Water marketing effects on crop-water management

J. Letey ❑ Ariel Dinar

This study considers a water marketing system in which farmers can buy a given amount of water, at a fixed price, and sell the amount not used. The system could induce farmers to upgrade their irrigation systems and reduce water application and drainage volume, while paying for drainage water disposal and maintaining profitability.

Increasing urban populations must be accommodated by increasing water supplies. However, opportunities in California to develop additional fresh-water supplies for human use are limited and expensive. A partial transfer of water presently being used for agriculture to urban use has been considered to satisfy increasing urban water demands. Water marketing is proposed as a means of facilitating the water exchange.

The agreement between the Metropolitan Water District of Southern California and the Imperial Irrigation District is an example of a form of water marketing that will provide an additional 100,000 acre-feet of water per year for urban use (an amount that would provide domestic water for approximately 700,000 people). Metropolitan agreed to cement-line leaking irrigation ditches carrying water to fields and to make other improvements in exchange for the water conserved. This program does not affect the amount of water available to farmers for irrigation.

Would an agreement whereby individual farmers could market a portion of the water available for irrigation at the field lead to further transfers? This question prompted our study on water marketing effects on agricultural crop-water management. Another major goal was to determine whether water marketing could help alleviate the problem of toxic drainage water in the western San Joaquin Valley.

Water marketing in cotton

The study assumed the farmer has a given quota of water for purchase at a fixed price and that the farmer could use or sell any portion of that water. Assuming no change in cropping pattern, the farmer has two options for using less water and making some available for sale: (1) upgrade the irrigation system to provide better control of uniformity and amount of irrigation or (2) stress or deprive the crops of water, producing lower yields. Both options are costly to the farmer, and their costs must be offset by the sale of water.

We selected cotton for analysis, because it is a major crop in the western San Joaquin Valley and also is a crop that can be stressed to reduce total dry matter production with relatively small decrease in cotton lint production. In other words, cotton has growth characteristics that might enable growers to save water under a marketing system. We computed crop-water production functions (relationship between yield and applied water) from experimental data reported by scientists from the U.S. Department of Agriculture, Water Management Research Laboratory in Fresno.

Several irrigation systems were investigated, but this report will consider only 1/2- and 1/4-mile-long furrows and a linear-move sprinkler system. Costs for the irrigation systems and related management expenses were taken from a report by the University of California Committee of Consultants. The irrigation uniformities, as characterized by Christiansen's uniformity coefficient, were assumed to be 70, 75, and 90 for the 1/2-mile furrow, 1/4-mile furrow, and linear-move sprinkler system, respectively.

Variables included in the analysis were cotton price, basic irrigation water cost, water quota, water market price, cost for drainage water disposal, and climatic conditions as characterized by pan evaporation. The amount of applied irrigation water that provided the highest profit to the farmer was determined for every combination of these variables. Applied water is used in this report to represent the infiltrated water that becomes available for crop production or deep percolation. Runoff from furrow systems was recycled and made available for the crop. The computations were done assuming no precipitation was used by the crop.

The optimal amount of applied water, resultant drainage volume, and optimal irrigation technology for various water market prices are shown in figure 1. The results are for the case where there is no drainage water disposal cost, the water price to the farmer is $25 per acre-foot, the water quota is 36 inches, cotton lint price is 75 cents a pound, and the pan evaporation during the growing season is 55 inches.

With no water market price (the present situation) 1/2-mile furrow is the optimal irrigation system, and the full quota of water is applied. A water market price of $35 per acre-foot does not provide adequate economic incentive for the farmer to change either irrigation system or applied water. Increasing the water market price to $60 per acre-foot provides an economic incentive to switch to 1/4-mile furrow irrigation and a slight reduction in water application with subsequent slight reduction in drainage volumes. A water market price of $95 or $120 per acre-foot provides incentive to switch to a linear-move sprinkler system with substantial reduction in amount of applied water and resultant drainage volumes.

Where the farmer must pay for drainage disposal at a rate of $145 per acre-foot, the linear-move is the optimal irrigation system even in the absence of a water market. In other words, regardless of water market price, the drainage costs provide an incentive for upgrading irrigation system.

The net monetary returns to the farmers for different water market prices and drainage costs of zero or $145 per acre-foot are presented in figure 2. Since the high cost for drainage water disposal is a strong incentive for decreased water application resulting in low drainage flows, changing the

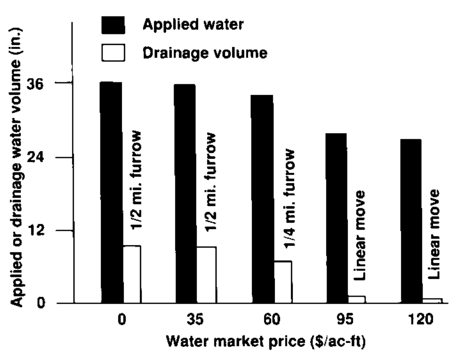

Fig. 1. Increases in water market prices offer incentives to upgrade irrigation systems, reducing applied water and drainage.

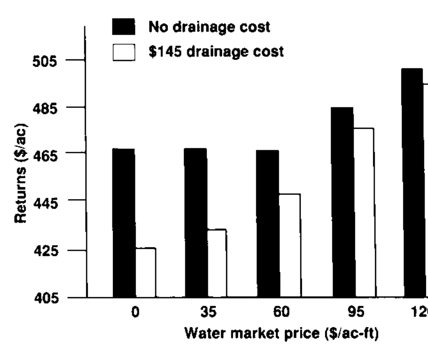

Fig. 2. Profitability to the farmer increases as water market prices rise.

water market price does not greatly affect the optimal amount of applied water (data not shown). With the opportunity to sell the "conserved" water, however, profitability to the farmer increases with increasing water market prices.

