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SINGLE-DECK CAGES *for* LAYING HENS

AGRICULTURAL EXPERIMENT STATION
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The COVER . . . Aisle view of typical cage house. The operator is filling feed trough directly from a 50-pound paper bag. This method requires less labor than supplying mash from feed carts or buckets.

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SINGLE-DECK CAGES *for* LAYING HENS

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DURING the past few years there has been a great deal of interest in the use of single-deck individual laying cages in the Southeast. The cage system described here should not be confused with the three- or four-deck system that has been used to a limited extent for many years in the South and East. The single-deck cage has several advantages over the multideck cages. (1) It is simple to build and is less expensive. (2) The manure falls to the floor and therefore requires less labor for manure removal. (3) The single deck of cages eliminates over-crowding the house, resulting in every bird having plenty of fresh air without forced ventilation.

HISTORY

Single-deck cages were perhaps first used in Hawaii. However, the greatest advances actually have been made in southern California where the cages have been in use commercially since 1935. It is estimated that in Los Angeles and Orange counties, the most densely populated poultry areas in America, 90 per cent of all poultry farms starting market egg production since 1945 have been of the individual wire-cage type. In 1946 the author visited many of these plants, and upon return to Alabama constructed the first cages of this type in the Southeast in 1947. Since that time the Agricultural Experiment Station has pioneered research with cages, and in 1953 there were over a half million hens in cages in Alabama, Florida, and Georgia. This number will probably double in 1954.

ADVANTAGES *and* DISADVANTAGES

The single-deck cage method has many advantages over other systems of producing market eggs. In general, production of 60 to

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*Acknowledgment is given J. C. Belcher, poultry farm foreman, for valued assistance in collecting records, building equipment, and supervising tests reported herein.

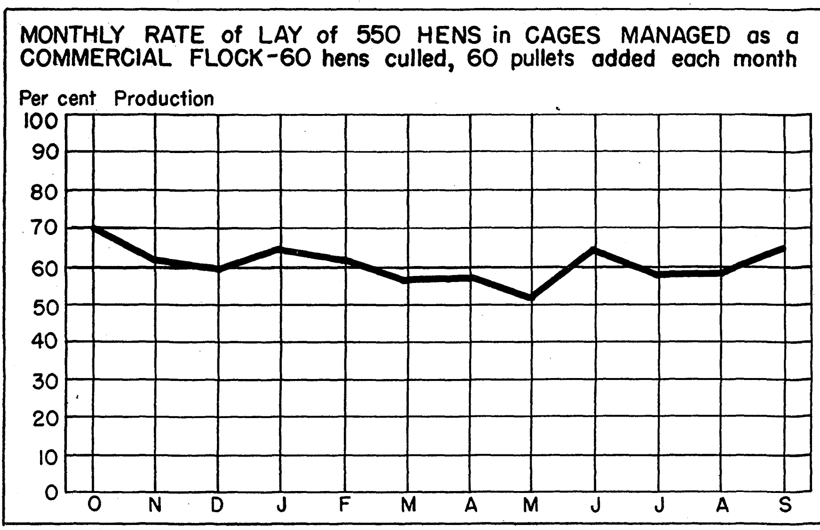

FIGURE 1. Because of regular replacements, rate of lay of cage-managed birds is quite constant throughout the year.

70 per cent throughout the year is obtainable because of extensive use of young birds and accurate, heavy culling. Not only is high average production obtainable with this system but the rate of lay is quite constant during all seasons. This fact is illustrated by the actual production of a 550-hen cage flock at the Agricultural Experiment Station during 1951-52, Figure 1.

These hens averaged 62 per cent production for the year. Their lowest production was 52 per cent in May and the highest production was 70 per cent in October. Uniform production of fresh eggs throughout the year is very desirable in planning a marketing program.

Very few hens show signs of broodiness because of the use of wire-floored pens. A high percentage of the eggs is gathered clean if the egg baskets are kept brushed free of dust. The hens cannot develop the habit of eating eggs if the cages are correctly constructed. Less exposure to organisms and weekly culling greatly reduce death losses, while losses from roundworms, lice, mites, and coccidiosis are easily prevented. Individual cages prevent birds from developing cannibalistic and pick-out habits. The amount of labor used is uniform throughout the year, and all work is done under clean conditions inside a well-ventilated house.

Regular replacement enables the poultryman to keep his house completely full of laying hens every day of the year. This is quite different from the average floor-operated poultry farm where the plant usually operates at full capacity for only about 1 month during the year. Culling and death losses usually result in the plant being about 50 per cent idle during the late summer months.

In Figure 2 is shown the percentage of idle plant throughout the year with floor layers. Cage houses should always be full of laying birds.

Perhaps the greatest advantage is the positive egg record of each hen, which makes culling easy and accurate. This enables a poultryman to obtain a large number of eggs per bird fed. The relationship between costs and profits from layers at various rates of production is shown in Figure 3. Since cage operators average about 225 eggs per hen fed and floor operators average about 180 eggs per hen fed, it is easy to see the advantages of keeping hens in cages for the production of market eggs.

The disadvantages most commonly cited include rather heavy investment per hen, labor requirements, fly problem, and replacements. Investment per hen varies considerably depending upon the amount of mechanical devices used and elaborateness of buildings. The cage house is about the same as that used for a floor flock. The cage, including feed hoppers and waterers, costs about $1.25. The extra investment per hen can thus be estimated to be

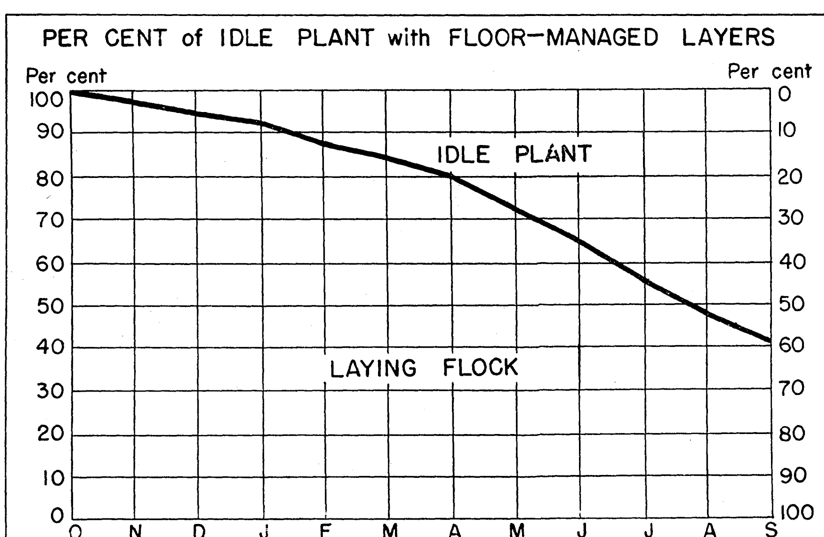

FIGURE 2. A typical floor-managed flock is operated at full capacity only for a short period because of culls and mortality. Thus, under such management the plant is 30 to 60 per cent idle four months of the year.

