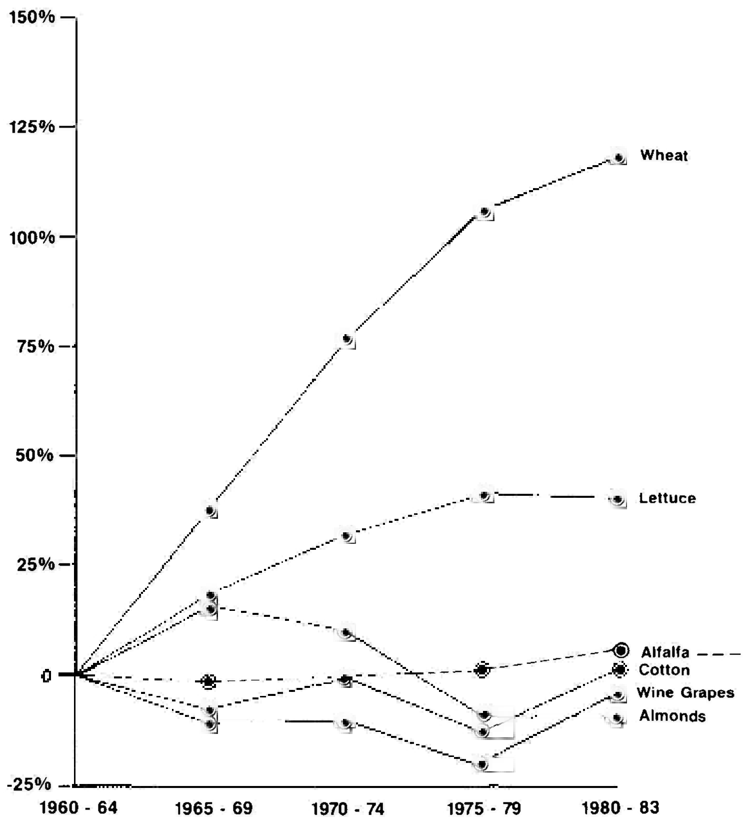
In some cases it is possible to increase farm output by fuller use of the irrigated land. In the Sacramento Valley, for example, about 10% to 20% of the cropland acreage lies fallow in any given year; the fallow percentage could easily be reduced to 5% to 10%, the equivalent of opening a sizeable block of new land.[14] In the Westlands Water District, about 100,000 acres could be planted and harvested twice instead of once a year, if water could be spared and drainage requirements met.[15]

Technological Advances

Between 1950 and 1970, the per-acre yield of California cropland, like that of U.S. cropland generally, rose steadily, largely because of a series of innovations: improved plant varieties, successive generations of pesticides and fertilizers, drip irrigation, increased double- and triple-cropping, more efficient farm equipment, and so on.[16] A recent addition to the arsenal of agricultural armaments is the technique of laser-leveling, in which graders are guided precisely by laser beams to smooth undulations in the land,

Cropland Yields Per Acre (1960-1983)

	Five Year Period	Percent Change of Average Yields
ALFALFA	1960-1964	0
	1965-1969	- 1.9
	1970-1974	1.9
	1975-1979	1.5
	1980-1983	5.5
ALMONDS	1960-1964	0
	1965-1969	16.4
	1970-1974	- 5.6
	1975-1979	- 20.9
	1980-1983	0.0
COTTON	1960-1964	0
	1965-1969	- 9.1
	1970-1974	9.1
	1975-1979	- 14.6
	1980-1983	14.9
WINE GRAPES	1960-1964	0
	1965-1969	- 14.1
	1970-1974	0.3
	1975-1979	- 7.7
	1980-1983	14.1
LETTUCE	1960-1964	0
	1965-1969	19.0
	1970-1974	12.5
	1975-1979	9.6
	1980-1983	- 0.7
WHEAT	1960-1964	0
	1965-1969	37.4
	1970-1974	38.6
	1975-1979	31.0
	1980-1983	11.1



SOURCE: County Agricultural Commissioner's Report 1960-1984.

allowing irrigation water to spread more evenly and also slowing erosion.[17]

Are yields still increasing? In California, the picture is mixed. Of eight leading crops (by acreage and dollar value), three — barley, wheat and oranges — continue to increase steadily in per-acre yield. Another three — almonds, cotton, and lettuce — show a flat or declining trend. Alfalfa yields are increasing at a very slow rate; per-acre production of wine grapes is now rising after an earlier period of decline.[18]

The best hope for continued yield increases seems to lie in the increasingly sophisticated work of the bioengineers, who are adding to traditional selective breeding new tools such as tissue culture, artificial seed coatings and recombinant DNA. Unlike such measures as adding fertilizer or leveling terrain, which change the environment in which plants grow, bioengineering techniques change the organisms themselves.

One recent success has been the breeding of several varieties of dwarf fruit trees. The new dwarf peaches and nectarines can yield twice as much fruit per acre as full-size trees; for other fruits the increases are even greater.[19] On the market soon will be partly artificial seeds in which a synthetic seed covering encases the natural embryo. Celery embryos, for example, can be raised in quantity in the laboratory, using tissue culture, and then coated, producing viable seed much faster than can be done naturally. Or seeds can be germinated, then arrested and coated for later planting. Such "pre-germinated" seeds get a vigorous start on growth.[20]

With the new recombinant DNA technology — "gene-splicing" — technicians can move the gene or genes that govern particular traits, manipulating characteristics much more quickly and precisely than through traditional breeding alone. Theoretically, the "splicer" can borrow traits from any organism and install them in any other.[21] In combination with the established techniques, these tools can be expected to produce more advances on the order of the dwarf fruit trees. Some observers go much farther. "What is coming without a doubt," says Dr. Mary Clutter of the National Science Foundation, "is a different kind of agriculture."[22]

Researchers in private industry and at universities are working to develop:

- **Herbicide resistance** — plant strains that won't be damaged by specific herbicides applied to kill weeds growing among them.[23]
- **Salt tolerance** — plants that will grow better in moderately salty environments. Research is focused on barley, wheat, triticale and tomatoes.[24]
- **Drought-resistance** — a microbe, symbiotic on the roots of cotton and soybean plants, that would help the plants endure dry periods.[25]
- **Disease-resistance** — cotton that resists fungal infections, for example.[26]
- **Altered product characteristics** — pulpier tomatoes that can be processed in canneries with less waste; seeds for animal fodder with increased content of the nutritionally valuable fatty oils.[27]

Researchers expect to succeed first at the relatively straightforward task of transferring characteristics that are controlled by single genes. Herbicide-resistance is one such trait, and resistant strains of several crops are expected on the market by 1990.[28]

Many other plant qualities appear to be controlled by the interaction of many genes. Because the exact associations that control given traits take longer to determine, successful alteration of these is farther in the future. Salt-tolerance is one such "multigenetic" characteristic; it apparently will be a decade or two before salt-tolerant plants are commercially available.[29] Other environmental-resistance traits, such as the ability to resist drought and frost, also appear to be multigenetic.[30] Another multigene characteristic is the ability to capture or "fix" nitrogen, so that plants can grow in poorer (or less fertilized) soils: 19 genes act together to create this trait.[31]

Plants eventually may be engineered to grow on marginal lands or in marginal conditions, and to yield unfamiliar products — new pharmaceutical chemicals, for example.[32] The possibility of "toughening" crops to resist various climate extremes is particularly tantalizing, since bad weather accounts for 80% of crop losses.[33]

The results of this research will not arrive all at once. Though small steps are being taken every day, major results are 10 to 20 years away.[34] But when the payoff of this accelerating new technology does come, it will make a sizeable difference to California agriculture. Yield increases in some crops seem assured, and farmers may be able to make profitable use of some land that now has severe constraints.

Yet technological advances in bio-engineering, like those in more traditional fields, will not remove the fundamental limits on California agriculture. Large amounts of water will still be required; erosion and salinity will still be of concern; and the land now recognized as prime will continue, by and large, to be the most productive.[35]

Notes

1. See *National Agricultural Lands Study, Final Report: Executive Summary*, p. 3.
2. Will Shafroth, "Conversion and Irrigation Acreage Data," Memo, 1984, summarizing unpublished data provided by state agricultural officials.
3. Will Shafroth, "Replacement Costs of Farmland in California", Memo, April 1985, based on conversations with Soil Conservation Service (SCS) and state agricultural officials. Soil class statistics are from SCS.
4. Will Shafroth, "Additional Data on Potential Farmland," Memo, July 1985, based on conversations with state agricultural officials.
5. Department of Water Resources (DWR), Southern District. *Report Investigating Under California Water Code Section 275 Use of Water by Imperial Irrigation District* (1981), p. 50
6. Shafroth, "Replacement Costs."
7. Shafroth, "Replacement Costs."
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10. DWR, *Report Investigating*, p. 51.
11. David N. Kennedy, letter to Jack J. Coe (DWR). August 26, 1981. Kennedy, now DWR director, was then general manager, Metropolitan Water District of Southern California.
12. Shafroth, "Replacement Costs."
13. 300,000 acres derived by adding specific acreages (50,000 west side of the Sacramento Valley, 100,000 Imperial Valley, 36,000 Coachella, 10,000 Coastal) and allowing for an additional 104,000 acres in the San Joaquin Valley, the east side of the Sacramento Valley, small acreages elsewhere and a margin of error.

