

## Results

Irrigation frequencies and soils are the primary factors in the allocation of different crop acreages. In general, as water quality declines, the number of irrigations increases. For example, at 900 ppm most 16X irrigations are selected, but from 1,100 ppm on, the other irrigation frequencies become more common until at 1,400 ppm only cantaloupe on the Indio soil is still using a 16X routine. This indicates that using a high irrigation frequency and maintaining a high soil moisture level would minimize the impact of reduced water quality.

The substitutions of the various production factors become evident from table 2. For example, cotton is grown on the Imperial Complex (clay soil) with 16X irrigation frequencies at 900, 1,000, and 1,100 ppm water. At 1,200 ppm the model shifts cotton to the Holtville-Imperial soil, a better drained soil than the Imperial Complex, substituting a soil type for water quality. Cotton stays on Holtville-Imperial until 1,400 ppm is reached; then it is shifted back to Imperial Complex, but the irrigation frequencies change from 16X to 22X. The irrigation routine or water management system is being substituted for a decrease in both soil quality and water quality. The same general conclusion can be made for sugar beets. This analysis supports the observation that better drained soils can handle low-quality water without drastically affecting crop yield.

An indication of a soil's economic value is its productivity when compared to other inputs that go into growing a crop. This study indicates that both Indio and Holtville-Imperial soils increase in relative value (or decrease less) as the water quality becomes poorer. The Indio soils show the least loss in productivity due to their ability to handle high-salt irrigation water.

Sprinkler irrigation, although commonly used on Imperial Valley farms, especially for germination purposes, did not enter into the optimum irrigation management results until extreme

water-quality values were reached. This is partially explained by the higher costs in renting and moving sprinkler systems. Secondly, it is difficult to quantify some of the secondary benefits of sprinklers on replanting costs and crop quality.

The impact of reduced water quality on farm income is indicated by a 19.5 percent decrease in farm income from 900 ppm to 1,400 ppm water, an average 3.9 percent decrease in income for every 100 ppm increase of total dissolved salts in the irrigation water.

In summary, an economic model defining one of many possible combinations of characteristics of a composite farm firm was developed, representing resources available in the Imperial Valley. The model was used to project significant shifts in cropping patterns as the salt content of irrigation water increased within the framework of the defined system.

A substitution effect appears between water quality and the quantity of water applied through both higher leaching fractions and more frequent irrigations. At high irrigation-water salinity levels, lighter, better drained soils maintain their productivity and therefore their value in agriculture as compared to the heavy clay soils. Finally, decreased yields and higher water use per acre of crops planted are projected to have a negative effect on farm incomes in the Valley as salt content of the Colorado River increases.

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# Irrigating for maximum

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This experiment indicates that a high yield of alfalfa seed can be obtained in the Imperial Valley if water management and insects are properly controlled. Irrigations guided by tensiometer at the 50-centibar level during seed production gave the best yield in 2 years of testing. Irrigation control was obtained by using surface drip irrigation.

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The three main requisites for good alfalfa seed production are irrigation, pollination, and insect control. The latter two can be accomplished with established management practices. The strength of the honey bee force required for pollination depends on factors such as plant population, time of year, and temperature. Insect control can be accomplished with available, proven insecticides. Insecticides that repel honey bees should be avoided.

Irrigation is the major alfalfa seed production problem in the Imperial Valley. Compared with alfalfa plants in other seed-producing areas, those in the Valley have a very shallow root system, normally 18 inches in depth or less, and the evapotranspiration rate is high. Alfalfa seed production is much easier to manage when the plants are deep-rooted. Deep roots are able to pick up moisture from a greater soil storage volume, which can supply moisture to the plant at a constant slow rate throughout the seed production period.

Shallow-rooted alfalfa requires frequent irrigations. If too much water is applied, the plant remains vegetative. To stimulate flower production and pollination, mild plant stress must be created by restricting the soil water supply. If too

# alfalfa seed yield

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Field plots used for study on irrigating alfalfa for seed.

little water is applied, the plant is overly stressed and loses its flowers. To obtain maximum yield, Imperial Valley alfalfa must be irrigated after the crop's seed has set, sufficient to prevent excessive stress until seed filling is complete. In most other seed-producing areas, irrigations after seed set are unnecessary.

Application of too much water to an alfalfa field in full bloom causes a decline in the sugar content of the flower nectar. The nectar's attractiveness to honey bees is reduced, and the bees go elsewhere. Drier conditions also are more favorable for pollen-collecting honey bees, because they prefer more powdery pollen.

## Methods

An irrigation trial was conducted in 1972 and 1973 at the Imperial Valley Conservation Research Center near Brawley to develop a better understanding of alfalfa seed soil moisture requirements for the Imperial Valley. The trial included four irrigation treatments, which were based on soil suction levels at the 9-inch depth measured by tensiometer and/or gypsum block readings. The levels used to schedule irrigations were, respectively, 10 centibars (cb), 50 cb, 100 cb, and 200 cb, starting at the mid-May bud stage. (A dial tensiometer reads from 0 to 100 centibars. The low cb range indicates a high level of available soil moisture; high cb range reflects low soil moisture.) These levels were used from the beginning of bloom, about June 1, until the crop was ready for harvest. During the "hay producing period," all plots were irrigated at 10 cb for maximum hay production. Drip irrigation was used, because it can be precisely con-

trolled. (Under Imperial Valley conditions, sprinkler irrigation appears to affect honey bees adversely, and yields are reduced.)

Moapa 69 alfalfa was planted February 14, 1972, on double-row, 40-inch beds (14 inches between rows) and irrigated with a drip system. (Chapin biwall tube placed midway between the double rows). The plot size was 10 feet by 20 feet (three beds per treatment). Data were taken only from the center beds. The trial included 24 plots, with the four soil water treatments replicated six times. Phosphoric acid was applied through the drip system at the rate of 100 pounds  $P_2O_5$  per acre after removing the hay crop and immediately before seed production. Pesticides were applied for lygus bug control, as necessary. Before seed production started, the hay crop was cut in mid-May in both years. The seed crops were harvested in July 1972 and August 1973.

Four bee colonies were placed near the plots to aid crop pollination.

## Results

The table shows the average alfalfa seed yields. For both years, a peak seed yield of over 1,200 pounds per acre was obtained when the soil suction was controlled at 50 centibars during the seed production period. Soil suction of 10 centibars resulted in excess vegetative growth. Tensions of 100 and 200 cb caused excessive plant stress and reduced seed yields. These effects are properly reflected in the 1972 data but are masked by an equipment malfunction in the 1973 trial. The differences between treatment yield averages were not statistically significant in either year, though

treatment effects were observably large in 1972. Because a wind storm destroyed part of the material as it was being harvested, data from only one complete replication were obtained in 1972. In spite of unfortunate problems in obtaining these data, the advantage of controlling soil suction at 50 cb seems real from these experiments.

AVERAGE ALFALFA SEED YIELDS WITH CONTROLLED SOIL WATER TENSION AND DRIP IRRIGATION

Year	Soil water tension (centibars)			
	10	50	100	200
1972	718	1,267	870	288
1973	1,288	1,372	1,010	1,086

## Conclusions

The best seed yields were obtained by irrigating at a soil water tension of 50 centibars during the seed production period. Lower soil water tension increased vegetative growth and reduced seed set. Higher soil water tensions resulted in reduced seed yields. Fortunately, the best yield was obtained at a soil moisture condition easily measured with tensiometers, so that any grower can utilize the technique. Some already have.

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