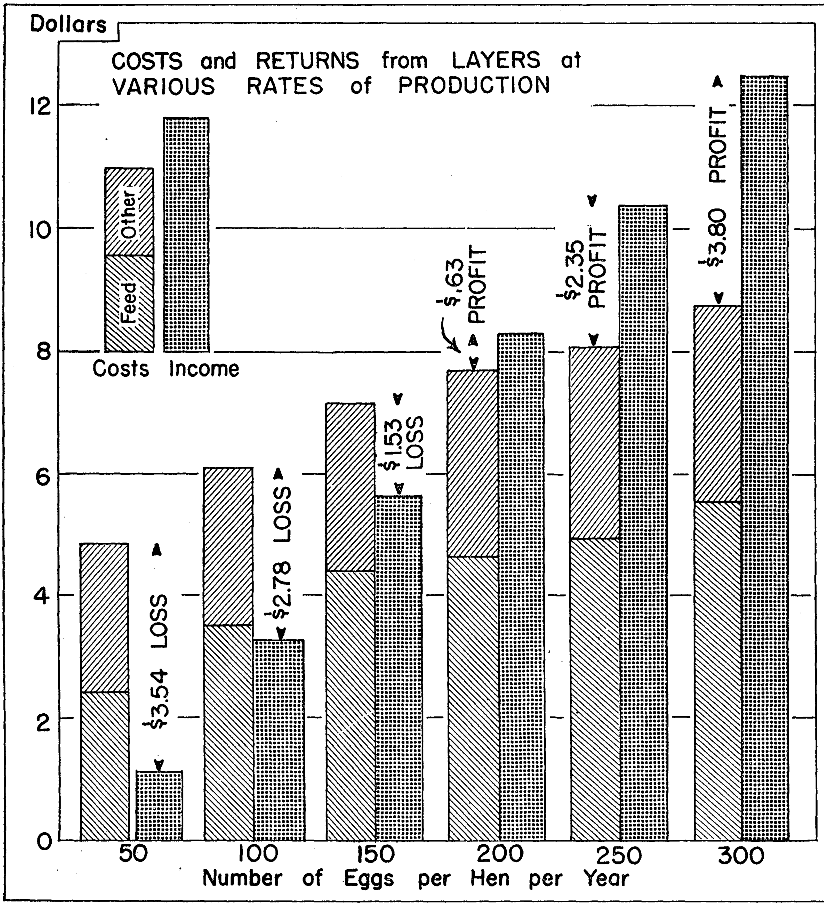

FIGURE 3. As the rate of lay increases, the margin of profit above feed and other costs goes up rapidly. Other costs include labor, housing, interest on investment, taxes, and insurance. Operators who use their own labor to a large extent realize a labor income in addition to the profit shown.

about $1. Results at this Station indicate that the cage system requires a little more labor than the floor method. Sometimes flies become quite a problem around cage plants due largely to improper management. Growing replacements, which requires starting chicks every other month throughout the year, may also be a disadvantage under some conditions.

CAGES *and* CLIMATE

Until the introduction of cages into the Southeast, single-deck cages had been used only in mild climates where only a roof was necessary. Those being operated in the Southeast, with the exception of Florida, are placed in more or less standard poultry houses. This, of course, adds to the starting cost. However, the cost of the house for cage birds is no greater than that for hens under floor-type management. It is not necessary to heat houses for caged layers unless they are located where the outside temperature goes below 15 degrees F. rather often. When cages are located in a well constructed house, the cage system may be found satisfactory for all of the southern half of the United States; if supplementary heat is provided, or insulated buildings are used, the cage system might be used to an advantage in any section of the country.

STARTING *the* CAGE SYSTEM

The best plan to follow in starting the cage-laying system is for the poultryman to decide on the number of layers to be kept and then build the house to accommodate that number of cages. Next he should order enough chicks to fill the house at one time, sometime between January and April. The chicks are brooded on the floor in one end of the cage house, using heatlamps as brooders. Under normal weather conditions, one 250-watt heat lamp will provide heat for 100 chicks. Cages can be assembled in one end of the cage house while the chicks are being brooded in the other end. When the pullets are 8 to 10 weeks old, they may be allowed to range outside the house while cages are being assembled in the remainder of the house. If this is not desirable, 2 three-month-old pullets may be placed in each cage already completed so the brooding end of the house may be cleaned and cages hung. About 4 months after the chicks are started, the operator should start his regular replacement stock, following the plan described under "Replacement Program", page 21.

CAGE HOUSE *and* EQUIPMENT

The house described here is suitable for central Alabama. Operators in Florida may find it desirable to use no side walls of any kind, while operators in northern Alabama should consider building their cage houses so they can be opened in warm weather and closed rather tightly during the winter. Most cage houses are rather narrow compared to the modern types of laying houses. Wide houses do not have any particular advantages for hens in cages. In

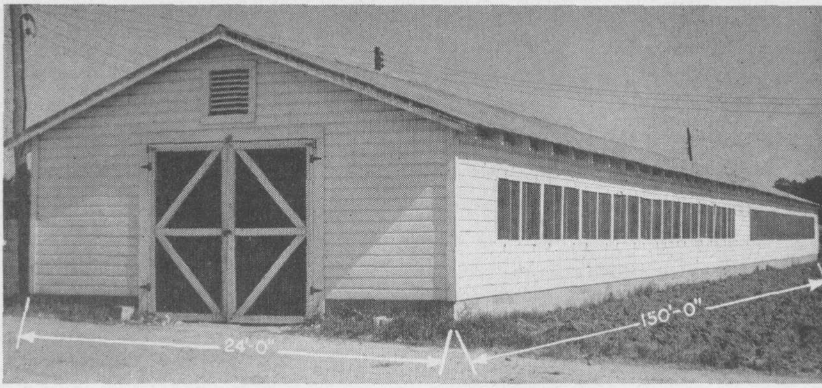

FIGURE 4. Above is one of the 1,000-hen capacity cage houses at the Agricultural Experiment Station of the Alabama Polytechnic Institute, Auburn, where cage-house research was pioneered in the Southeast.

a wide house some hens must remain very close to the outside windows, while others are located in the center of the house. This condition makes it difficult to supply uniform ventilation and light. Hens in the center of the house often need more air and light, while those near the windows may be too cool and have adeqate light. In narrow houses there is less difference between the center and outside cages. Therefore, it is easier to ventilate and supply light to all of the cages.

When ground elevation permits, it is best to build the cage house with the ridge pole running east and west. These houses are cooler in the summer since the late afternoon sun does not shine directly on the cages. They can be made warm in winter by closing all of the north side and possibly some of the south side. Houses running north and south are entirely satisfactory if shade is provided along the west side of the building.

