IS THERE A CRISIS AHEAD FOR THE CALIFORNIA ALFALFA INDUSTRY?

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ABSTRACT

The past few years have been excellent for profitability of alfalfa in California. California has firmly moved into the position as the nation's premier dairy state, and produces more alfalfa hay than any other state. The record high prices of recent years growers have enjoyed in 1996-97 are likely part of a long-term imbalance between the supply and demand for forages. We do not currently produce sufficient alfalfa to satisfy CA markets, and this trend is likely to intensify, contributing to high prices, and optimism among growers. However, alfalfa remains in a very vulnerable position with regards to water supplies and land-use issues. Although it is an efficient in water-user, the gross quantities required per year statewide are large. Field crops, and alfalfa in particular has been targeted as being less necessary compared with urban and environmental water demands. A profound ignorance of the value of alfalfa to the food chain, wildlife habitat, and cropping systems contributes to a willingness to target forages for water transfers. Continual erosion of acreage (in spite of increases this year) is likely to take place in the future. This may benefit the remaining growers due to higher prices, but lead to greater pressure and instability in the dairy industry. A "slowly developing" crisis due to restricted acreage and water-use may confront alfalfa in the future. Methods of producing alfalfa & forages more efficiently under tighter water supplies, as well as efforts towards educating the public about the broader value of forages to California are needed.

INTRODUCTION

The dairy-forage industry in California when considered as a whole, generates about $4.5 billion in cash sales each year, not including economic activity of related and support industries (Table 1). As a continuum, it is unquestionably the most important agricultural enterprise in California. Forages and dairy are inexorably linked. Each is dependent upon the other, unlike, for example almonds, walnuts and peaches, which are sometimes lumped under tree crops, but could exist independently. Although some alfalfa goes for other uses (horses, sheep, beef), most alfalfa goes for milk production.

California has developed into the nations' premier dairy state as well as the largest producer of alfalfa hay. There is a limit as to the distance at which forages and coarse feeds (corn & small grain silage) as well as alfalfa hay can be traded economically. This means that if we are unable to produces adequate feed in California, we increase the risk of eroding the state's number one agricultural industry: dairy.

Table 1. Value of top 10 California Commodities (and national rank)

Commodity	Value ($Millions)
(1) Milk & Cream	$3,717
(1) Grapes	$2,159
(1) Nursery	$1,610
(5) Cattle/calves	$1,151
(2) Cotton	$1,074
(1) Almonds	$1,009
(1) Hay (alfalfa)	$ 813
(1) Lettuce	$ 735
(1) Flowers	$ 703
(1) Tomatoes	$ 664

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An examination of long-term dairy and forage trends, and likely future trends in population, land and water-use may be instructive as to "where we might be" in the future. The term "crisis" is perhaps a little provocative, but that was the intent. In this paper we hope to provide a glimpse of what these recent trends have been, and hope to speculate about what future trends might have in store for the states' $4.5 billion/year alfalfa-dairy industry.

SHORT-TERM AND LONG-TERM ALFALFA & DAIRY TRENDS

Short Term Trends. In the past two years, prices have reached record-high levels for alfalfa hay. Heavy winter rains and flooding have damaged or destroyed stands in some areas in 1995-1997, contributing to loss of productivity. The monetary losses in alfalfa due to the January 1997 floods were greater than any other crop (Table 2). The most badly affected counties were Yuba, Stanislaus, and Kings. However, favorable weather conditions have mostly prevailed for the remainder of the year, and some very high quality hay was produced in the spring and the fall of 1997 due to clear, warm weather conditions.