14. Shafroth, "Replacement Costs."

15. Shafroth, "Potential Farmland."

16. People for Open Space, *Bay Area Farmland Loss: Trends and Case Studies*, (San Francisco, 1980), p. 4. Summarizes national and statewide yield data.

17. Ralph N. Shulstad and Ralph D. May, "Conversion of Non-cropland to Cropland: The Prospects, Alternatives and Implications," *American Journal of Agricultural Economics*, December 1980, p. 1081.

18. Martha L. Turner, "Production Trends in Major California Crops", Memo, July 1985, based on historical County Agricultural Commissioners' data.

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20. Martha L. Turner, "Biotechnology" (Memo, 1985, based on interviews with seven experts in the field), pp. 2-3.

21. CALP, *Genetic Engineering*, p. 13.

22. CALP, *Genetic Engineering*, p. 21.

23. Turner, "Biotechnology," p. 2.

24. Turner, "Biotechnology, p. 1.

25. Turner, "Biotechnology," p. 6.

26. Turner, "Bioengineering," p. 2; CALP, *Genetic Engineering*, p. 23.

27. Malcolm Ritter, "A Solid Tomato? Gene Splicers at Work on the Farm," *San Francisco Sunday Examiner and Chronicle*, August 12, 1984, p. B-7.; Turner, "Biotechnology," p. 2.

28. CALP, *Genetic Engineering*, pp. 25-26; Turner, "Biotechnology," p. 2.

29. Turner, "Biotechnology," p. 1.

30. CALP, *Genetic Engineering*, p. 26.

31. CALP, *Genetic Engineering*, p. 26.

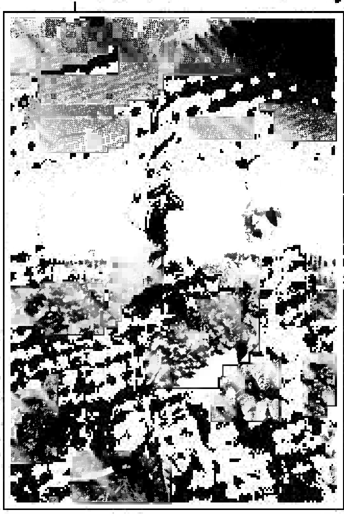
32. Turner, "Biotechnology," pp. 2 and 6.

33. CALP, *Genetic Engineering*, p. 23.

34. CALP, *Genetic Engineering*, pp. 29-31.

35. Turner, "Biotechnology," pp. 1 and 6.

THE FUTURE OF CALIFORNIA AGRICULTURE



The Future of California Agriculture

Summary of Resource Problems

Urbanization. Erosion. Salinity. Compaction. The vanishing Delta peat. Groundwater overdraft. Any of these threats to California's farmland base, by itself, might justify only slight concern; but what about the composite effect?

Problems

To review some of the numbers:

• — California has 9.5 million acres of irrigated cropland, 1.9 million acres of dry-farmed cropland, and 19.7 million acres of privately-owned grazing land. Within the highly productive coastal climate belt are 800,000 acres of irrigated cropland.

• — About 44,000 acres a year of cropland and considerable areas of grazing land are being converted to urban uses. The conversion rate is most troubling in the climatically favored coastal belt, where the irrigated cropland base is being urbanized at the rate of 20,000 acres, much of it agricultural, each year. And, each year other acreage, mostly grazing land, is converted to "rurban" large-lot development.

• — At least 4.8 million acres of irrigated cropland, 812,000 acres of dry cropland and almost 7 million acres of grazing land are losing soil faster than nature can replace it.

• — Yields in some areas are also being reduced by soil compaction (chiefly the result of using heavy machinery on wet mineral soils). According to the state Department of Conservation, about 2.4 million acres of cropland are affected.

• — In the Delta, 447,000 acres of productive farmland face an uncertain future because of the oxidation of peat soils, the high cost of maintaining levees around the subsiding fields, and governments' growing reluctance to come to the rescue.

• — At least 1.6 million acres of irrigated cropland in California have salinity problems because of poor drainage or high ground water table. Another 2.9 million acres have a problem due to naturally saline or alkaline soils. In the San Joaquin Valley, yields are now reduced on 650,000 acres. The solution — artificial drainage — is difficult in many areas because of toxic substances in the soil, and thus in the water, that must be disposed of.

• — A small number of acres, mostly in isolated valleys unconnected with the state's major water systems, may cease production when local stocks of groundwater are exhausted. In large areas near the coast, notably in the Oxnard and Salinas regions, sea water threatens to intrude as the water level in mainland aquifers declines. Though the acreage threatened has never been precisely measured, it appears that tens of thousands of acres of cropland are affected.

• — On many more acres, long-term production is threatened by steep increases in the cost of water. Higher prices will result from longer pumping lifts as water tables in overdrafted aquifers decline; also from the renegotiation of old water contracts; and from the great expense of new surface water projects, if they are built. Rising water costs could take away the competitive edge that California growers of many crops now enjoy compared with growers in other states and around the world.

Offsetting Factors

Other factors may offset some of these potential losses:

• — Per-acre yields of many crops can be expected to rise. (Of the eight leading California crops in 1983, by acreage and dollar value, five were on an upward trend.) The latest impetus comes from bioengineering. But results seem unlikely for at least 10 to 20 years.

• — Production also might be increased by irrigating lands now dry-farmed or used only for range, by converting rangeland to dry-farm, or by increasing the acreage double- and triple-cropped. The acreage that could be newly irrigated, barring a sharp increase in available surface water supplies, might be as much as 300,000 acres. It also seems likely that some marginal lands will become more productive as crops are "engineered" to prosper in difficult conditions.

Conclusion

Considering all these aspects, what conclusions can be drawn?

• — California agriculture is indeed losing some of its land base. The most tangible and well-documented loss is urban conversion, which, if the current rate continues, will take at least 660,000 more acres by the year 2000 and probably much more if "rurban" growth is taken into account.

• —Though the other threats to farmland cannot be so neatly summarized, we can safely say that productivity is threatened to some degree on at least 5.4 million acres of cropland[1] — just less than half of the total — and on 7 million acres of grazing land, about one acre in three.

• — Yield increases and the irrigation of remaining suitable lands may offset some of this damage. However, production will be diminished if resource problems are not dealt with.

Why Be Concerned With Agricultural Resource Problems?

Does this prospect justify alarm? Not automatically. After all, the perennial economic problem of agriculture, from the farmer's point of view, is over-production, leading to a poor bargaining position and low prices. Indeed, given the difficulties that agriculture faces today — falling land prices (except in urbanizing areas), the interest burden, subsidized foreign competition — it may seem untimely to focus on long-range resource concerns.