When possible the roof of a cage house should be of aluminum. This material makes the house cooler during the summer months when temperature is important, since caged layers are usually affected more by hot weather than hens kept on the floor. This is because the hens are about 3 feet above the floor where it is hotter than at floor level. Hens in cages are also handicapped during hot weather by being unable to come in contact with the floor, which is usually cooler than the air.

House Plans

A blueprint (No. MI-5) showing the details of constructing a laying cage house and equipment may be obtained from the Extension Service of the Alabama Polytechnic Institute, Auburn. The blueprint was prepared from plans developed by the Department of Poultry Husbandry of the Agricultural Experiment Station. While quite satisfactory, these plans can be modified to suit particular conditions without affecting usefulness. A less expensive house can be built by using treated posts set in the ground as the framework for the side walls instead of the foundation and studs as shown in the drawing. This is the type of construction used in mild climates where no side walls are needed.

It is usually best to leave a dirt floor under the cages if manure is to be removed only 2 to 4 times per year. Concrete walkways may be constructed down the aisle to aid in caring for the hens, but dirt under the cages tends to keep the manure dry and helps in fly control. If flies are to be controlled by weekly or semi-weekly cleaning, concrete floors are an advantage.

Laying Cages

Laying cages may be purchased ready-built, or may be constructed by the poultry farmer. Many factories in the Southeast offer factory-made cages for sale. The choice in this matter is entirely up to the individual; however, in either case the cage should have a door that is easy to open, but which will not allow the hen to get out. The cage should have a large, smoothly jointed hopper. Wire spacing should be close enough to prevent cannibalism. The water system should be easily leveled, cleaned or repaired.

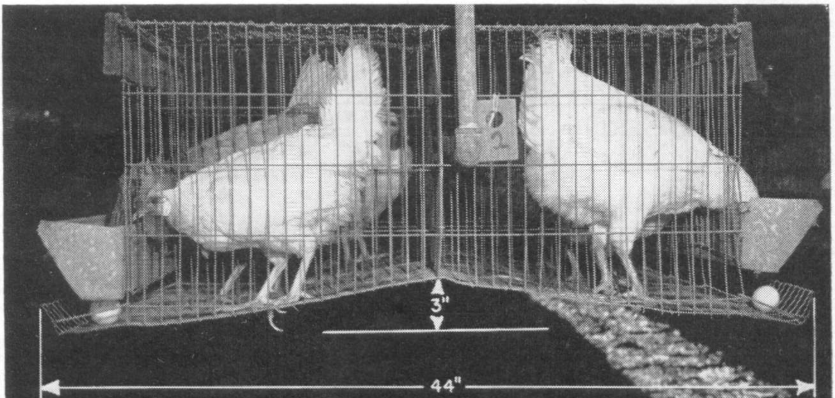

FIGURE 5. End view of back-to-back cage unit, showing width and floor slope. Note location of water supply, feed troughs, and egg baskets. Factory-built cages are usually 54" wide.

The egg tray should be easily cleaned and extend far enough beyond the cage front to keep the hen from picking the egg and allow the operator to gather the egg quickly. The cage should have a simple, fast, and accurate method of recording the production per hen. The cages should be hung securely in straight level rows with rust-proof wire.

The plan of building cages shown in the mentioned blueprint has proved satisfactory. However, minor changes may be made to suit particular conditions without reducing the efficiency of the cage. The cost of the cage is a major item in this type of poultry business. Therefore, any savings that can be made are important. The complete cage includes the feeding hoppers and watering system. Hence, in comparing the investment in cages, it must be kept in mind that for floor-managed birds roosts, nests, feeders, and water fountains must be added to the cost of the house. These equipment items for floor-managed hens usually cost about 40 per cent as much as the complete laying cage.

Results of tests conducted for a 2-year period on three different widths of cages for Leghorns are given in Table 1.

It will be noted that production by months was almost the same in each of the different width cages. This indicates that 8- × 18-inch cages would be the most profitable for White Leghorns considering cage, housing, and labor costs. Mortality was 3 per cent for each of the groups in the 12-month period in 1950-51 and 5, 8, and 9 per cent in 12-, 10-, and 8-inch cages, in 1951-52. Culling percentage was 57 per cent for the 8-inch group, 58 per cent for

TABLE 1. EFFECT OF CAGE SIZE ON EGG PRODUCTION OF LEGHORNS, 1950-51, AND 1951-52

Month	Production obtained by months in		
	12- × 18-inch cage	10- × 18-inch cage	8- × 18-inch cage
	Per cent	*Per cent*	*Per cent*
October	43	40	38
November	51	45	48
December	63	64	60
January	65	66	64
February	63	64	62
March	66	67	65
April	64	66	66
May	62	64	66
June	60	60	62
July	57	58	60
August	56	55	56
September	59	59	61
AVERAGE	59	59	59

FIGURE 6. Side view shows width of cage, which may be 8, 10 or 12 inches depending upon operator's preference. Above the cage doors are the record cards for each individual hen.

the 10-inch group, and 56 per cent for the 12-inch group in 1950-51 and 89, 93, and 102 per cent, respectively, in 1951-52. It is doubtful if the narrower cage would be practicable for heavy breed hens because of the difficulty of turning around. Observations indicate they do all right, however, in 10-inch cages.

Under certain conditions poultrymen may keep two birds in each cage profitably. When this is done the cage should be 12 $\times$ 18 inches in size. Accurate culling is more difficult when this system is used, unless one Leghorn and one Red are placed in each cage so that eggshell color may be used to determine which hen is laying. This system sometimes complicates the feeding schedule. Cannibalism and cowardism are also disadvantages when two laying birds are placed in each cage, and the fly breeding is more difficult to control. However, housing and labor costs are greatly reduced by this plan.

MANAGEMENT

Feeding

The feeding schedule used for layers in cages is somewhat different from that used for layers kept on the floor. The main difference is in the amount of grain fed. A hen in a cage does not get much exercise; therefore, she does not require as much energy feed as a hen kept on the floor. In general, caged hens should receive only about one-half as much grain each day as birds on the floor. When a 20 per cent protein mash is fed, about 5 pounds of grain per 100 hens per day is considered adequate. The hens may become too fat if more than this amount is fed for a considerable length of time.

To determine the best feeding method for layers in cages, the Agricultural Experiment Station in a preliminary test compared the following: (1) commercial pellets; (2) commercial all-mash; (3) commercial all-mash with added B vitamins; (4) home-mixed all-mash ration with high analysis of vitamin D, calcium, and vitamin B; (5) commercial mash with grain fed separately; and (6) 26 per cent supplement and grain mixed together. The protein content of all rations was approximately 18 per cent. The egg-laying records of caged layers fed the foregoing rations in the 255-day test are given in Table 2.