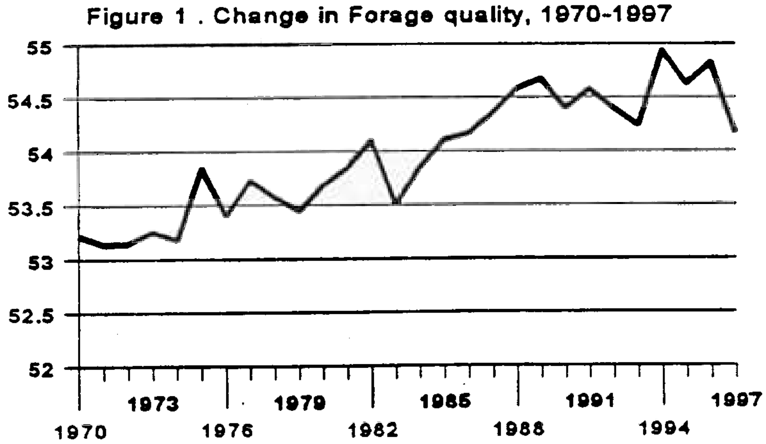
Table 2. Estimates of crop loss during the January, 1997 floods, including top five affected crops (CDFA)

Crop	Lost	Damaged	Value ($)
Alfalfa	23,020	5,340	23,365,556
Peaches	331	2,204	23,012,205
Walnuts	1,644	6,836	18,618,970
Cotton	19,252	3,500	7,499,002
Wheat/barley	42,165	17,470	13,322,591
Total	*121,642*	*17,470*	*155,275,903*

However, many growers have lengthened cutting schedules to increase yields, often at the expense of forage quality, during summer months in 1997. Petaluma Hay Analysis has shown a reduction in the average TDN of the hay samples it receives (each year typically >1000 samples per year-Figure 1). The long term trend of generally increased average forage quality since 1970 may be moderating in the 1990s, due to the high prices.

These high prices in 1996-1997, and more limited profitability in other crops such as cotton and tomatoes, have caused increased plantings in the fall of 1997. Optimism is the mood of the day, tempered by the expectation of wetter winters as many predict. New plantings are up statewide, some estimate between 5-15%, and there is a shortage of alfalfa seed, caused by heavy demand, and diminished seed production in recent years. Many have moved to an earlier fall planting due to expectations for wet weather, a good strategy even in a dry year.

Figure 1 . Change in Forage quality, 1970-1997



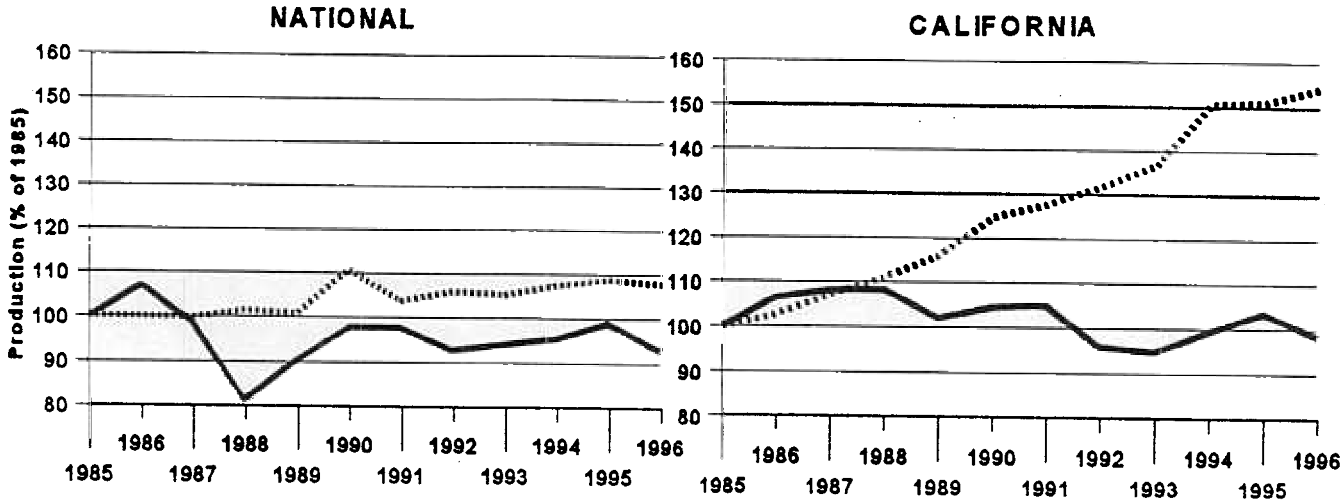


Figure 2. Changes in productivity (alfalfa tons/year or milk pounds/year) expressed as a percentage of 1985 production, 1995-1996. Dashed line indicates milk and solid line indicates alfalfa for all US States (left) and California (right).