With a water market price of $95 or $120 per acre-foot, the farmer's profits are higher after paying the $145 per acre-foot drainage costs than with free drainage but no water market. This finding has great significance for the western San Joaquin Valley, because it suggests that the water market would provide funds for rather large drainage disposal costs.

Conclusions

Water marketing opportunity provides several benefits. Our analysis suggests a water market price somewhere between $60 and $95 per acre-foot would induce a shift in irrigation technology, decreasing water application and making some water available to the urban sector. At the same time, the farmer's profits would equal or exceed those without water marketing.

Water marketing also leads to reduced nonpoint water pollution by greatly reducing the amount of deep percolation. The water percolating below the root zone serves as the transporting medium for agrichemical pollutants such as nitrates and pesticides. Water marketing allows the farmer to pay substantial rates for drainage water disposal with modest loss of income.

The benefits to fish and wildlife would vary and depend on the location. Negative effects of reduced water application could result from curtailed supplies of high-quality runoff water which supplies surface water bodies. Conversely, reduced subsurface drainage volumes potentially containing toxic elements would improve the quality of surface waters. Reduction of drainage water volumes and the farmer's ability to pay disposal costs could enhance the environment for fish and wildlife in the western San Joaquin Valley.

Legal, political, and implementation barriers must be overcome before a water marketing system consistent with this analysis can be adopted. Nevertheless, the results of this study clearly identify the advantages to both urban and agricultural water users and environmental quality. They also indicate that strong efforts to develop a water marketing system directed toward on-farm irrigation management are advisable.

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Cold-tolerant rose clovers

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Seed collected from "native" or wild stands of rose clover withstood the cold, dry conditions of mountainous northern California in exploratory trials. They are potential new legume species for colder rangeland areas.

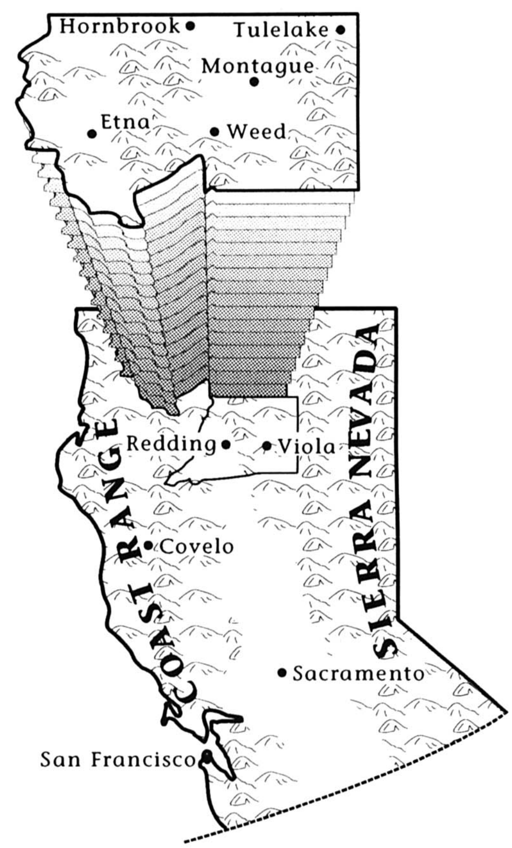
Since rose clover was introduced into California in 1944 by Merton Love, it has become an important forage species on foothill ranges. Acceptance of this winter-growing, naturally reseeding, annual clover (*Trifolium hirtum* All.) in the mild-winter climatic zones has been very good. Hardseededness, or seed-coat impermeability, reduces water uptake by the seed, delaying germination of a portion of the seed crop for a year or more. This property allows survival during years of drought. Nitrogen-fixing by rose clover improves soil fertility. Cattle, sheep, and deer thrive on rose clover, even during the summer and fall when the plants are dry. Doves (*Columba livia* Gmelin), quail (*Lophortyx californicus* Shaw), and other birds consume and spread the seeds. It is also excellent as a low-maintenance, soil-stabilizing plant on disturbed sites.

Unfortunately, the more mountainous areas of northern California have not benefited from the use of rose clover. Over 1.7 million acres of harvested rangeland in Siskiyou, Shasta, Lassen, and Modoc counties are potentially suitable for adapted varieties of rose clover. Currently the only practical legume for these ranges is alfalfa.

Early work in Siskiyou County suggested the possibility of using rose clover. Trials in 1954 with spring (April) plantings at the H. Dillman ranch in Scott Valley and Leavers Ranch in Shasta Valley revealed approximately 3 to 4 inches of growth by May or June. No growth or long-term survival was seen, however, with a similar seeding at the Hart Ranch in Shasta Valley. In the early 1970s, similar trials with G. Barnes in Scott Valley failed to show potential.

In contrast, Wilton rose clover seeded over 25 years ago in an area east of Covelo (Mendocino County) at an elevation of 4000 feet has persisted and spread. Mt. Barker subclover was also planted in the area and performed well until the first colder than average winter. After that, the subclover was completely gone, but the rose clover remained.

"Wild" or naturalized rose clover stands have been found in both Shasta and Siskiyou counties. At 3200 and 4300 feet in eastern Shasta County, vigorously growing and blooming stands of rose clover have been seen along roadways. In Siskiyou County, at an elevation of nearly 3000 feet near the Oregon border, rose clover has been observed since 1980. Communications with previous landowners and man-



The five Siskiyou County trial locations range in elevation from 2800 to 4000 feet. Rose clover seed was collected from naturalized stands near Hornbrook, Viola, and Covelo for comparison with commercial varieties. At present, alfalfa is the only practical legume for these mountainous areas.