These results should not be taken as final until additional tests have been completed. It does appear that hens in cages fed only pelleted mash did not maintain satisfactory egg production. The commercial mash used gave higher production when supplemented with other nutrients. All-mash gave the same results as mash and grain fed separately. The all-mash ration, however, was easier to feed from the standpoint of labor. All-mash rations can be used for caged layers. The ration should be made special for this type of operation, since a common all-mash ration similar to that used for floor birds will quite likely be too low in protein, vitamin D, and possibly other nutrients. Twenty-six per cent supplement mixed with grain also gave good results, but care must be used with this method to keep the ration properly balanced.

In selecting the brand of feed to use for cages, the poultryman is faced with the same problems as in selecting a feed for floor man-

TABLE 2. RATIONS FOR CAGED LAYERS, 1950

Ration	Egg production
	Per cent
Commercial pellets, hen size	52
Commercial all-mash	59
Commercial all-mash plus vitamin B	63
Home-mixed, high analysis	63
Commercial mash with grain fed separately (80:20)	59
26% supplement, corn, wheat, and oats mixed together	64

TABLE 3. COMPARISON OF FIVE COMMERCIAL FEEDS FOR CAGED LAYERS (5½ MONTHS), 1950

Mash	Culled	Production	Cracked eggs	Price per dozen	Feed cost per dozen	Income per cage above feed cost
	Per cent	*Per cent*	*Per cent*	*Cents*	*Cents*	*Dollars*
A	43	70.6	2.0	49.4	22.50	2.58
B	39	72.4	4.1	48.9	21.22	2.74
C	34	69.6	2.3	49.1	24.27	2.35
D	36	72.5	1.9	48.8	23.94	2.46
E	25	76.2	2.2	50.0	26.12	2.65

agement. There is always some question as to which brand of feed will give the best results. The poultryman can determine this for his particular conditions only by making the comparisons on his farm. The Agricultural Experiment Station conducted tests with caged layers using five common commercial brands of laying mash with limited amounts of grain. Each brand of feed was fed to 100 layers. The results are given in Table 3.

The birds on this test were handled as recommended for caged layers. They were culled each week and the cull birds were replaced with nearly mature pullets. In the case of four of the feeds, the percentage culled was about the same, whereas with feed E it was quite low. The percentage of production also was higher from feed E than from any of the other feeds. Feed D had the fewest cracked eggs, which is an indication of shell quality.

All of the eggs laid by each flock each day were graded into large, medium, and small, and were sold according to the daily prices for those particular grades. The price per dozen shown in Table 3 is the price received for all of the eggs laid by each feed group, and, therefore, is a guide to egg size. In this test, there was very little difference in egg size, which is considered usually not affected much by feed. The cost of feed per dozen is based on the price of the feed and, of course, the rate of lay. Feed E had a very high cost per dozen even though hens on this feed laid at the highest rate. Feeds A, C, and D had about the same feed cost per dozen, while feed B was quite low in this respect. The income above feed cost for the 5½-month period is, of course, the item of interest to most poultrymen. It will be noted that the feed that gave the highest rate of lay and largest eggs did not return as much income over feed costs as feed B. All of the feeds used were quite satisfactory. This test indicates that regular commercial laying mashes that give good results with floor-managed layers will also perform well when the hens are kept in laying cages.

Hens in cages make more efficient use of their feed if supplied some grit. This is fed usually at the rate of 2 pounds per 100 hens on top of the mash about once each week. Oyster shell or limestone is fed also on top of the mash as an added source of calcium for eggshell formation. This should be done 2 or 3 times each week or mixed with the grain and fed daily, since hens cannot store much calcium for future use in forming eggs. Some commercial all-mash feeds contain about 4 per cent calcium carbonate. When such feeds are used, no extra oyster shell or limestone should be fed.

Water Supply

A good supply of cool, clean water is essential to high egg production. Since the cost per bird for a watering system is quite high, this subject, therefore, should be given careful consideration.

One water system used in the experimental cage house consists of a tank in which the water level is controlled by a float valve and a pipe line extending along the center of the cages with one fountain cup for each unit of four hens. The pipe should be ¾ inch in size in order to make drilling and threading easier for installing the cup fountains. The cups are located at the cross partitions so

FIGURE 7. Close-up view of a hen drinking from a fountain cup. One of these is located at the cross partitions of four cages and serves four hens.

that they are accessible for four hens. Hen-size cups will more nearly prevent water waste than will chick-size cups.

The supply tank should be about 4 feet above the drinking fountains to give the correct pressure. The cups will not operate satisfactorily if the pressure is too high or too low. Leaking cups should be removed and cleaned to prevent excess moisture on the floor, which makes it difficult to control breeding of flies. The supply tank and the cup fountains should be checked daily to be sure that the hens are getting water. It is advisable to drain the pipes once or twice daily during extremely hot weather to provide the hens with cooler water. Care should be taken to prevent a water system of this type from freezing, since the system is easily damaged and repairs are costly. It may be drained those nights when freezing temperatures are expected, provided the cage rows are hung at a slight slope to allow the water to drain freely. The water should not be turned on until the temperature in the cage house is above freezing. There are several methods of heating the water that may be used if the cages are to be operated in climates where a considerable amount of freezing weather might be expected.

Insulated nichrome wire, like that used in soil-heating cable, may be threaded through the water pipe containing the cups to serve as a heating element. At each end of the pipe the wire is thrust through a rubber cork. One end of the element is connected to the electrical system and the other end is grounded. A wire 105 feet long with .41 ohms per foot will make a 310-watt heater that will raise the water temperature about 15 degrees. Longer wire gives less heat and a shorter wire provides more heat. Consult an electrical concern for advice before attempting to heat the cage water supply by this method.

Another method of preventing a frozen water system is to heat the water in the supply tank. The warmed water is circulated through the cage supply pipe and back to the tank by a centrifugal pump installed in the water system.

Still another method for supplying water is a continuous open trough extending the length of the cages. The troughs are V or U type with 1½-inch sides. They are made of galvanized sheet metal in sections and cemented or clamped together as they are put into the cage unit. The water tank with a float valve is connected to the trough with a rubber hose. The tank is elevated just enough to supply ½ inch of water in the trough. The trough must be leveled to prevent some cages being without water. Another way

FIGURE 8. A V-type water trough has certain advantages over the pipe-cup system.

of using this water system is to allow water from an elevated tank to run continuously in at one end and out at the other. The V or U type of water supply is less expensive than cup fountains, keeps the floor drier, gives less trouble during freezing weather, provides a watering place for each hen, and allows cowardly hens to drink all the water they want. The greatest disadvantage is the time and effort necessary to keep the troughs clean. A brush just the size of the trough may be used to clean the trough once each week through the opening directly over the trough on factory-made cages. If the water is turned off for about 1 hour regularly each day, the hens will help a great deal in keeping the trough clean by eating as much of the wet feed in the water trough as possible.