Longer- term alfalfa and dairy yield trends. Nationwide, dairy production has increased about 7-9% percent over the past 12 years (Figure 2). Some states have shown declines during this period due to reduced cow numbers. Most states have increased production per cow substantially, especially western US states. At the same time, alfalfa hay production has declined about 5-8%, indicating that hay production has not at all kept pace with increases in dairy productivity during this period on a national basis.

In California, the differences between alfalfa and dairy production trends is even more striking. California has increased milk and cream production over 50% in the past 12 years, a rate of increase far greater than eastern states. Approximately half of this increase is due to increases in milk yield per cow, and the remainder due to increased cow numbers. During this same period, the number of dairies has declined to currently about 2,300 dairies.

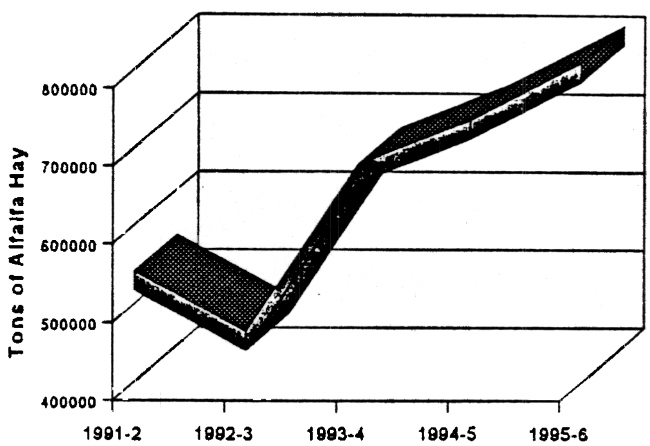


Figure 3. Alfalfa hay moving into California from neighboring states, 1991-1996 (CDFA).

Primarily due to this increased demand, alfalfa hay has been moving into California dairy markets at a much greater rate (Figure 4. Much of this hay (and cubes) come from Nevada. Many locations in Nevada are closer to Central California dairy sheds than are the production areas in Northern California or the Southern California Deserts.

ALFALFA AND DAIRY DEMAND- A FUNDAMENTAL IMBALANCE?

Differences between ability to supply and demand for high quality alfalfa by dairies have created a fundamental imbalance between suppliers and consumers of forage. The alfalfa industry) simply cannot keep pace with the rate of growth of dairies. California has been an alfalfa-deficit state for several years, and this trend is intensifying. Many believe that this is essentially a permanent situation, with forages under increasing demands in the future.