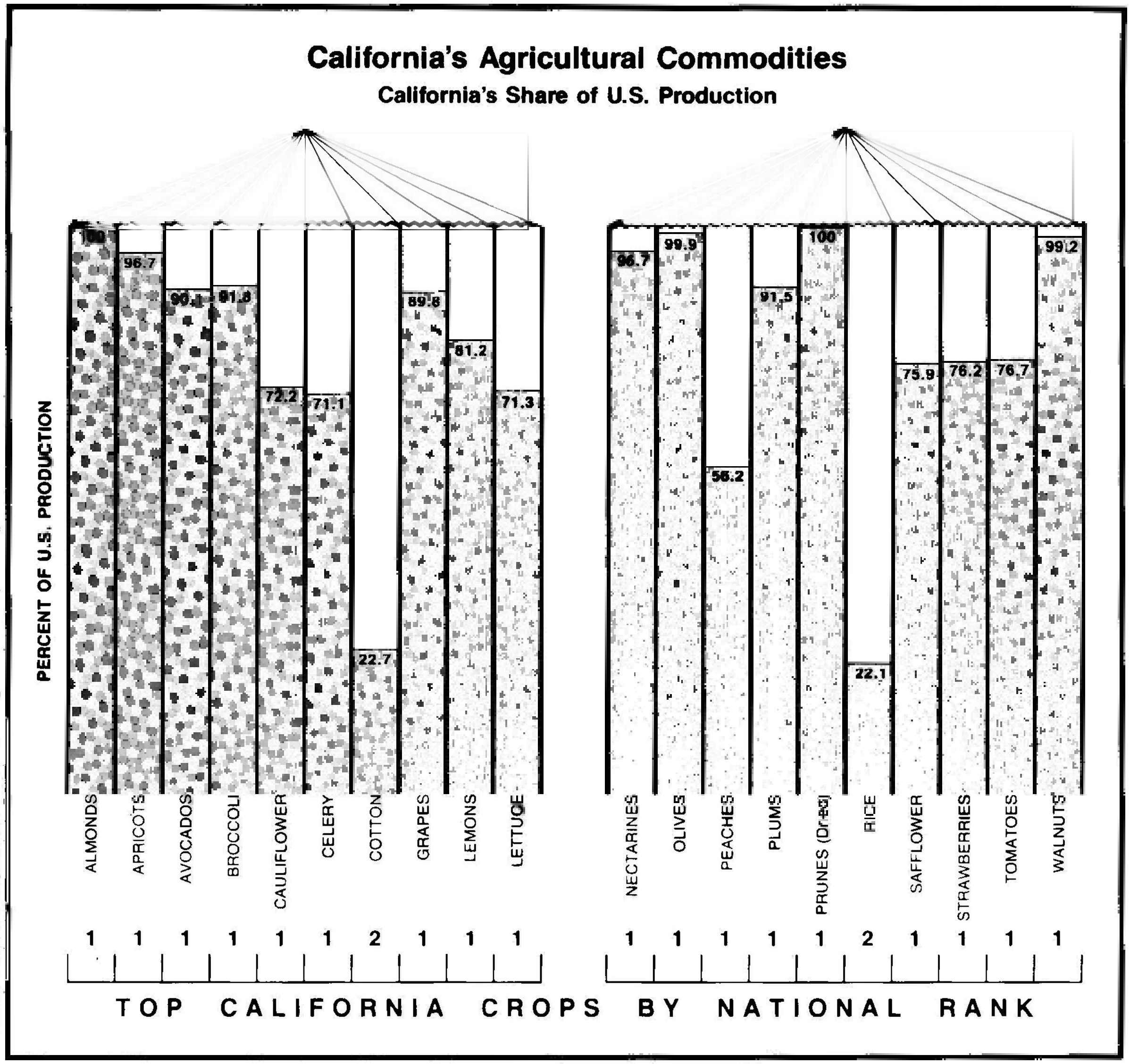
But if the sentimental response —"Farmland is wonderful, we must keep every acre in production, regardless of cost" — is not adequate, the complacent response —"There's plenty of land, we have no reason to worry" — is even more inappropriate. There is simply too much at stake.

California agriculture is important to the nation and to the world. It is a mainstay of the state's economy. Literally billions of taxpayers' dollars have been invested to put this land into service. The cost of developing new farmland to replace what is lost is high; the highest quality and most specialized of the land cannot be replaced at all. And in addition to producing food and fiber, agricultural land serves the well-being of California in a number of incidental — but no less important — ways.

The Importance of California Agriculture

California is, by any measure, the nation's leading agricultural state. Its 31 million acres of agricultural land — about 3% of the national total[2] — typically yield 10% of total national farm income. The state leads the nation in production of 48 different crop and livestock commodities and produces about half of the fruits, nuts and vegetables, both fresh and processed, grown in America.[3] If California were a nation, it would rank among the top 10 agricultural producers in the world.[4]

Quantity is not the only measure of the state's agricultural production. Equally significant are variety, quality and timing. California produces more than 200 crops, ranging from cotton, wheat and grapes to such specialties as kiwifruit, pomegranates and persimmons; several crops are grown commercially in no other American state. Other commodities are produced in special quality here. San Joaquin Valley cotton, for example, is among the world's best, and unusually uniform in grade.[5] California almonds have a higher proportion of meat to shell than those grown elsewhere.[6] Finally, there is the seasonal advantage: thanks to its climatically favored coastal belt, the state produces many crops when other areas cannot. As noted, only southern Florida and the lower Rio Grande Valley in Texas compete as domestic winter vegetable growers. If the nation is to keep the ability to produce these foodstuffs within its borders, these three areas must stay in production.



SOURCE: California Department of Food and Agriculture. *California Agriculture — 1984.*

Economic Value

In 1984, California farmers and ranchers received more than $13 billion for their products.[7] But the value of an industry to the state's economy is, of course, more than the gross amount it receives. To make the land yield, the farmer must buy such "inputs" as labor, equipment and seed; after harvest, the product typically requires processing, creating another round of earning and spending.

This "multiplier effect" is usually expressed as a total contribution to economic activity. For every extra dollar received by dairy farmers, for instance, $3.66 of gross output is generated in the economy. Multipliers vary for different farm products. The 3.66 figure for milk products is the highest; meat, at 2.66, has the lowest multiplier. Other commodities are in between. These numbers do not take account of the economic effect of the transportation and distribution of foodstuffs to the consumer and thus actually understate agriculture's position in the economy.[8]

Security Pacific Bank, in its annual report, *California's Agricultural Trends and Issues*, assigns a multiplier of 4.0 to agriculture as a whole. The real contribution of the industry to the California economy, the bank estimates, is $54.4 billion — a little more than 12% of a gross state product of about $450 billion.[9] In general, agriculture compares well as an economic engine with other significant California industries.[10]

Agriculture close to metropolitan centers is of particular benefit to local economies. Because the urban center can supply just about any service the farmer needs, the income stays in the region. In more remote areas, the farmer must go farther for some of what he needs, spreading the economic effect more widely.[11]

California farmers employ, besides themselves and their families, about 250,000 workers, seasonal and permanent. California farm wages are slightly above the national average.[12]

Exports

The export market is important to California farmers — and California farmers are important to the nation's balance of trade. In 1983, with over 2.8 million acres producing crops for the export market, California sold just over $3 billion worth of agricultural products overseas, amounting to 22% of its total gross sales. Cotton accounts for a quarter of exports, with three of four bales produced here leaving the country; 42% of California rice is exported. Other leading export crops are almonds, grapes, raisins, lemons, oranges and wheat.[13]

Agricultural exports in general constitute one of the major pluses in the nation's balance of trade. In 1983, California contributed 8.6% of the farm export total. The state accounts for all U.S. exports of almonds, apricots, cauliflower, dates, figs, garlic, pistachios, prunes, raisins, olives and walnuts; and for more than half of national exports of asparagus, avocados, broccoli, carrots, celery, cotton, dry beans, fresh grapes, grape juice, lemons, lettuce, oranges, peaches, plums, rice, strawberries, tangerines and processing tomatoes.[14]

The export market is always changing, seldom predictable. Currently, the high value of the dollar is hampering the trade in California agricultural products.[15] So are subsidies extended by other nations to their own producers — notably Common Market support of European oranges and raisin grapes.[16] China is achieving self-sufficiency in cotton, thus eliminating one major buyer of the California crop. East Asian nations are increasingly producing their own rice.[17]

On the other hand, population growth continues at home and in some of the affluent nations that make up the U.S. export market; in the long run, this implies an increase in demand on American farms. And there seems no doubt that domestic and international demand will continue to climb for those specialty crops of which California is the chief, in some cases the only, producer.

Climate gives California some continuing advantages, too. California Valencia oranges, for example, are popular in Europe in the spring, before the Mediterranean groves begin to produce. And the state may be called upon from time to time as a producer of last resort when climate cycles elsewhere are unfavorable. Half the world's rice is grown in areas subject to the unpredictable monsoons.[18]

In the 1970s, a short-lived surge in export demand led farmers to plant more land than ever before. Since then, demand has slackened. But it is possible — indeed, probable — that more such surges will come, that agriculture again will need all the productive capacity it can find.

The Public Investment in California Agriculture

For most of a century it has been public policy to encourage the development of agriculture, especially in the arid Western states. The public has in fact invested large amounts of money to put agricultural land into production in California.

1. Water supply.

By far the largest of these public investments has been the federal development of projects to supply irrigation water — projects far more expensive than farmers could afford to build jointly themselves. The greatest of these are the responsibility of the Bureau of Reclamation. The Central Valley Project captures the waters of the Trinity, Sacramento, American, Stanislaus and San Joaquin rivers for Central Valley agriculture; Hoover and Imperial dams on the Colorado, together with the All-American and Coachella canals, make possible the irrigation of the Imperial, Coachella and Palo Verde valleys; federal projects on the upper Klamath and other rivers support smaller areas of irrigated agriculture.