Breed to Use

The Agricultural Experiment Station has completed 2 years' testing of breed performance under cage management. Each test was conducted by buying day-old chicks from different hatcheries, raising them together until they started laying, and then keeping them in cages for a 6-month period. A different strain was used each year in an attempt to include more nearly the strains that represent the breeds used. However, since only two strains of each breed were tested, it is obvious the records obtained do not provide

TABLE 4. COMPARISON OF BREEDS FOR EGG PRODUCTION IN CAGES, 1950 AND 1951

Breed	Six-month record per 100 hens starting test				
	Pullet cost	Feed cost	Value eggs	Culled	Mortality
	Dollars	*Dollars*	*Dollars*	*Per cent*	*Per cent*
White Plymouth Rock	130.50	136.51	246.65	37	24
New Hampshire	127.50	168.56	309.32	39	7
White Leghorn	130.00	157.28	294.41	48	15
Rhode Island Red	129.00	163.41	350.42	35	6
Leghorn X New Hampshire	126.00	186.23	430.28	37	6

a very accurate measure of the respective breeds. The results are given in Table 4.

The cost of the mature pullet was determined by deducting the income of the fryers sold at 10 weeks of age from the feed and chick cost. Since fryers were a good price at the time these were sold, the heavy breeds had some advantage over the Leghorns. There was practically no difference in the cost of producing pullets of the various breeds under these conditions.

In general, the breed that had the highest feed cost produced the greatest number of eggs as indicated by the value of eggs. Breeds with a low feed cost produced the least number of eggs. The Leghorn-Red cross produced eggs at the lowest feed cost per dozen followed by Rhode Island Reds, White Leghorns, New Hampshire, and White Plymouth Rocks. The strain of Leghorns used in 1950 performed very poorly and it is believed from other tests and field trials that Leghorns rate higher for use in laying cages than the results of this test indicate. The performance of the cross-bred birds was very good.

There was not a great deal of difference in the percentage culled, and the relatively low culling rate for cages accounts for higher than usual mortality and also the rather low income per hen above feed costs. The mortality among the White Plymouth Rocks and White Leghorns was especially high, due mostly to fowl leucosis.

These tests seem to indicate that any breed or strain that will do well in the production of eggs under floor management will also do well when kept in cages.

Record System

One of the main advantages of the cage system is that closer culling can be practiced, which in turn results in a higher percentage of production and in lower mortality. To make the most of this advantage, it is necessary to have an adequate record system. The system may be simple or complex. To be of most value, it should not be so simple that it fails to provide all of the needed information. On the other hand, it must not be so laborious that its value is lowered because of the labor cost. In the simpler systems, washers on a wire, clothespins on cage wires, or pegs in holes are used to record a 7- to 14-day laying period. While the simple system is of great value in culling the hens, it does not provide as much information as is needed for best operations. It is almost necessary to have some type of card record of each hen on which the date she was hatched, breeding information, date she started to lay, molt periods, broodiness, and similar information can be kept. A card of this kind may be attached to each cage, or kept in a book at the entrance of the house. Of course, a combination of these two systems may also be used. The 2-week egg production record may be kept on the cage by a mechanical counting device and this record put on a card along with other necessary information at the end of each 2-week period. It is doubtful if any one type of record system has all of the advantages. The system that will suit the particular cage operator and provide the foregoing facts is the one that should be used.

FIGURE 9. To save time, the operator records only hens that fail to lay.

Culling

The rate of culling will vary from year to year, depending upon quality of pullets raised, price of eggs, and price or market for culled birds. To obtain high production is very important in order to justify the rather high investment per bird and to make the operation profitable. Culling is one way of keeping the rate of lay high. However, under certain conditions culling may have to be kept to a minimum, while under other situations there is practically no limit to the number that may be culled profitably. To answer this question, the operator must know the cost of growing a replacement pullet and the average value received for each cull hen. When these two figures are about the same, the culling program should be very strict. As a guide, the operator should each week remove any hen that has failed to lay 7 eggs in the past 14 days. When the cost of growing a new pullet is considerably greater than the amount received for a cull hen, the operator should be a little more lenient in culling the slower producers, especially if eggs are bringing a high price per dozen. The culling rate may vary from 5 to 10 per cent of the flock each month. When the operator is a good manager and breeding, feeding, and disease are properly looked after, an average of 240 eggs per cage per year can be maintained by culling about 8 per cent each month.

Lights *for* Caged Layers

Hens in cages will respond to artificial light about the same as hens kept on the floor. It is best perhaps to use both morning and evening lights in cage houses, since no dimming system is necessary. By so doing the operator can control the end of the working day. He will not have to keep changing the turn-on time of morning lights to prevent the daylight period from getting shorter due to the sun setting earlier each day during the fall of the year. A 14-hour day is desirable. It is usually necessary to start using light sometime in August to maintain this length of day and to continue using light during the fall, winter, and until about April. During the winter months if the rate of lay goes unusually low, a longer working day may be used with the corresponding increase in production. However, when more light is used, it is more difficult to discontinue light in the spring without a drop in the rate of lay. One light bulb every 10 feet down a row of back-to-back cages supplies adequate light for the hens. If 3 rows of cages are placed in the house, the center row of lights should be staggered so that the bulbs in this row will be located midway between the bulbs on the two outside rows of cages. One 25-watt bulb per socket will provide enough intensity of light; however, if winter production lags, the hens may be further stimulated by increasing the intensity with 40-watt bulbs. The more nervous Leghorns seem unable to stand light of greater intensity for any great length of time. All-night lights may be used throughout the year instead of morning and evening lights. Under this system the rate of lay is usually very high, but the rate of replacements also may be greater.

Fly Control

If a cage-type poultry unit is located in a suburban area close to other dwellings and town property, flies must be controlled because of public health. There are two ways to attack the problem: killing adults and controlling breeding. Both are necessary in order to obtain satisfactory control.

Adult flies in and around the cage house may be killed by several different methods. The walls and doors may be sprayed with a DDT or a BHC spray. These sprays have fairly long life and the areas treated will continue to kill flies and mosquitoes for several weeks. Since flies become resistant to either of these products, it is best to alternate between the two. Little danger is involved as far as the chickens are concerned. Other sprays usually of the pyrethium type are good adult fly killers, but they do not have any great lasting effect. Many flies also can be killed by electrically baited fly traps, common home-made fly screen traps, or poison bait. All of these systems are of little value unless efforts are made to prevent flies from breeding in the manure under the cages.

Flies do not breed freely in **dry manure**. Therefore, excess moisture in the manure should be prevented. The watering system should be checked regularly in this respect. Adequate floor ventilation is helpful. The area directly underneath the cages should consist of coarse sand or gravel that will drain well so that excess moisture will drain quickly. Manure piles that resemble a cone under each hen dry much more quickly than piles that are flat. Therefore, every effort should be made to assist in the formation of cones by (1) allowing manure to accumulate before start of fly season, (2) maintaining dryness, and (3) spraying to kill larvae. Lime and phosphate may be added to the manure weekly to control odors, keep the manure drier, and add to the fertilizer value of the manure.