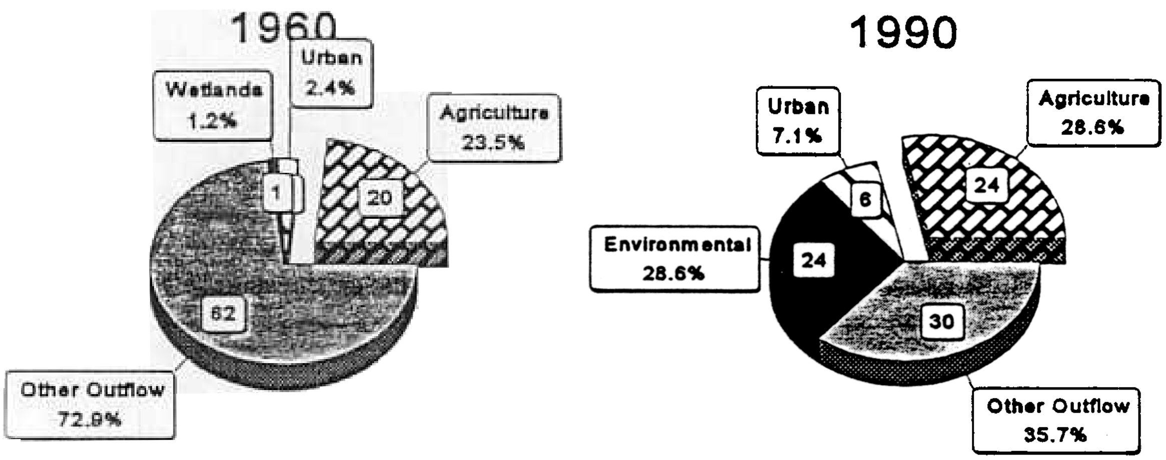


Figure 4. Use of Water resources in California, 1960 and 1990. Number in box on pie chart is million acre feet of water used. Environmental use includes Wild & Scenic Rivers (21% of total) Instream (1%), Wetlands (1%) and Delta Outflow (5%).

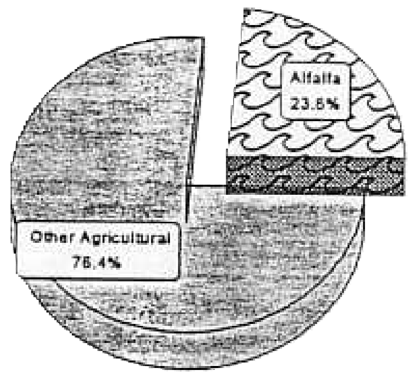
THE CALIFORNIA WATER SITUATION

Without irrigation, California would likely be the nation's largest wheat producing state. Most agriculture is purely a function of our ability to irrigate the rich, non-erodible, deep soils of California's Central Valley, deserts, Intermountain valleys and coastal valleys. Forages are no exception in their dependence upon irrigation water.

California's water allocation patterns have changed dramatically over the past decades. Agriculture's share of California's water has risen about 20% during the 1960-1990 period to about 24 million acre feet (Figure 1). During the same period, urban water use has increased about 300%, and specific allocations for environmental use has risen over 2,000%. These increases have come at the expense of "unallocated" outflow which has been reduced by over 50%. Demands from all sectors for California's water have risen precipitously. These figures do not include more recent allocations and agreements which allocate more water for environmental use. With agriculture, it should be noted that a 20% increase in water-use in 30 years has corresponded with dramatic increases in agricultural economic returns, and in many cases yield.

Alfalfa yields, for example, have risen about 1.5 t/acre during this period (about 27%).

Figure 5. Estimated share of California's agricultural water by California's alfalfa crop (1990). Data is California Department of Water Resources (DWR, 1993), but using our estimated mean for each hydrologic region. Using DWR's low and high estimated Applied Water amounts, proportion ranges from a low of about 20% to a high of about 27.5% of CA water used by alfalfa.



Alfalfa is a major water user in California. Alfalfa likely consumes about 23-24% of California's agricultural water in any given year. The California Department of Water Resources provides a low and high range of water-use estimates for the different Hydrologic Regions. Based upon a total agricultural water use of 24 million acre feet, alfalfa might use from 19.9% (4.785 million acre feet- low estimate) to 27.6% (6.62 million acre feet-high estimate) of California's water used for agricultural purposes.

THE VULNERABILITY OF ALFALFA

Alfalfa and forages are in a very vulnerable position when it comes to water. This is due to the following reasons:

☛1. High total water use

☛2. Perceived low economic value compared with total water used

☛3. Severe lack of understanding of forages by general public

☛4. Lack of flexibility for quickly reducing water-use without reduction in yield.

☛5. No alfalfa industry organizational structure is in place to respond to challenges or educate the public.