The Central Valley Project is the largest supplier of water to California farms. By September 30, 1984, the Bureau of Reclamation had spent $3.4 billion to build and operate the system; less than $1 billion had been recovered through sales to water and power users.[19]

On the Colorado River/Imperial Valley system, construction and other repayable costs approach $60 million (after the share attributable to the City of San Diego is subtracted); of this, about $20 million remains to be repaid.[20]

The federal government also makes interest-free loans to help individual irrigation districts construct water distribution systems. Over $96 million has so far been loaned and recovered; $38 million in loans are outstanding.[21]

California's own system of reservoirs and conduits, the State Water Project, also serves Central Valley agriculture. Unlike the federal project, the state charges for water at rates intended to recover full project cost. Agriculture is responsible for about 12% of the total, a share that ultimately will amount to about $3.4 billion; 90% of that remains to be paid.[22]

Another form of state investment in agriculture is the policy that allows agricultural contractors to purchase surplus water, designated for and paid for by municipal and industrial contractors but not yet needed by them. For this water, agricultural districts pay only transportation costs.[23]

2. Soil Conservation.

Since the 1930s, a sizeable bureaucracy has promoted soil conservation and agricultural productivity. The federal Soil Conservation Service, whose research is cited often in these pages, also grants considerable aid to farmers through local Resource Conservation Districts; from 1974-84, the agency spent $147 million in the state, including overhead.[24] The lesser known Agricultural Conservation and Stabilization Service also supports various soil and water conservation practices; investment between 1974 and 1985 was at least $79 million.[25] State government, too, has made some small expenditures in the field.[26]

Public Investment in California's Agricultural Land

Program	Amount (millions)
Central Valley Project	$3,400
Imperial Valley Water Projects	60
Loans to Irrigation Districts	96
State Water Project	3,400
Soil Conservation Service (since 1974)	145
Agricultural Conservation & Stabilization Service (since 1974) (conservation programs only)	79
Williamson Act Subventions	145
Farmland Mapping & Monitoring Program	2
TOTAL	$7,327

SOURCE: American Farmland Trust

These figures cannot simply be added up to produce an estimate of total government investment in California agriculture. Indeed, a number of elements — support by the university system, farm advisors and departments of agriculture in many counties, and others — are not listed. But the sampling should make it clear that the public puts a significant amount of money into agriculture.

Some may criticize aspects of this support; others applaud it. But the investment is there, and protecting it should be a matter of concern.

3. Tax Relief and Information Gathering.

The state's most notable investment in agricultural land preservation has been through the California Land Conservation Act of 1965, the Williamson Act. Under this program, farmers who agree to keep their land in farm use for a 10-year period pay lower property taxes, with the state refunding most of the difference to local governments.[27] Since 1972, these paybacks or "subventions" have totalled $145 million; the current annual rate is about $13.5 million.[28]

The state's Farmland Mapping and Monitoring Program can also be regarded as an investment in agriculture. Begun in 1980, the program is designed to produce a clear picture of what is happening to the state's farmland base. Expected cost through fiscal 1985-86: $2.4 million.[29]

Replacing Farmland — The Costs and Limitations

As noted, up to 300,000 acres of land remain in California that can reasonably be considered irrigable, and new technologies may someday make additional acreage usable. But these possibilities do not make the loss of existing excellent lands a matter of indifference.

First, it must be emphasized that some of California's best agricultural lands — fertile flatlands in the coastal climate belt — cannot be replaced. No more than 10,000 acres remain in that region that could be put under irrigation — and essentially none of that acreage is flat valley-floor terrain.

Second, there are the obstacles to be overcome in developing new land. The cost of overcoming those obstacles ranges from very low in some cases to almost prohibitive in others.

The initial challenge is to provide water. If that supply is assured, uneven land must be leveled and irrigation systems installed. In many cases, minerals must be added to the soil, for instance, gypsum to overcome alkalinity. In areas where salt drainage is a problem, tile drains must be installed. This preparation, in some areas, can cost $1,000 to $2,000 an acre and take two to three years to complete.[30]

The most readily irrigable land, as earlier discussed, is an area of about 50,000 acres on the west side of the Sacramento Valley. Other (much smaller) areas along the margins of the Sacramento and San Joaquin valleys, in or abutting the foothills, will stay fallow unless the Folsom South and Tehama-Colusa Canal extensions are built, or groundwater is developed.

In Southern California, the most important block of irrigable land remaining, the West Mesa District adjoining the Imperial Valley, plainly is not the equal of existing farmland in the valley. Soils there have "low inherent fertility and low water-holding capacity," the Department of Water Resources reports. "Substantial soil amending will be needed to improve soil conditions for production."[31] Yet West Mesa could be profitable, if a strong market developed for the somewhat limited range of crops that can be grown there; if owners were willing to make a substantial investment; and if conservation is successful in making water available.[32]

These facts do not diminish, rather they underscore the value of the land now in production — especially high-quality land that already has an adequate water supply and is relatively free of such resource problems as erosion and salt buildup. Here, the work has been done, the obstacles overcome, the investment made.

Incidental Values

Agricultural land serves the people of California in ways other than by producing food and fiber:

- It has scenic value as attractive and interesting landscape, and contributes to the state's cultural history.
- A great deal of our agricultural land also serves as wildlife habitat; large areas in the Central Valley and elsewhere become wetlands in the winter, vital to migratory birds.
- Farmland around and between cities doubles as urban buffer zone, separating the urban areas, providing a pleasantly contrasting setting for them, and emphasizing the distinct identity of each.

Farmland is valuable, too, for what it does not do. Properly managed, it produces fewer problems for society to deal with than do other uses of the land. Not being paved, it absorbs rainwater and thus helps to limit floods. Not being highly populated, it requires little in the way of services from local government. (As noted in the conversion section, farms and ranches often pay more in tax dollars than they receive in public services, in effect subsidizing the rest of us.) And agriculture is an excellent use for lands that are by nature dangerous places for many people to live: flood plains, fault zones, fire hazard areas.

Notes

1. This figure is derived by adding the 1.6 million acres of irrigated cropland affected by poor drainage or high water table, the 2.9 million acres of irrigated cropland impacted by saline soils and the 912,000 acres of excessively eroding dry cropland. Additional cropland acres are impacted by soil erosion, soil compaction and peat oxidation, but it is impossible to derive an accurate figure without a detailed survey of the state.
2. Based on comparison of California NRI figures with *National Agricultural Lands Study Final Report* (1981), p. 3; "forest land" was deducted from NALS "agricultural land" total.
3. Security Pacific Bank, *California's Agricultural Trends and Issues* (Los Angeles: SPB, 1985), p. 1.
4. Bank of America, *An Overview of California Agriculture and Bank of America Recommend Policy Guidelines* (San Francisco, 1985), p. 1.
5. Martha L. Turner, "Cotton Quality" (Memo, June 1985, based on telephone conversation with Lowell Zelinski, Fresno County Farm Advisor).
6. Security Pacific Bank, *Trends and Issues* 1985, p. 36.
7. Security Pacific Bank, *Trends and Issues* 1985, p. 1.
8. Esther Kovari, "Multipliers in California Agriculture" (Memo 1985, prepared for AFT).
9. Security Pacific Bank, *Trends and Issues* 1985, p. 1.
10. Kovari, "Multipliers."
11. Kovari, "Multipliers."
12. Security Pacific Bank, *California's Agricultural Trends and Issues* (Los Angeles, 1983), p. 23.
13. California Department of Food and Agriculture (DFA), *Exports of Agricultural Commodities Produced in California, Calendar Year 1983* (Sacramento, 1984), pp. 4-7.
14. DFA, *Exports 1983*, p. 6.
15. DFA, *Exports* 1983, p. 5.
16. Security Pacific Bank, *Trends and Issues* 1985, pp. 36-37; DFA, *Exports 1983*, p. 7.
17. Security Pacific Bank, *Trends and Issues* 1985, pp. 36-37.
18. Security Pacific Bank, *Trends and Issues 1985*, p. 37.
19. U.S. Department of the Interior, Bureau of Reclamation, "Repayable Investment of the United States and Funds Returned to the Treasury, September 30, 1984," p. 128.
20. U.S. Department of the Interior, Bureau of Reclamation, Lower Colorado Region, *Financial Statement for the Period Ended September 30, 1984: All-American Canal*, Schedule No. 3.
21. Martha L. Turner, "Loan Programs for Irrigation Districts" (Memo, 1985).
22. DWR, *Management of the California State Water Project (Bulletin 132-84)*, p. 261.
23. Martha L. Turner, "State Support of Agriculture Through the State Water Project" (Memo, March 1985).
24. California Association of Resource Conservation Districts, Select Committee, *California's Soil Conservation Report*, (Sacramento: CARCD, 1983) p. 15; Martha L. Turner, "Soil Conservation Service Budget for California" (Memo, April 1985)
25. Martha L. Turner, "Agricultural Stabilization and Conservation Service Investment in California Agriculture" (Memo, 1985, transmitting information provided by Larry Plumb, director of the California regional office of ASCS).
26. Martha L. Turner, "State Support of Resource Conservation Districts and State Soil Conservation Activities" (Memo, 1985).
27. Ann Foley Scheuring, ed., *A Guidebook to California Agriculture* (Berkeley: Univ. of Calif., 1984), p. 351.
28. California Department of Conservation, "Open Space Subvention Entitlements" (a series of separate annual tables).

29. Martha L. Turner, "Farmland Mapping and Monitoring Program" (Memo, 1985).

30. Will Shafroth, "Costs Associated with Bringing Land into Agricultural Production" (Memo based on conversion January, 1985 with Lowell Zelinski, Fresno County Farm Advisor).