If fly breeding cannot be controlled by dryness, larval poisons may be used. Usually these are applied in liquid form with a garden sprinkling can. One or two applications per week are necessary. Aldrin or dieldrin may be used at the rate of $5\frac{1}{2}$ and 7 ounces of 18 or 23 per cent emulsion per 100 square feet; or polybor may be used at the rate of 2 pounds per 100 square feet per week. As a word of caution, this amount of borax will make the manure unusable as a fertilizer for crops having a low-boron tolerance. Another warning is that aldrin and dieldrin are quite poisonous in the concentrated solutions. Therefore, they should not be allowed to remain in contact with the skin. Fuel oil sprinkled under the cages also will control fly breeding, but the manure is not satisfactory for crops after much of this product has been used. The oil also increases the danger of fire.

No one particular control measure will solve the fly problem. It will require a combination of measures, putting most effort on the conditions that are most troublesome. When the cage house is located close to dwelling houses, it may be necessary to clean under the cages once or twice a week during the fly season to attain absolute control of fly breeding. This can be done without excessive amounts of labor if a V- or U-shaped drag is pulled the entire length of each back-to-back row of cages. The manure is then picked up at the end of the house and hauled to distant fields or spread very thinly over adjacent areas. Sawdust sprinkled under the cages after each cleaning allows the drag to be more easily and effectively used.

REPLACEMENT PROGRAM

After the cage system is underway, a few chicks are started every 2 months to keep the cages full of laying hens at all times. This means that the growing equipment is used continuously throughout the year. Therefore, only about one-fifth as much equipment is required as is usually needed. There is some variation in the number of replacement pullets each month. The rates at which the hens were culled by months over a 1-year period to maintain a 60 per cent or better production are as follows:

MONTHS	AVERAGE CULLING RATE PER MONTH
	Per cent
January, February, March	6
April, May, June	7
July, August, September	10
October, November, December	6

The foregoing rates show that the heaviest culling was done during summer months when weather was hot and normal molting tendency was greatest. The largest number of replacement pullets should be started in the early spring to take care of this high culling rate. It is advisable to have plenty of replacement pullets available. The extra pullets usually can be sold at a profit to back-yard poultry keepers. It is pointed out that cage operations are never as profitable as they should be when there is a shortage of ready-to-lay pullets. When this is the case, culling is neglected, rate of lay declines, mortality increases, and income is materially lowered.

Range- or Confinement-Raised Pullets

In the spring of 1950, the Agricultural Experiment Station bought 300 chicks of each of five different breeds. The chicks of each breed were brooded on the floor of a colony brooder house until 2 months old. The pullets were then divided; half of them were raised to maturity in wire-floored outdoor growing pens and the other half was allowed free range on a clover-grass area. All pullets were given the same management in laying cages after reaching maturity at about 5 months. Results of this test are given in Table 5.

The range-raised pullets showed their superiority over pullets raised in confinement. The range pullets in this test cost less to raise, laid more eggs, and had lower mortality and fewer culls. The exception was with the New Hampshire breed. It is possible that this breed, used so much for confinement-broiler production, may excell all other breeds under close confinement.

It must be kept in mind that providing range for small flocks of replacement pullets of different ages throughout the entire year is much more difficult than raising a flock of about the same age on

TABLE 5. COMPARISON OF CONFINEMENT- WITH RANGE-RAISED PULLETS

Breed	Cost		Eggs laid		Mortality		Culled	
	Range	Confined	Range	Confined	Range	Confined	Range	Confined
	Dol.	*Dol.*	*No.*	*No.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
White Rock	1.15	1.22	94.3	90.0	4	4	42	44
New Hampshire	1.15	1.20	91.6	113.0	2	0	52	32
Leghorn	1.30	1.34	85.1	70.4	4	6	66	62
Rhode Island Red	1.18	1.26	118.4	71.6	0	4	32	70
New Hampshire X Leghorn	1.19	1.24	106.9	97.9	4	2	42	52
AVERAGE	1.10	1.25	99.3	88.6	2.4	4.0	46.8	52.0

range during the spring season. Pullets of different ages must be separated by a fence or the shelters located quite a distance apart to prevent mixing. This adds considerably to the cost of rearing because fences must be provided or extra time must be spent tending each shelter. It is also quite difficult to provide good range during the hot summer, dry fall, and cold winter months. Pullets do not range very freely during any of these periods. Also, there is the danger of parasite and disease troubles with range-reared pullets. At the Agricultural Experiment Station pullets are raised in confinement, except during the spring, because of the foregoing conditions.

Equipment

There are many types of brooding and growing equipment that are satisfactory for raising pullets. In many cases the system or equipment found successful by one grower will have to be modified somewhat to fit conditions of other operators. At the Agricultural Experiment Station two general systems are in use.

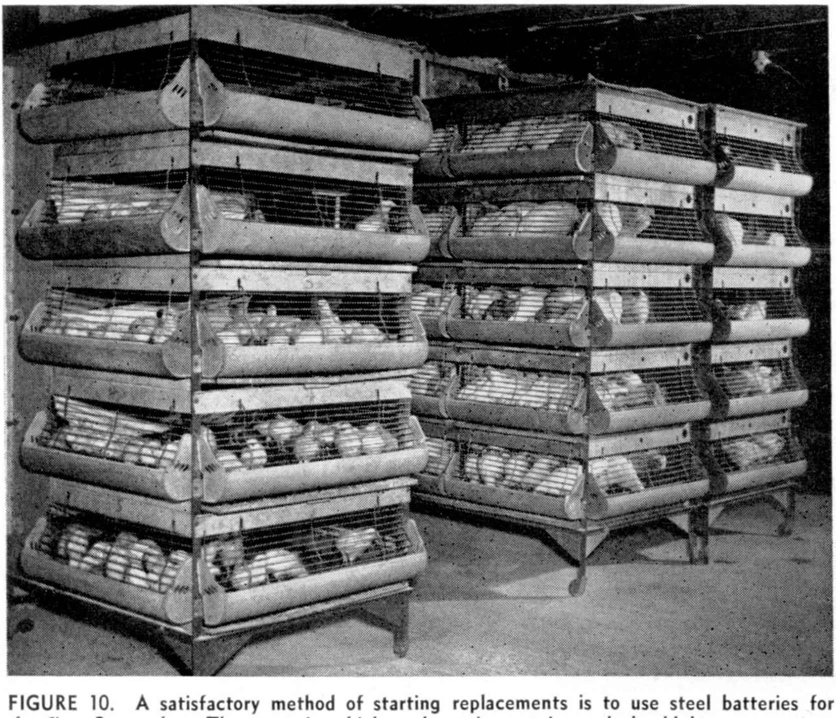

FIGURE 10. A satisfactory method of starting replacements is to use steel batteries for the first 2 months. The room in which such equipment is used should have some supplementary heat.