Point 1 is readily acknowledged by all parties. However, these facts can also be misinterpreted. In spite of high total water use, alfalfa is very efficient in its ability to turn water into useable dry plant material. It is deep-rooted, utilizes the whole soil profile, is very high yielding, grows almost year around, and is harvested many times. The whole above-ground plant matter is harvested, compared with many crops (annuals or perennials) where only a small proportion (typically less than 50%) is harvested. The major effect is acreage and its year-round growth.

However, alfalfa has water-use efficiency values which are far superior to many crops.

Point 2. Critics of alfalfa typically point to the low economic value of alfalfa per unit of applied water, compared with "higher value" crops such as grapes, tree crops, and specialty crops. Certainly, there has be a gradual replacement of forages (and other field crops) with specialty crops over the years, a trend which is likely to continue. However, this analysis is quite simplistic and unrealistic in many California regions. On-farm systems are quite complex and require a more vigorous analysis. Specialty crops engender a much higher risk, and can often prove to be unprofitable. Many specialty crop growers expect to make money in only a percentage of seasons. Alfalfa is much more of a "bread and butter" crop, which has dependable markets, provides a steady cash flow through the season, and improves the soil for other crops. Thus many specialty crop growers would grow alfalfa with minimal profitability for these reasons. Alfalfa is a key component of profitability on many California ranches.

Additionally alfalfa creates value for a multiple of related enterprises worth billions of dollars. The primary one is the $3.7 billion dairy industry, which would not exist in its present form without alfalfa. But in addition to this, thousands of jobs are created in seed production, trucking, export & shipping, equipment manufacturing and sales, and a host of other related enterprises. Hence the calculation of dollars/unit of water for a primary "raw material" crop such as alfalfa is typically underestimated.

Point 3 is one which many alfalfa growers are increasingly aware. There is a tremendous lack of appreciation and understanding of the purpose and function of forages in the general population. Most people can't go and "pick their own" alfalfa, as they can strawberries and apples, and the translation of the value of hay and forage for milk production or recreational horses is tenuous at best. Other commodities are much more recognizable. Contrast the public's ignorance of the necessity of forages with a more widespread appreciation of lawns and golf courses; they simply have more experience with the latter than the former. This lack of understanding readily translates into litigation, law, public pronouncements, and the political process. This gulf of basic understanding of the role of forages places forages at much greater risk in the public sphere.

Point 4 will be discussed more thoroughly later (Can we produced alfalfa with less water?). However, it is clear that, since alfalfa has a fairly linear relationship between applied irrigation water and productivity, there are few easy methods for reducing water-use without reducing yields.

Point 5. Alfalfa growers value the fact that there are no government subsidies or special commodity programs for their crop. It is marketed in a highly decentralized way, with many buyers and sellers. However, many growers feel that they should have a greater ability to respond to issues and crises as they arise. There are currently no highly active statewide alfalfa grower organizations. The closest is the Farm Bureau Hay Committee, which meets once a year, and local hay committees and hay grower associations. Growers from different regions rarely have an occasion to talk things over and decide upon responses to common issues, such as water resources, forage quality evaluation, pests.

These factors are reasons that alfalfa as a crop may be especially vulnerable to pressures from the public to shift water to other uses, and other public issues, such as pesticide use. Alfalfa and forages are often considered low on the totem pole of crops, even with farmers. The question as to whether the important alfalfa industry will be able to respond to these questions in the future remains open to discussion.

PROJECTED TRENDS IN WATER DEMAND

Population growth now exceeds projections made in the 1980s and growth has continued into the 1990s despite the recession of the early 1990s. By the year 2020, many studies have predicted population to be at 45-55 million, and if the previous underestimates are any indication, it may be more than this. In the late 1980s there were 3.75 million urban acres in California, and we are the most urbanized state in the nation.

