ing biological control organisms the water quality can be expected to improve. As a result, this country's commitment to the Mexican government to supply better-quality water from the Colorado River drainage system can be more readily realized. Also, the widespread distribution of fish such as the *Tilapia* that are capable of reducing mosquito-breeding habitats undoubtedly will reduce significantly the threat of invading mosquito-carried viruses such as Venezuelan equine encephalitis, and the need to control such mosquitoes with insecticides.

We anticipate that within a year most waters in the Southern California desert will be treated at savings of one-half to one-third over current techniques . . . a savings over $500,000 in direct costs alone. In addition, water will be delivered to users more efficiently, and indirect savings to users will be realized in the form of more efficient irrigation and greater crop returns.

Conclusions

The biological control of aquatic weeds by imported African *Tilapia* fish in the lower Sonoran Desert of California is possible in practical levels in irrigation canals and drains, and in recreational lakes. In order to extend this control to all portions of the irrigation system, a concentrated effort to increase fish production and efficiency of dissemination are being emphasized to make available large numbers of fish early in the season for annual stocking in problem areas. Severe winter water temperatures reduces the numbers of these tropical species to levels below those necessary for practical control.

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Restricted feeding of

A number of variables govern the amount of feed consumed daily by full-fed laying hens. Most important are body weight, ambient temperature, energy level of the feed, and egg production rate. A change in any one of these variables causes a compensatory change in feed intake as the birds attempt to adjust energy consumption to energy needs. But chickens are not all equally proficient in making that adjustment.

For a number of years, broiler breeder stock has routinely been maintained on limited feeding programs, because these heavy strains tend to overconsume energy when given continuous access to feed. Overconsumption results in a buildup of excessive body fat and less efficient conversion of feed to hatching eggs.

White Leghorn strains, which produce most of California's market eggs, are considerably more efficient than the broiler breeds in regulating energy intake to meet energy requirements. Therefore, it is common commercial practice to full-feed Leghorn layers, giving them access to feed 24 hours a day.

In the past, few questions have been raised concerning the validity of this practice, but more recently, researchers have been reexamining the possibility that Leghorns, too, tend to overeat and that some feed restriction might result in more efficient egg production. The dramatic rise in feed prices has prompted an increase interest in the subject.

The University of California Cooperative Extension has been conducting field trials over the past several years to test the practicality of restricted feeding of Leghorn layers in cages under commercial conditions. The trial to be reported here was carried out in open-type housing at the Orange County Industrial Farm. Access to feed was controlled by hinged covers on the feed troughs (see diagram). From a central cable running the length of the house, a nylon cord was attached through a set of pulleys to each trough cover. A hydraulic ram, when activated by an automatic time clock, pulled the central cable and raised the hinged covers, giving the birds access to the feed. At the end of each feeding period, the ram action reversed and the covers returned to a closed position.

Experimental design

This trial was designed to test three different treatment effects:

1) Effect on performance of full feeding (free access 24 hours per day) vs. restricted feeding (three 1-hour feeding periods per day).
2) Bird density effect on feed intake under full- and restricted-feeding regimes (3 vs. 4 birds per 12-inch by 18-inch cage).
3) Effect of age of bird at initiation of feed restriction (24 vs. 32 vs. 40 weeks) on performance.

The eight treatments were replicated four times, with each rep consisting of 24 layers (eight 3-bird cages or six 4-bird cages). The 768 birds in the test were all of the Shaver strain. Egg production, egg size, feed consumption, and body weight records were kept, starting at 24 weeks of age and continuing through 64 weeks of age.

All treatments received the same ration. During the warm months of the year it was formulated to contain 17 percent protein and 1,225 kilo-calories of metabolizable energy per pound; for the colder winter period the protein level was dropped to 16 percent and the energy raised to 1,250 kcal per pound.

Results

Bird density effect. A comparison of the data in tables 1 and 2 quickly confirms what we have learned in other trials: that crowding layers in cages adversely affects egg production and feed conversion. The higher density treatment was included in this test to determine if crowding further reduced feed intake when feeding time was limited. Percentage-wise, there was a greater restriction in the 4-bird than in the 3-bird cages. However, average daily intake in pounds was