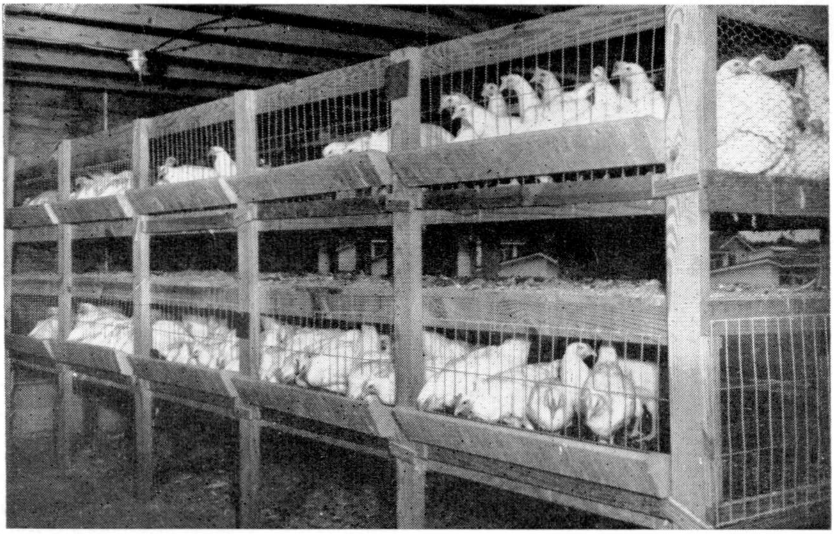

FIGURE 11. Home-made wooden batteries may be used for developing pullets 3, 4, and 5 months old. When mature the pullets are used as needed to replace culled hens.

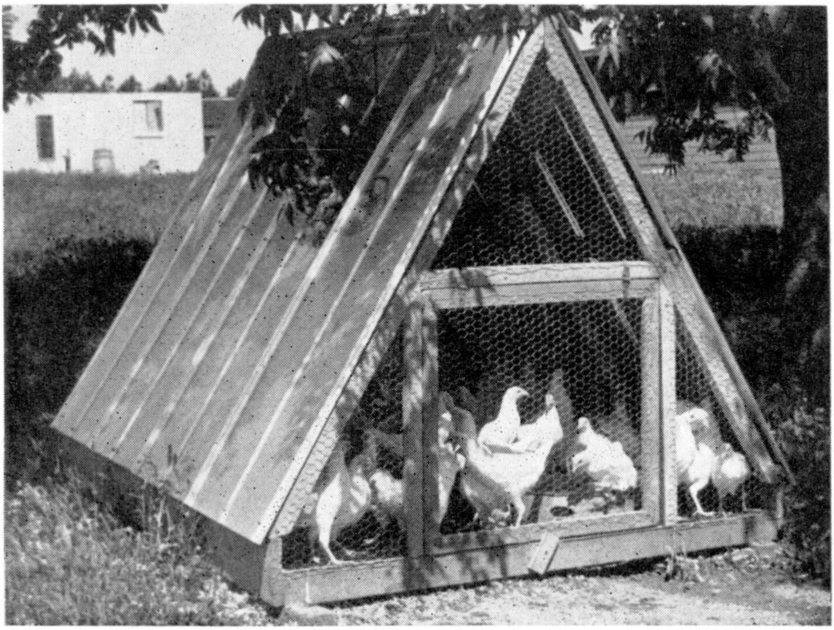

FIGURE 12. An alternate system of growing replacements consists of using small range shelters for both brooding chicks and developing pullets.

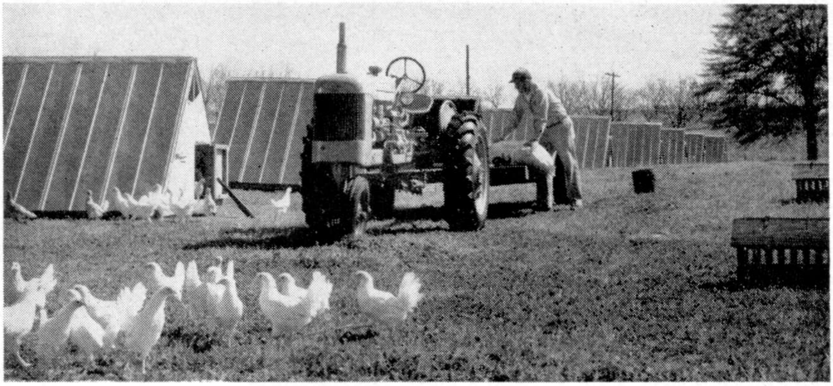

FIGURE 13. Range-raised pullets are superior to confinement-raised birds when range and weather conditions are favorable.

If the cage flock is between 500 and 1,000 hens, therefore, requiring 100 to 200 pullets every other month, perhaps battery brooders are the most satisfactory way of starting the chicks. When the flock is larger, a floor brood of chicks started every other month will require less labor. In both cases the chicks can either be moved to wire-floored developing cages, Figure 11, or to range shelters,* Figure 12, for the remainder of the growing period.

The chicks should not be overcrowded or cannibalism may be serious. The young chicks should be isolated as much as possible from both the growing pullets and laying hens. The success of the cage operation depends to a great extent upon the quality and adequacy of the number of pullets raised. This job must be done right and carefully planned if the cage flock is going to do well.

Vaccination

In practically all sections of the United States, it is now considered essential to vaccinate growing pullets to prevent outbreaks of fowl pox during the laying period. This is a simple, inexpensive practice that may be done any time after the chicks are 2 weeks old and until they are 4 months of age. Perhaps the most desirable time is around 2 to 3 months. Fowl pox is not nearly as likely to appear and cause losses in egg production of pullets kept

*Completely described in Leaflet No. 28 published by the Agricultural Experiment Station of the Alabama Polytechnic Institute.

in cages (one to the cage) as it is in a flock kept on the floor, provided mosquitoes are kept under control. However, it is still a good management practice to vaccinate pullets to prevent this disease.

In many sections Newcastle disease is rather common. In order to prevent losses in egg production due to this disease, it is advisable to vaccinate pullets by the web-wing method, using a live-virus vaccine when they are about 2 to 3 months old. Should the disease make its appearance in young chicks, it may be necessary to use the nasal-type vaccine on day-old chicks to prevent losses. If this is done the pullets should be revaccinated by the web-wing method just described when they are 2 to 3 months of age in order to make certain of full, lifetime immunity. It is a rather general practice to mix the virus (dry powder) of Newcastle and virus of fowl pox, using only one diluent and vaccinating for both diseases at the same time.