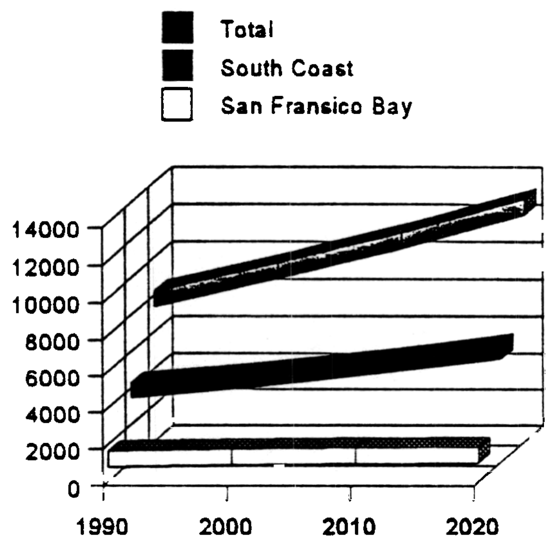


Figure 6. Anticipated future urban demand for water, 1990-2020 (Department of Water Resources figures for average years).

This growth in population will have an increasing impact upon water and land-use. The California department of Water Resources estimates that the total urban applied water demand will increase by an additional 5.4 million acre feet by the year 2020 (a 70% increase from 1990 levels- Figure 6).

Since development of additional water resources (new dams) is highly questionable, where is this water going to come from? Many municipalities are looking to water transfers to agriculture to meet their needs. There are major proposals for water transfers currently underway, including proposals for transferring agricultural water from the Colorado River basin to San Diego, and additional transfers of water from the Sacramento Valley to the LA Basin. The "free market" for water is the catch-word of the day, with some believing that water should be allocated according to its greatest cash market value (rather than beneficial use, which has been the historic criteria).

In addition to urban demand, additional allocations for environmental is a major factor. Environmental interests are a relatively new player in the ever-contentious California water wars, but current allocations for wetlands, endangered species, bay-delta health and scenic rivers equals or exceed the amount of water allocated to agriculture (Figure 3). There is a legitimate need, in the minds of many Americans, to assure protection of wildlife and open spaces. Unfortunately, this has often pitted "environmental interests" against "agricultural interests" when it comes to water. This is a false dichotomy. Agriculture, as a process of nature, provides a great deal in the way of wildlife habitat and open spaces which should be of value to the general public and to environmentalists in particular.

Marc Reisner, historically a critic of agricultural water-use through his book 'Cadillac Desert' and other publications, recently has weighed in heavily on the side of farmland and farmland protection in these discussions. In a recently-published study (Reisner, 1997), he details the troubling loss of valuable California farmland to urban pressures and argues for public support of allocations of water for farming purposes. He recognizes that not only direct urbanization, but water allocations is the mechanism by which farmland is lost. Points out that "in a state headed for a population of 50 million, farms--though they aren't parks of wilderness— take on a special importance as open space that relieves the congestion of sprawl and supports wildlife". Although his views are controversial with some environmentalists, and may not please all growers, it represents a dramatic defense of disappearing farmland on the part of an erstwhile critic.

> "Any bird, mammal, amphibian, or insect is apt to prefer a farmed field to a treeless new subdivision or shopping mall" - Marc Reisner, 1997

In spite of perhaps a glimmer of recognition of the importance of agricultural landscapes to wildlife habitat, there will be ever- increasing pressure in the future to transfer water from "low value" agricultural crops for urban and environmental purposes. It's not too difficult to specify which commodities are primarily indicated here. The question is: how will the alfalfa industry respond?

CAN ALFALFA BE PRODUCED ON LESS WATER?

Alfalfa yield is directly related to evapotranspiration (ET). In alfalfa, as ET increases, yield also increases until maximum yield occurs at maximum ET. The maximum potential ET is controlled by climatic conditions and soil moisture. ET amounts less than the amount required for maximum yields are caused by insufficient soil moisture. Maximum yields are typically obtained by properly managing the irrigation such that sufficient soil moisture exists throughout the growing season.