Leghorn layers

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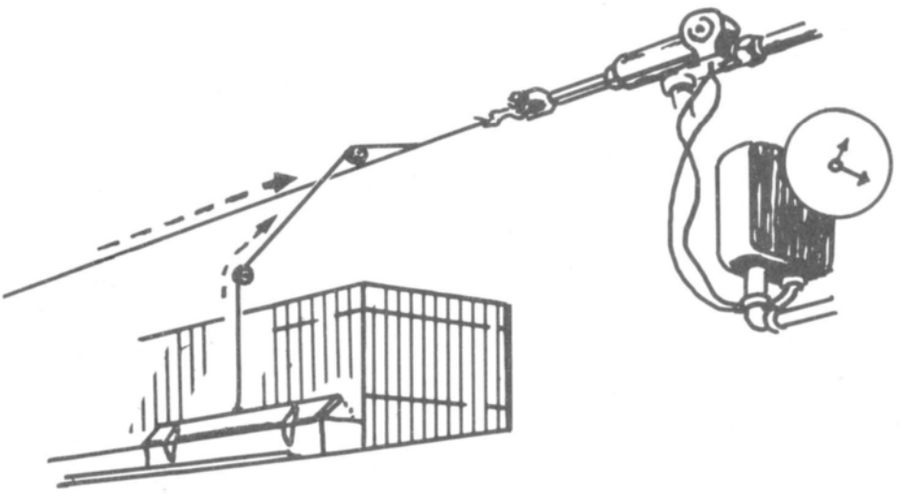

To control access to the feed, trough covers are opened and closed by the action of a hydraulic ram attached to a central cable. The time clock activates a solenoid valve leading to the ram.

TABLE 1. EFFECT OF FULL AND RESTRICTED FEEDING ON PERFORMANCE OF LAYERS HOUSED 3 BIRDS PER 12" X 18" CAGE

		Restricted		
	Full-fed	@ 24 wk.	@ 32 wk	@ 40 wk
Feed intake (lb.)1	26.5	23.1	24.3	24.2
Feed restriction (%)	-	-12.8	- 8.3	- 8.7
Hen-day egg production (%)	70.8	69.5	68.5	68.6
Feed conversion (lb./doz.)	4.67	4.20	4.40	4.61
Egg size (grams)	60.3	59.3	59.1	60.5
Body weight (%)2	103	96	96	103

1 Pounds per 100 birds, average per day
2 Percent of hatchery goal at 64 weeks of age

TABLE 2. EFFECT OF FULL AND RESTRICTED FEEDING ON PERFORMANCE OF LAYERS HOUSED 4 BIRDS PER 12" X 18" CAGE

		Restricted		
	Full-fed	@ 24 wk.	@ 32 wk.	@ 40 wk.
Feed intake (lb.)1	28.1	23.1	24.7	24.4
Feed restriction (%)	-	-17.8	-14.6	-11.8
Hen day egg production (%)	67.7	62.9	62.6	63.1
Feed conversion (lb./doz.)	5.08	4.60	4.85	4.91
Egg size (grams)	60.2	60.2	59.3	59.9
Body weight (%)2	100	95	98	103

1 Pounds per 100 birds, average per day
2 Percent of hatchery goal at 64 weeks of age

unaffected. The poorer performance in the 4-bird cages can only be attributed to increased social stress from crowding.

Because housing four layers per 12-inch cage is not recommended, no further reference will be made to the data in table 2.

Feed consumption. Layers housed three per cage that were limited for the full 40 weeks of the trial to three 1-hour feeding periods per day consumed 12.8 percent less feed than the full-fed controls. Delaying feed restriction until peak production was reached (32 weeks of age) or until the birds were 40 weeks of age reduced the restriction by about one-third.

In a previous test, limiting the feeding time to two 2-hour feedings per day (4 hours total) resulted in an 8 to 10 per cent reduction in feed intake. In this trial, more daily feedings (three) but less total time (3 hours) increased the restriction.

Hen-day production. Rate of lay was numerically lower by 1 to 2 percent when feed was restricted, but those differences were small and statistically insignificant (table 1). Waiting to initiate restriction until the peak or post-peak period had been reached did not improve production. It was our experience that the birds more readily adapted to restricted feeding with less stress at 24 weeks than at an older age.

Feed conversion. The most efficient conversion of feed to eggs was achieved with feed restriction starting at 24 weeks of age. A reduction of 0.47 pound of feed per dozen eggs represents a savings of about $0.03 in production costs or a total of $0.60 per hen on an annual basis at present feed prices.

Egg size. Feed restriction had essentially no effect on egg size in this trial. Intake of both energy and protein was sufficient to meet egg production requirements. If restrictions were to be increased, a point would be reached where egg size would be affected.

Body weight. Body weight differences due to treatment were small, but the trend was for the restricted birds to be lighter in weight.

Conclusions

These results and other data obtained through Cooperative Extension field studies suggest that Leghorn layers do tend to overconsume on full-feeding programs. Some restriction may be in order with substantial economic savings a possibility. Under the conditions of this study, a 12 to 13 percent reduction in feed intake did not adversely affect performance.

A commercial egg producer wishing to adopt the practice of restricted feeding should first carefully assess his present program. What is the current daily feed intake of his flock? Based on the ration formula and intake level, are the birds overconsuming on energy, protein, and other nutrients, according to accepted standards?

If the decision is made to follow a restricted feeding program, continuous monitoring will be necessary to avoid problems. Consultation with a nutritionist would be advisable. It is recommended that a portion of the flock be maintained as full-fed controls so that performance comparisons can be made directly.

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