In a few areas it may be necessary to consider immunizing the pullets against infectious bronchitis. Since this disease may be spread quickly to nearby chicks or hens, which might cause high mortality or loss of eggs, any poultryman considering this should contact recognized poultry specialists for further information.

FIGURE 14. Shown here is the wing-type method of vaccinating 2- to 3-month-old pullets against fowl pox and Newcastle diseases.

PRODUCING HATCHING EGGS

The cage system was developed primarily for use in the production of commercial market eggs; however, the success of this system has interested many poultrymen in keeping breeding flocks in cages. This program requires artificial insemination of the hens to obtain fertile eggs.

A technique of artificial insemination for poultry was developed in 1937. Since that date a great deal of research on the subject has shown that fertility between 85 and 95 per cent can be maintained by inseminating hens once each week. The method generally used requires two experienced operators; however, the procedure is not difficult to learn, and after a few hours of practice, two operators should be able to inseminate 200 or more birds per hour. Semen is collected from the males, also kept in individual cages, by the following method: The male is stimulated to protrude his copulatory apparatus, and the semen is squeezed or "milked" from the bulbous ducts by pressure of the thumb and forefinger around the vent.

The amounts of semen collected from male chickens average between 0.5 and 1.0 cubic centimeters per collection. Except in the case of pedigree breeding, the semen from several males may be collected and pooled before inseminating the females; however, one should not collect a larger volume of semen at one time than can be used in 20 or 30 minutes. For maximum semen production, males should be worked either every day or every other day.

Since it is very difficult to collect semen from males running with females, it is necessary to segregate the males from all females. Best results will be obtained when males also are separated from each other. Some cage operators practicing artificial insemination keep their males in the regular laying cages. In this case, careful observations should be made to see that the male's large comb and wattles do not prevent him from drinking freely from the water system used.

For artificial insemination of a female, the oviduct must be extruded through the vent so that a syringe containing semen can be inserted directly into the vagina. This is done by sudden pressure above and below the vent, which causes the oviduct to protrude. There are two main openings or tubes inside the hen's vent, the oviduct being the one on the left side. The protruded oviduct, in general, resembles a small red tube that has had its sides folded back on itself.

After the oviduct is extruded, a 1 cc. tuberculin syringe (graduated in hundredths and without needle) containing semen is inserted about 1½ inches into the oviduct's opening, and the semen is injected. All pressure should be released from the hen's body before the plunger of the syringe is forced. The semen and the syringe is manipulated by the second operator.

Each female should be inseminated once each week, in the afternoon, with .05 cc. of semen. A small percentage of the eggs produced the first day after insemination will be fertile; however, hatching eggs should not be saved until the second or third day after the first insemination.

A male yielding 1 cc. of semen per collection could possibly keep 20 hens per day or a total of 140 hens per week inseminated, assuming that birds are worked 7 days per week. In a practical program, however, one should depend only on a minimum average yield of semen per male (0.5 cc.), and probably should count on inseminating only 5 or 6 days per week. The number of females that can be inseminated per male per week under these conditions is between 50 and 60.

When rearing males to be used in artificial insemination, one should produce about twice as many mature males as will actually be used to produce the necessary amount of semen for the flock. This will permit culling for physical defects and also will enable the operator to select those males that produce an abundance of semen. Several males also should be kept in reserve to replace those lost to disease and other causes.

Although the technique of artificial insemination is not difficult to learn, it is much easier to master after having witnessed the operation performed by experienced operators. It is suggested that those persons interested should contact the poultry department of the agricultural college of their state for a demonstration.

Field results in producing hatching eggs by this system are so limited that the author cannot recommend this plan for general use over the standard floor system at this time. It does seem to be efficient and practical for the use of poultry breeders and possibly some broiler hatching egg producers.

POSSIBLE PROFITS *from* MARKET EGGS

The question of how much profit can be made from production of market eggs in single-deck cages is one that is impossible to answer. There are many factors to be taken into account, none of which can be forecast with any degree of accuracy. Any kind of estimate depends upon normal conditions that, according to many, never exist.

First, the cage system is not a substitute for good business judgment and poultry knowledge. It might be easier for the beginner to start with cages rather than with the floor system. However, over a period of time, success will depend more on the operator than on the method. There are so many different systems of managing hens on the floor or in cages and the two systems are so different that it is almost impossible to actually compare the two systems under similar conditions.

Perhaps the best reason to consider hens in cages more profitable for production of market eggs than hens on the floor is that, where this system has been used for any length of time, practically all of the new houses are of the cage type. This is true for those starting in business or for old-time poultrymen who are remodeling or otherwise increasing their laying flocks. L. P. Sharp and A. D. Reed, University of California, in 1950 made a survey of 25 different flocks involving 31,000 layers. Their results show that cage flocks returned to labor and investment $2.68 per bird, whereas, floor-managed flocks returned $2.22 per layer. The cage flocks returned above labor and investment 78 cents per bird as compared to 34 cents per floor-managed bird. Cage flocks had a higher income per hen from eggs—$8.72 compared to $7.47. Cage flocks laid an average of 230 eggs, or 24 more eggs per hen than the average of the floor flocks. Cage flocks laid 2 per cent more large eggs, 2 per cent more fall eggs, and 17 per cent more pullet eggs. The floor-managed flocks had a lower feed cost per hen than cage birds, $5.41 as compared to $6.27. Cage flocks used 17 pounds more feed per hen. Culls from cages brought 9 cents more per hen than from floor flocks.

At the Agricultural Experiment Station, Auburn, Leghorn hens managed on the floor averaged about 200 eggs per year, with an 18 per cent mortality. Similarly managed hens in cages laid about 236 eggs per year per hen fed, with about 3 to 5 per cent mortality. This means that the culling system used resulted in about 3 dozen more eggs per year per hen fed, and in reduced death losses of about 14 hens out of each 100 kept. The 3 dozen extra eggs had a value (August, 1953) of about $1.50. This together with the lower mortality amounted to about $1.75 more labor income per hen, since other costs were about the same. In other words, if an operator realized a labor income of $2.00 per hen from a floor-managed flock, he should realize a $3.75 labor income per bird from hens managed in cages.

The cage plant is really a factory where routine schedules can be adopted and factory methods of efficiency can be applied. Since little land is necessary, it can be located near attractive markets for poultry and eggs. While this system is not likely to supersede floor and range plants as a whole, it will supplement production of high quality eggs or compete for the market. No one can advise any poultryman off-hand whether he should adopt the cage system in preference to the floor system or vice versa. However, a study of conditions in the area where the poultryman intends to build his business, an examination of available capital and other assets, and an evaluation of his own inclinations and abilities should make it reasonably easy to determine whether he should continue to use the old standard floor system or adopt the newer cage system.

ACKNOWLEDGMENT

Credit is given to Lawrence W. Todd of the Progressive Farmer staff for photographs appearing on the cover page and on page 16.

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