Under limited water supplies, strategies for alfalfa growers might include

1. Deficit irrigate the entire field.
2. Reduce the irrigated acreage.
3. Convert to an irrigation method capable of applying water more uniformly
4. Grow a different crop

Deficit irrigation means applying less water than is needed for maximum yield. Deficit irrigation can stretch a limited water supply, but at the same time crop yield will be reduced. The amount of yield reduction depends on the relationship between alfalfa yield and applied water, which can be affected by irrigation method and management, climate, soil type, and nutrient levels.

Alternatively the irrigated acreage can be reduced such that maximum yield occurs on the remaining acreage. Thus, yield per acre and revenue per acre will remain constant, but total production will decline because of the reduced acreage.

Which approach is the best? Results of applying both options are presented in Tables 3 and 4. These data were developed using a crop production relationship for the San Joaquin Valley, developed at the UC Kearney Agricultural Center. Other conditions used for these data include a 100-acre field, crop price of $100 per ton, fix costs of $400 per acre (cultural, land, taxes and insurance, irrigation system, equipment, etc.), and water costs of $50 per acre-foot. Maximum yield for this field was assumed to occur at 50 inches of water.

Table 3. Economic analysis for deficit irrigation over 100 acres.

Applied Water (AF)	Yield (tons/acre)	Total Revenue ($)	Total Fixed Costs ($)	Total Water Costs ($)	Total Profit ($)
417 (100%)	10.3	103,000	40,000	20,850	42,150
375 (80%)	9.8	98,000	40,000	18,750	39,250
334 (70%)	9.5	95,000	40,000	16,700	38,300
292 (60%)	8.9	89,000	40,000	14,600	34,400

Table 4. Economic analysis for reduced acreage option. Yield per acre was 10.3 tons.

Applied Water (AF)	Acres Irrigated	Total Revenue ($)	Total Fixed Costs ($)	Total Water Costs ($)	Total Profit ($)
417 (100%)	100	103,000	40,000	20,850	41,150
375 (80%)	90	92,700	36,000	18,750	37,950
334 (70%)	80	82,400	32,000	16,700	33,700
292 (60%)	70	72,100	28,000	14,600	29,500

Based on this analysis, the deficit irrigation option resulted in higher profits under limited water supplies compared with the reduced acreage option for the assumed costs. However, for both options, as the water supply decreased, profit also decreased to values less than occurred for the a full watering situation. Maximum profit occurred for near maximum yields

As the water cost increases, profit decreased for both scenarios. However, maximum profit under the deficit irrigation option occurred at water amounts less than that needed for the maximum yield. For water costs of $100 per acre foot and $125 per acre-foot, maximum profit occurred for water amounts equal to about 80 percent of that needed for maximum yield, and at $150 per acre-foot, maximum profit occurred at an amount equal to 70 percent of the maximum. For the reduced-acreage option, maximum profits occurred for 100 percent of the applied water, but profits were less than those under the deficit irrigation option.

Field studies and observations have shown that the largest yields occur for the first cuttings and the smallest yields occur for the latter cuttings. Thus, a third option is to irrigate for maximum yield early in the year and then decrease or terminate irrigation amounts for the latter cuttings. Several projects conducted in the Tulare County, CA, the Imperial Valley, and in Arizona have investigated this matter ("summer dry-down").

Using the data from the Tulare County project (Frate, C. 1988. Field crop notes.), an economic analysis was conducted similar to those in Tables 3 and 4. Results, in Table 3 showed maximum profit to occur for the maximum yield strategy, and that as the seasonal amount of applied water was decreased, both yield and profit decreased.

Table 5. Economic analysis for reducing irrigation amounts for the later cuttings ("summer dry down"). Assumptions were the same as for Tables 1 and 2.