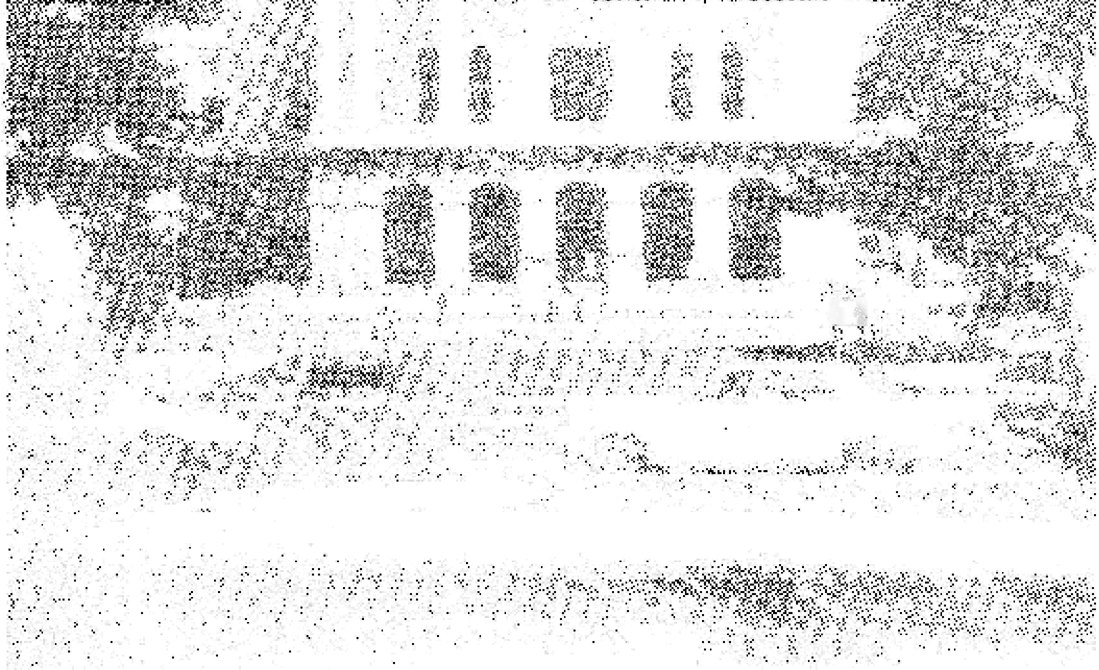
31. DWR, Southern District, *Report Investigating under California Water Code Section 275 Use of Water by Imperial Irrigation District.*

Policy Options

There are many policies the State of California can reasonably consider in response to the resource problems affecting its farmland. These options range from providing basic information and education for citizens and policy makers to playing an active role in preserving individual farmland parcels.

The policies the American Farmland Trust (AFT) offers for consideration are modest, feasible both politically and economically. We propose no fundamental shifts in course, no far-reaching changes of attitude, no new bureaucracies.

These suggestions are aimed solely at state government. In the past, the federal government has taken the lead in many of these policy areas; but the federal role appears to be shrinking. The budget of the principal federal agency responsible for agricultural resource issues, the Soil Conservation Service, has declined in recent years. Other state governments have moved to pick up the slack, developing workable state-federal partnerships. It is time for California, the nation's leading farm state, to catch up or, better still, to become a leader in the field.



Some of the initiatives we propose are already under way in California, but could be more effectively pursued. In other cases what is needed is a fine-tuning of existing laws, or common sense steps to implement policies already on the books.

In our review of the situation, one theme that recurs is the need for better information. AFT's research on California's agricultural resources turned up the best data available, yet in some areas the information is inadequate. Figures on salinity and drainage problems, for example, involved some guesswork. Not all statewide erosion figures are derived from on-the-ground surveys; many are indirect projections of what is probably happening, based on information about rainfall, slope and land use. In the area of farmland conversion, we can say with relative certainty how much farmland is being urbanized, but no one really knows how much of the burgeoning "rurban" or "ranchette" development has been at the expense of agricultural land. Even in the much-studied area of water policy there are surprising information gaps: for example, we do not know how much coastal farmland is threatened by sea water intrusion.

In some cases, information exists but is not available in a convenient form. The Department of Water Resources (DWR) has a wealth of data on land-use, but its many publications only present these data relative to water supply. Given DWR's mandate, this is to be expected; but this limits the usefulness of the information.

Although we call for better data collection and information-sharing as a major policy option, we hasten to add that it could be many years until every acre of farmland and every drop of water in California is precisely accounted for. In a perfect world, government policy would be based on such perfect information. But the information we do have is considerable and it suggests that we should not delay in addressing the problems facing our agricultural land. If we wait 5, 10 or 15 years on some issues, the consequences could be substantial.

Heeding this conservative admonition, AFT has gone beyond the recommendation that California learn more about its agricultural resources to present a list of substantive policy options for conserving farmland, soil and water. None of these policies is a panacea. Each, though, could help in some significant way; in combination, they could improve the situation markedly.

Conversion Policy Options

California has many laws that in one way or another encourage the conservation of farmland. A recent inventory by the California Senate Local Government Committee found that there are at least 20 state statutes that contain farmland conservation policy statements. But in many cases, these expressions of state policy are not being carried out as effectively as they could be. Many could become much more effective if slightly modified; in other cases, entirely new initiatives may be required.

Gather Resource Information

Current situation: The Farmland Mapping and Monitoring Program (FMMP), begun in 1980 and administered by the Department of Conservation, is developing an inventory of California's farmland based primarily on Soil Conservation Service soil survey data. The information is presented in the form of multicolored important farmland maps showing urban areas and agricultural land of various types. However, no funding is currently available for map printing. Once the first inventory is complete, annual updates are planned in 41 of California's 58 counties. Year-to-year comparisons will give the first clear picture of exactly where conversion is occurring.

By late 1985, the state's data collection was in computer-accessible form and preliminary, blueprint-style maps covering approximately 60% of the state's cropland had been prepared. These unfinished maps, however, are difficult to read. Local governments and other interested parties cannot yet make full use of the valuable information that has been assembled.

Moreover, in large parts of the state, the SCS has not completed the surveys on which the state maps are based. Although most of the rapidly urbanizing areas have been mapped, counties including San Joaquin, Sacramento, Yuba, Sutter and Butte still constitute major gaps. Until these areas are incorporated into the program, it will be impossible to provide accurate statewide estimates for farmland conversion.

☐ Policy Option # 1
Print Important Farmland Maps

The Legislature could budget money for the full color printing of the Farmland Mapping and Monitoring Program's Important Farmland Map series. The state expects to have spent $2.4 million through fiscal year 1985-86 on this program; a relatively small additional expenditure would allow the information to reach its intended users. Much of the cost of printing could be recovered by selling maps to local governments and organizations. In many areas, demand would be high.

Precedent: Virtually every other state has some county Important Farmland Maps printed. Oklahoma has printed maps for the whole state and Washington has maps for all but a few counties.

☐ Policy Option # 2
Accelerate soil surveys

The state could help fund the completion of the SCS soil surveys in those areas that lack such surveys, thereby filling important gaps in the Farmland Mapping and Monitoring Program coverage. Even with state funding, surveys for all of California would not be complete until the mid-1990s. To provide statewide farmland conversion data sooner, the state could undertake interim mapping for the unmapped areas, providing less detailed but still vital information.

Precedent: In recent years, California's support of soil surveys has been limited to forest and rangeland (soil vegetation surveys). In 1984, every state except California, whose soil surveys on farmland were not complete, cost-shared with the Soil Conservation Service. Other states' contributions for farmland-related soil surveys range between $200,000 and $1 million. California's contribution: $0.

☐ Policy Option # 3
Undertake an historical conversion trends study.

Although the Farmland Mapping and Monitoring Program will publish its initial report assessing conversion trends in 1986, it will be 5 to 10 years before those trends can be reliably discerned based on FMMP data. Earlier data exists, however. The Department of Water Resources has been gathering land-use information for many years, reaching back, in some areas, to the 1940s. To assess historical conversion trends, the state could use the DWR data to show where farmland has given way to non-agricultural uses, as well as where new agricultural land has been brought into production.

Precedent: Maryland, Delaware, and South Carolina have undertaken historic farmland conversion studies which have enabled them to better address their agricultural resource problems.

Information On Farmland Preservation Techniques

Current situation: Many techniques for preserving farmland in farm use have been developed and tested by local governments in California and other states. An extensive literature describes these methods. (See sidebar.) But there is no central clearinghouse in Sacramento to which local governments and organizations can go for this information.

☐ Policy Option # 4: *Publish guidebook on farmland preservation techniques*

The state could assemble information on farmland protection techniques and make it available to local governments and other interested parties. The state would not have to take a stand on the utility of the techniques or their applicability in particular cases, but simply transmit the wide experience gained here and in other states.

Precedent: The states of Massachusetts, Connecticut, Vermont, and Wisconsin have published and distributed handbooks or guidebooks on farmland preservation techniques for both citizens and local governments.

Technical Assistance

Current situation: The state now provides very little technical help to local governments or private organizations concerned with conserving agricultural land. In past years, the Governor's Office of Planning and Research made some effort in this direction, publishing bulletins and reports on policy options as well as publishing useful general plan guidelines; it also gave staff assistance to local governments. Today, such aid has all but ceased. The State Coastal Conservancy does provide technical assistance to cities, counties and non-profit organizations for farmland conservation activities within the coastal zone.

☐ Policy Option # 5: *Offer technical assistance to local governments and the private sector*

California could increase assistance to local governments and private organizations in two ways: first, by serving as the clearinghouse for information on agricultural land protection techniques (see above); second, by providing trained staff to work with local governments in identifying the land to be protected and in developing a farmland protection program.

Specifically, the state could:

- *Adopt guidelines for the implementation of certain agricultural land protection policies or programs*
- *Prepare legal analyses of the programs*
- *Provide analysis at the request of localities of the best ways to achieve farmland protection objectives in a given area.*

Precedent: State agencies in Illinois and Wisconsin provide technical assistance to local governments on farmland protection. Illinois' Bureau of Farmland Protection assists local governments wishing to devise farmland protection programs. In Wisconsin, the Bureau of Land Resources within the Department of Agriculture provides both financial and technical assistance to counties to prepare farmland preservation plans. To date, Wisconsin has spent nearly $2.8 million in this area.

State Policy on Farmland Conservation

Current situation: The state does not require its own agencies to avoid actions that convert agricultural land. Even as the state promotes the preservation of such land through the Williamson Act and local general plan requirements, its Department of Transportation (just one example) plans highways that convert prime land.

☐ Policy Option # 6: Regulate or oversee the actions of state agencies

California could adopt, by executive order or legislative mandate, a state policy on agricultural land conservation. The policy would require the state to address the impacts that state projects or projects partially funded by the state have upon agricultural land. Agencies would have to document and justify reasons why a proposed non-agricultural use outweighs continued agricultural use of property before granting project approval. In some cases, the agencies would need to identify alternatives which would minimize farmland conversion. To reduce delays in the permitting process, agencies could be required to review each project within 60 days.

Precedent: Eleven states have legislative mandates and/or executive orders which require state agencies to review and often mitigate state projects' effects on the loss of farmland. In the first two years of its existence, Illinois' law kept over 20,000 acres from being converted to non-agricultural uses and saved $20-$30 million in state project funds.

State policies affecting local government

Current situation: The state already requires local governments to carry out various policies aimed at preserving agricultural land. Among the relevant state laws are the Knox-Nisbet Act, which established the Local Agency Formation Commissions, and the Planning and Zoning Law. The framework for protection appears strong, at least on paper.

In practice, the situation is different. Some state policies affecting farmland prove, on close reading, to contain only unenforceable calls for good planning. Often the state has failed to give local governments the tools they would need to pursue farmland protection aggressively. Finally, the state pays little attention to whether local governments carry out mandated policies, some of which are not implemented at all. In some cases, as noted above, direct actions by the state even undercut the policies it has asked local governments to pursue.

There is one major exception to these generalizations: the immediate coastal zone. Local governments controlling coastal lands must prepare and implement local coastal plans that meet state standards specified in law, under the oversight of the California Coastal Commission. The protection of agricultural lands is one of those standards.

Special districts

Current situation: In addition to cities and counties, California has a third form of local government: special districts. These limited-purpose bodies exist to provide specific services to areas as small as a few blocks or as large as several counties. Currently, the state permits these districts to construct public works projects without complying with the land use policies that cities and counties have set. Thus, while a county might decide to retain certain farmlands in agricultural use, a special district could simultaneously be promoting development in the same farm area by building a sewerage system or some other urban-scale facility. Although the actual effect of such conflicts on farmland is small today, the potential for conflict is great.

☐ Policy Option # 7: Require special districts to adhere to local general plans

State law could be amended to require all special district policies to be consistent with local general plans.

Local Agency Formation Commissions

Current situation: Local Agency Formation Commissions (LAFCos) are local bodies established by state law in almost every county. They have the power to approve or veto proposed annexations of land by cities and special districts. As a framework for these decisions, LAFCos delineate "spheres of influence," or ultimate city boundaries: urban limit lines, in effect. LAFCos currently are required to "consider" how their decisions affect agricultural land. Such consideration, however, has not made LAFCos effective protectors of farmland.

☐ Policy Option # 8: *Require Local Agency Formation Commissions to give higher priority to farmland conservation*

State law could be changed to require LAFCos to make certain findings before approving annexations or changing designated spheres of influence. Before opening an area to growth, a LAFCo would have to show one of two things: either that the probable development would not be at the expense of agricultural land, or that the community's need for the kind of development in the location envisioned is paramount.

Local revenue sources

Current situation: Proposition 13 limits local governments' ability to raise revenue. Ad valorem property taxes are restricted to certain levels, and many other property-based fees are prohibited. To carry out effective programs to protect farmland, local governments often need some additional sources of revenue.

☐ Policy Option # 9: *Permit local revenue to be raised for farmland protection programs*

In June 1986, the voters will consider Assembly Constitutional Amendment 55, which would restore constitutional authority for local governments to issue general obligation bonds. If passed, it would allow counties and cities to raise considerable sums for any purpose, farmland protection included, with the approval of two-thirds of the local voters.

California could also impose certain special taxes on property, including, for example, a "real estate transfer tax" collected at the time of sale. One option, especially appropriate as a source of funds for farmland preservation, is a farmland conversion tax levied when farmland is urbanized. This tax would also require a constitutional amendment in California.

Precedent: An analysis of locally funded purchase of development rights programs (PDR) reveals a variety of funding schemes. King County, Washington's $50 million PDR program is financed through the sale of general obligation bonds. Counties in Maryland receive revenues from a state real estate transfer tax. Forsythe County, North Carolina, funds its PDR program out of general revenues.

State Mandates to Local Government

Current situation: As noted, the state has assigned farmland preservation goals to local government but has not insisted that progress be made in achieving those goals, nor offered help to local governments that attempt to do so. Not surprisingly, many laws are not carried out as the Legislature intended, if at all.

☐ **Policy Option #10:**
Implement and enforce state mandates to local government

The state could establish an implementation and enforcement group: a team of experts, located within an existing agency, equipped to assist local government in initiating and carrying out farmland protection and other policies.

State involvement with preserving individual parcels of farmland

Current situation: The state is not now in the business of preserving specific parcels of farmland. An exception is in the coastal zone, where the State Coastal Conservancy does engage in or provide funding for farmland preservation transactions.

☐ **Policy Option # 11:**
Assist in the preservation of individual parcels of farmland

The state could establish a capital fund for the purchase of development rights on farmland. (See sidebar.) The fund, raised by bond issue or appropriation, could be used to assist the land-preservation efforts of local governments and private non-profit organizations. In conjunction with local plans, the state could acquire development rights from farmland parcels. To administer such a purchase program, the state could establish, within an existing agency, a California Agricultural Land Trust.

Precedent: Six states have purchase of development rights programs for farmland. Allocations total almost $150 million, with New Jersey's $50 million bond and Massachusetts' $40 million authorization heading the list. Just over 20,000 acres of land have been protected by this technique.

Some Local Farmland Preservation Techniques

1. Comprehensive Planning. Each California county must have a general plan; actual zoning must be consistent with this plan. Though this alone wouldn't ensure the preservation of land designated for agricultural use, it's a good starting point.

2. Agricultural Zoning. A zone is a legally binding designation of the uses to which land may be put, including the type, amount, and location of development. Agricultural zoning promotes and protects agriculture from encroachment by non-farm land uses. Many types of agricultural zoning are in use by some 300 localities around the country. They range from setting large minimum lot sizes (though they may encourage "ranchettes") to establishing sophisticated "sliding scale" residential density-based allocations and conditional use approaches.

3. Urban Limit Lines. Urban limit lines or "spheres of influence" can protect farmland indirectly by preventing urban development outside the specified boundaries. Such limits, set and largely enforced by the Local Agency Formation Commissions, may or may not be set with the well-being of agriculture in mind. They do not prevent "rurban" or ranchette development in the countryside.

4. Williamson Act. Under this state program — and others like it in other states — farm owners who contract with the county agree to keep their land in agricultural use get their property taxes reduced to a level reflecting the agricultural use of the land. An owner choosing not to renew the contract normally must wait 10 years before undertaking a non-agricultural activity, or under special circumstances, cancel the contract.

5. Purchase of Development Rights (PDR). A conservation agency, public or private, can permanently protect farmland by purchasing development rights from the owner, leaving all other aspects of ownership intact. The price paid usually reflects the difference between the market value and the restricted or agricultural value.

6. Transfer of Development Rights (TDR). In this more complicated procedure, development rights are moved from one place to another. Once a government has designated farmland for preservation, developers are invited to purchase rights from farmers and exercise them on property zoned for development.

7. Private Land Trusts. These private, non-profit organizations work with individual landowners to preserve land, using a variety of tools and techniques, including the conservation easement. Landowners often realize income and estate tax benefits from private conservation transactions.