Applied Water (AF)	Yield (tons/acre)	Total Revenue ($)	Total Fixed Costs ($)	Total Water Costs ($)	Total Profit ($)
483 (58) [1]	9.68	96,800	40,000	19,550	37,250
325 (39) [2]	9.90	99,000	40,000	16,250	42,750
250 (30) [3]	8.89	88,900	40,000	12,500	36,400
217 (26) [4]	7.28	72,800	40,000	10,850	21,950
192 (23) [5]	6.43	64,300	40,000	9,600	14,700

[1] Wet treatment - three irrigations per cutting. [2] Standard treatment - two irrigations per cutting. [3] Single treatment - one irrigation per cutting. [4] No irrigations in July and August. [5] No irrigations July thru December. Numbers in parentheses are inches of applied water.

Caution should be used in generalizing these results. A different behavior could occur depending on site-specific conditions. For example, an analysis similar to those used for Tables 1 and 2 was conducted using a crop production relationship for the Barstow area. Results showed no difference in profit between the two options.

A third option is to convert to an irrigation method capable of applying water more uniformly throughout the field. Thus, by converting from an irrigation system with poor uniformity to one with a higher uniformity, the same yields might be obtained with less water. Table 6 lists maximum potential irrigation efficiencies of various irrigation methods, based on evaluating nearly 1000 irrigation systems. These efficiencies assume that sufficient water will be applied to maintain maximum yield. These data show that continuous-move sprinkler systems (center-pivots, linear-moves) and micro irrigation have the potential for the highest irrigation efficiencies. The efficiency of periodic move systems such as wheel-line sprinklers is for a no-wind condition.

The most common irrigation method of alfalfa is flood or border irrigation. These irrigation systems can be very efficient, but they can be very difficult to manage at a high efficiency. Their uniformity depends on soil and field properties, many of which cannot be manipulated or even measured by the irrigator. Thus, managing these systems efficiently is somewhat of a trial-and-error process.

The uniformity, and thus the potential maximum efficiency, of pressurized irrigation methods depends on their hydraulic design and maintenance. Both of these factors can be manipulated by the irrigator to achieve good uniformity. Managing these systems is relatively easy compared with a flood system. However, capital costs, energy costs, and maintenance costs of these systems can be much higher compared with those of a flood system.

Table 6. Practical maximum potential irrigation efficiencies.

Irrigation Method	Irrigation Efficiency (%)
Sprinkler	
Continuous-move	80-90
Periodic-move	70-80
Portable Solid-set	70-80
Micro-irrigation	80-90
Furrow	70-85
Border	70-85

Options for converting to a more efficient irrigation system include upgrading an existing flood system, converting to a sprinkler system such as center-pivot or linear-move sprinklers (where applicable), and converting to drip irrigation. Will the conversion reduce water and increase profits? On sandy soils, converting to drip irrigation or sprinkler irrigation will probably improve yields and possibly profits depending on the cost of the conversion. On fine-textured soils, results are much more uncertain.

CONCLUSIONS

The alfalfa industry has enjoyed high prices and increased interest among growers in recent years. However, trends in demand for water from agriculture places alfalfa and other forage crops at considerable risk in the future. Water transfers and loss of productive potential due to urbanization are especially relevant for the alfalfa industry, but also for dairy. These trends may have greater impact on the dairy industry rather than forages, since forage growers may be compensated for lost water or shift to other crops. Better methods of irrigating more efficiently and communicating the vital role of forages to the general public are needed.

REFERENCES

DWR, 1994. California Water Plan Update. Bulletin 160-93 State Department of Water Resources, PO Box 942936, Sacramento, CA 94236.

Northwest Economic Associates. 1994. The Economic Impacts of the proposed Federal Bay/Delta Standards on the California Dairy Industry. A Study Prepared for Western United Dairymen, Vancouver, WA

Reisner, M. 1997. Water Policy and Farmland Protection. A New Approach to Saving California's Best Agricultural Lands. American Farmland Trust. 1949 Fifth St., Suite 101, Davis, CA 95616.