Soil Erosion Policy Options

Since the late 1960s, when then-Governor Ronald Reagan eliminated a long standing Soil Conservation Commission, the state has had only a minimal role in soil conservation. In fact, California is the only state that does not have a soil conservation plan. Although the federal Soil Conservation Service will continue to be the agency most involved in soil conservation, there are important roles the state could play.

Soil surveys.

Current situation: Only about 60% of California is covered by farmland soil surveys. The SCS does not expect to complete some areas until almost the turn of the century; other areas have yet to be scheduled for survey.

The Soil Conservation Service is the only agency that now inventories, assesses and monitors soil resources on a significant scale. The information it gathers is invaluable, but in some cases more data or better field-checking are needed. Sometimes the need is for analysis to make the data more usable. For example, SCS inventories indicate how many acres are believed to suffer from sheet and rill erosion and how much land is thought to suffer from wind erosion, but do not reveal how many acres must be counted in both columns.

☐ **Policy Option #12:**
Accelerate soil surveys

As noted under "Conversion Options" above, California could provide funding to complete soil surveys ahead of schedule. If the surveys can't be completed at least within a few years, the state could fund the SCS and its own Department of Conservation to develop interim information on soils in regions of special concern.

Less ambitious, but still useful, would be to computerize existing soil survey information.

☐ **Policy Option #13:**
Gather more information about the state of soil resources

The state could work with the SCS to plug these information gaps and put information in the most widely useful form. The result might be a joint state-federal assessment of soil resources. Duplication would be avoided; costs could be shared.

Technical assistance

Current situation: The state provides no direct assistance to farmers wishing to practice soil conservation. Through the University of California, it does support the County Cooperative Extension offices (Farm Advisors) on which farmers rely for information. Conservation, however, has not been a focus of Cooperative Extension.

☐ **Policy Option #14:**
Offer additional technical assistance to farmers

By providing soil and water conservation information through Cooperative Extension, the state could make the information much more accessible to farmers. If more farmers understood the problems and solutions, more could be done.

Precedent: Many states provide technical assistance to landowners on soil conservation. Wisconsin has established and funded a soil erosion inventory throughout the state. This program will be followed by a 50% cost sharing program to the counties. Total state funds now allocated, $2.8 million.

Local governments assistance

Current situation: Soil erosion can have serious effects on a community, because of fertility loss and because of the offsite impacts — damage to streams and rivers by the eroded sediment. Local jurisdictions often lack the tools to address these problems. The state now offers no legal guidance.

Policy Option #15:
Prepare model soil conservation ordinances for local governments.

The state could make model soil erosion control ordinances available to local governments. The ordinance could outline possible restrictions on certain farming and building practices.

State soil conservation plan

Current situation: California has no official soil conservation plan. In recent years the Legislature has supported the preparation of a "California Soil Conservation Report". A Soil Conservation Advisory Committee was recently formed and charged with the development of a state soil conservation plan. The plan will describe the problems and set goals and priorities for addressing the problems.

Policy Option #16:
Prepare a state soil conservation plan

The state could pursue this initiative, providing the support needed to complete the plan. Though advisory in nature, such a plan would give the Legislature what it has not yet had: a list of specific soil conservation related actions to consider. A later step would be the funding of particular plan proposals.

Some Erosion Control Methods

1. No-till or conservation tillage. Various techniques to greatly reduce erosion are available for planting crops without turning over the soil on entire fields. These techniques are little used in California. If bioengineering succeeds in producing plants that compete better with weeds (or that won't be damaged by weed-killing herbicides), a main obstacle to no-till planting will diminish.

2. Leveling. Laser-leveling can give a field exactly the right slope to allow irrigation water to flow across it without causing erosion. On steeper terrain, terracing reduces soil loss.

3. Windbreaks. Rows of trees can be barriers against wind erosion. However, trees tend to be taken out to make more ground available for tillage or permit easier passage by large field machines. But improvements in shelterbelt techniques have reduced the amount of land that must be taken out of cultivation to accommodate the trees.

4. Range management. Various erosion control methods can be applied to rangeland; however, the number of animals grazed must be kept to the level the land can support, without deterioration.

5. Fallowing or retirement of land. In some situations, the best erosion control method is simply to leave the land alone for a while — or, in extreme cases, to withdraw it permanently from cultivation and put it to other agricultural uses such as grazing.

Salinity Policy Options

Salinity poses difficult problems for policy makers and for engineers. Most solutions that have been seriously considered (see sidebar) seem to create other problems. With public concern over the disposal of agricultural wastewater on the increase, the state is likely to be taking a more active interest in this issue.

Because the problem involves all levels of government and thousands of individual farmers, the most suitable role for the state may be to undertake research, disseminate the results and coordinate the efforts of others.

Undertake basic research

Current situation: Considering the wide concern about the issue, surprisingly little is known about the magnitude of salinity and drainage problems in California. Little effort has been made to assess the situation, and basic aspects of the issue are not well understood.

☐ **Policy Option #17:**

The state could establish a program to assess precisely the extent and severity of salinity and drainage problems throughout California and to monitor changes in the situation. Additional research could answer important questions, including:

- *What is the potential effect of increasing concentrations of chemicals, including selenium, in soils and drainage waters?*
- *How can the volume of wastewater be reduced? (See sidebar.)*
- *If drainage water is pooled in evaporation ponds, how much farmland will have to be used for the ponds themselves?*
- *What is the most appropriate site for final disposal of these wastes — the "ultimate sink"?*
- *How realistic are other long-term possibilities for dealing with wastewater — desalinization, for example?*

Some Partial Answers to Salinity/Drainage Problems

Possible solutions to the salinity/drainage dilemma fall into two groups: measures designed to reduce the amount of wastewater, and options for final disposal of that waste.

1. Water conservation. By applying the amount of water needed to sustain the crop and to leach salt out of the root zone — and only that quantity — the farmer can reduce the amount of drain-water produced.

2. Drainage water reuse. Some mildly saline drainage waters can be used again to irrigate salt-tolerant crops, delaying the disposal problem.

3. Development of salt-tolerant plants. If more crops could thrive on relatively salty water, still more use could be made of irrigation waters before they become too saline to recycle.

4. Retirement of some susceptible lands. Where toxic substances in soils complicate the drainage problem, some acreage can be retired.

5. Disposal into salt water bodies. The Imperial and Coachella valleys send drainwater to the Salton Sea, which continues to rise and to grow saltier. In the San Joaquin Valley, the Bureau of Reclamation has proposed and partly constructed a San Luis Drain to conduct the drainwater to Suisun Bay; the recently recognized problem of contamination by selenium and other minerals has put completion of the drain in doubt. Wastewater aqueducts over the Coast Ranges to the ocean are also being discussed.

6. Evaporation in ponds. Evaporation ponds require an amount of land equal to 15% to 20% of the farmland served; then the solid mineral residue still must be disposed of, perhaps by trucking to the ocean.

7. Desalinization. Wastewater can be desalinated, yielding usable water. The super-salty brines that remain can be used to generate electricity in solar ponds. (Such brines can absorb great amounts of heat without evaporating and thus function well as solar collectors.) DWR operates an experimental desalinization/solar pond plant near Los Banos.

Water Policy Options

Water policy in California has become increasingly controversial. There is more and more concern about the environmental consequences of large surface water projects, yet there is no consensus on the next major steps to be undertaken by the state. Smaller and very useful steps, however, are possible.

Local water conservation plans.

Current situation: The Department of Water Resources and the Cooperative Extension Service have a great deal of information on agricultural water conservation methods. Water conservation is practiced in many areas, but on a voluntary, uncoordinated basis.

☐ Policy Option # 18:
Require local water suppliers to prepare and implement water conservation plans.

The state could adopt policy requiring local agricultural water suppliers to prepare and implement water conservation plans. State policy could dictate the general content of these plans and provide for review by a state agency; specific provisions could be left to the local suppliers, who understand local conditions. DWR could provide technical assistance upon request.

Funding water conservation activities.

Current situation: Agricultural water conservation is almost exclusively done at the farmer's expense. In some areas, rising water prices have made conservation an attractive proposition; in other areas, there is little incentive to conserve.

☐ Policy Option # 19:
Propose a bond act for local water conservation activities

The Legislature could place before the voters a general obligation bond act to fund water conservation activities. Bond money could pay for the initial development of conservation plans; for advisory audits of existing water use on farms; and for water-conserving improvements. The money could be divided among areas of the state according to climate and water use patterns. If the voters approved the bond act, DWR could administer it.

Groundwater recharge programs.

Current situation: Many local agencies around the state have groundwater recharge programs. However, recharge must be pursued on a larger scale to reduce overdraft, to counter sea water intrusion, and to store water for withdrawal in times of drought.

☐ Policy Option # 20:
Propose a bond act for groundwater recharge programs

The state could place before the voters a bond act to fund groundwater recharge programs. The money could be divided among regions according to the magnitude of overdraft problems. Within each region, DWR could determine which groundwater basins are most in need of recharge, submit the priority list for public review, and allocate grants accordingly. Water suppliers that share an aquifer could be encouraged to submit a joint application. As an alternative, a grant program might be set up for areas threatened by sea water intrusion only.

Some Methods of Saving Water on the Farm

1. Precise estimation of crop water needs. When water is expensive or conservation is a priority, it becomes important to discover precisely how much water plants need at given points in their growth, and to give them what they need and no more.

2. Precise estimation of leaching requirements. If too little additional water is applied for leaching, salt accumulates in the root zone. But if too much is applied, water is wasted and drainage problems increase.

3. Choice of efficient irrigation methods. Some irrigation systems deliver water more efficiently than others. Generally speaking, gravity systems (in which the water stands on the surface or flows down furrows) are most wasteful; sprinkler systems do the job better and permit more precise control. Drip irrigation systems, which deposit small amounts of water precisely at the roots of individual plants, are sometimes but not always advantageous. Today, most California cropland is irrigated by the imprecise gravity methods.

4. Good system management. The choice of method only begins the complex task of planning and running an irrigation system. Proper design, maintenance, and operation all help keep water losses low.

5. Control of losses in transportation. In 1976, DWR estimated that 10% of the water intended for agricultural use never makes it to the field; it is lost on the way, either evaporating or sinking into the ground from unlined and unroofed ditches. Preventing such losses is an easy way to increase the water supply for farms.

Hydrologists caution that conservation measures on individual farms may not reduce water use in an entire district as much as expected, simply because one farmer's "waste" often forms part of the next farmer's water supply. Greater overall efficiencies, however, are certainly possible.

The Challenge

The empire of California agriculture is varied, rich and vast. In the past, it has expanded many times. But its limits are now apparent. If the realm has many provinces, it is also true that some of the provinces are small — especially the important coastal climate belt that makes the state a winter vegetable garden and a producer of specialty crops.

The future of that agriculture is full of unanswerable questions. How fast will the demand for California farm products increase? Will the export market rebound? How large a productivity surge should we expect from bioengineering? Will population growth accelerate again? Will new water supplies become available?

But it is this uncertainty that is perhaps the strongest argument for conserving the agricultural resource base — for striving to keep the best of what the state has; 20 . . . 50 . . . 100 years from now, it will be far better to discover that we have farmland in reserve than that there is too little to meet our needs. "Waste not, want not" was good advice when our vast and bountiful landscape was first settled; it is just as valid today, as more and more people are attracted to the Golden State, and the whole country depends on California agriculture.

GLOSSARY

acre-foot: The volume of water or solids that will cover one acre to a depth of one foot (43,560 cubic feet or 13,233.48 cubic meters).

aquifer: A subterranean deposit of permeable rock, sands or gravels capable of yielding substantial amounts of water to a well.

base line: A surveyed line established with more than usual care, to which surveys are referred for coordination and correlation.

base map: A map showing certain basic data to which other information may be added.

built-up area: An area mainly occupied by buildings; broadly synonymous with urban in its physical sense.

carrying capacity: The maximum stocking rate possible without inducing damage to vegetation or related resources; may vary from year to year on the same area due to fluctuating forage production.

channel: A natural stream that conveys water; a ditch or channel excavated for the flow of water.

erosion: (1) The wearing away of the land surface by running water, wind, ice, or other geological agents, including such processes as gravitational creep. **(2)** Detachment and movement of soil or rock fragments by water, wind, ice or gravity. The following terms are used to describe different types of water erosion:

— **accelerated:** Erosion much more rapid than normal, natural, or geologic erosion, primarily as a result of the influence of the activities of man or, in some cases, of other animals or natural catastrophies that expose bare surface, for example, fires.

— **geological:** The normal or natural erosion caused by geological processes acting over long geologic periods and resulting in the wearing away of mountains, the building up of flood-plains, coastal plains, etc; also called natural erosion.

— **gully:** The erosion process whereby water accumulates in narrrow channels and, over short periods, removes the soil from this narrow area to considerable depth, ranging from 1 to 2 feet (3-6 m) to as much as 75 to 100 feet (23-30.5m.)

— **natural:** Wearing away of the earth's surface by water, ice, or other natural agents under natural environmental conditions of climate, vegetation, etc., undisturbed by man; also called geological erosion.

— **rill:** An erosion process in which numerous small channels only several inches deep are formed; occurs mainly on recently cultivated soils and/or recent cuts and fills.

— **sheet:** The removal of a thin, fairly uniform layer of soil from the land surface by runoff water.

— **streambank:** Scouring of material and the cutting of channel banks by running water.

erosive: The action of wind or water having sufficient velocity to cause erosion. Not to be confused with erodible as quality of soil.

evapotranspiration: The combined loss of water from a given area and during a specific period of time by evaporation from the soil surface and by transpiration from plants.

fair market value: That value that would induce a willing seller to sell and a willing buyer to buy.

family farm: A farm business in which the operating family does most of the work and takes the risks.

farmland: Land used for agricultural purposes. Types, as defined in the United States, and modified for California indicates:

— **prime farmland:** land which has the best combination of physical and chemical characteristics for the production of crops. It has the soil quality, growing season and moisture supply needed to produce sustained high yields of crops when treated and managed, including water management, according to current farming methods.

— **farmland of statewide importance:** land other than "Prime Farmland" which has a good combination of physical and chemical characteristics for the production of crops.

— **unique farmland:** Land which does not meet the criteria for "Prime Farmland" or "Farmland of Statewide Importance," that is currently used for the production of specific high economic value crops. It has the special combination of soil quality, location, growing season and moisture supply needed to produce sustained high quality or high yields of a specific crop when treated and managed according to current farming methods. Examples of such crops may include oranges, olives, avocados, rice, grapes, and cut flowers.

— **farmland of local importance:** Land that is either currently producing crops, or has the capability of production. "Farmland of Local Importance" is land other than "Prime Farmland," "Farmland of Statewide Importance," or "Unique Farmland." This land may be important to the local economy due to its productivity.

farm operator: A person who operates a farm either by performing the labor himself or directly supervising it.

fee simple title: A title on which the owner owns all rights to an entire property with unconditional power of disposition during his life.

grazing land: All lands grazed by livestock for commercial purposes.

land capability class: One of the eight classes of land in the land capability classification of the U.S. Soil Conservation Service; distinguished according to the risk of land damage or the difficulty of land use; they include:

Land suitable for cultivation and other uses.

Class I: Soils that have few limitations restricting their use.

Class II: Soils that have some limitations, reducing the choice of plants or requiring moderate conservation practices.

Class III: Soils that have severe limitations that reduce the choice of plants or require special conservation practices, or both.

Class IV: Soils that have very severe limitations that restrict the choice of plants, require very careful management or both.

Land generally not suitable for cultivation (without major treatment).

Class V: Soils that have little or no erosion hazard, but that have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland or wildlife food and cover.

Class VI: Soils that have severe limitations that make them generally unsuited for cultivation and limit their use largely to pasture or range, woodland or wildlife food and cover.

Class VII: Soils that have very severe limitations that make them unsuited to cultivation and that restricts their use largely to grazing, woodland or wildlife.

Class VIII: Soils and landforms that preclude their use for commercial plant production and restrict their use to recreation, wildlife, water supply or aesthetic purposes.

land rights: Any interest acquired in or permission obtained to use land, buildings, structures, or other improvements; includes the acquisition of land by fee-title or certain designated rights to the use of land by perpetual easement; also includes the costs of modifying utilities, roads and other improvements.

row crop: A crop planted in rows, normally to allow cultivation between rows during the growing season.

runoff: That portion of the precipitation on a drainage area that is discharged from the area in stream channels; types include surface runoff, groundwater runoff or seepage.

salinization: The process whereby soluble salts accumulate in the soil.

salinity: The concentration of dissolved solids or salt in water.

salt-affected soil: Soil that has been adversely modified for the growth of most crop plants by the presence of soluble salts, exchangeable sodium or both.

SMSA: Standard Metropolitan Statistical Area. A county with an incorporated urban population of at least 50,000 people.

tile drain: Pipe made of burned clay, concrete, polyvinyl chloride (PVC) or similar material, in various lengths, laid to collect and carry excess water from the soil.

tile drainage: Land drainage by means of a series of tile lines laid at a specified depth and grade.

tillage: The operation of implements through the soil to prepare seedbeds and rootbeds, control weeds and brush, aerate the soil and cause faster breakdown of organic matter and minerals to release plant foods.

tolerance: The relative ability of a species to survive a deficiency of an essential growth requirement, such as moisture, light or an overabundance of a site factor, such as excessive water, toxic salts, etc.

topsoil: The surface plow layer of a soil; sometimes called surface soil. The original or present dark-colored upper soil that ranges from a mere fraction of an inch to two or three feet thick on different kinds of soil.

Definitions in this glossary were taken from *Resource Conservation Glossary*, Soil Conservation Society of America. 1982, Ankeny, Iowa, unless otherwise indicated.

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