8-1961

# Factors Affecting the Performance of Broilers

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To the Graduate Council:

I am submitting herewith a thesis written by G. R. Nair entitled "Factors Affecting the Performance of Broilers." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Science.

Dr. H.V. Shirley, Major Professor

We have read this thesis and recommend its acceptance:

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Accepted for the Council:
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Vice Provost and Dean of the Graduate School

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August 14, 1961

To the Graduate Council:

I am submitting herewith a thesis written by G. R. Nair entitled "Factors Affecting the Performance of Broilers." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Poultry.

A. V. Shirley Jr.
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We have read this thesis
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# FACTORS AFFECTING THE PERFORMANCE OF BROILERS

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A Thesis

Submitted to

The Graduate Council of

The University of Tennessee

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In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

G. R. Nair

August 1961

ACKNOWLEDGEMENT

The author wishes to express his sincere gratitude to the International Cooperation Administration of the United States Government, the Government of India and the Government of Kerala State, and the University of Tennessee, for having made this work possible.

The author wishes to acknowledge the assistance of and express appreciation to:

Dr. H. V. Shirley, his Major Professor, under whose guidance the research was conducted and the thesis prepared.

Dr. O. E. Goff, Head of Poultry Department, for technical guidance and advice in all phases of the author's graduate program.

Mr. Robert Smith, Mr. Robert Mitchel, Mr. David Shoaf, and to Mr. George McGhee, members of the Poultry Department staff, for assisting in the collection of data presented in this thesis.

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# INTRODUCTION

The efficiency of broiler production has increased greatly in recent years and can be attributed to advancements in the areas of breeding, management, nutrition, and disease control. No single factor in any one of these areas can be said to account for the major share of this increased efficiency but rather it is the combination of a large number of factors such as breeding techniques, and breed improvement, of improved management practices, and of advances in nutrition and disease control.

The optimum combination of conditions or factors for broiler production is seldom, if ever, realized. Information which might have been considered adequate at the time it was obtained may soon become out-dated. To continue to increase the efficiency of broiler production, frequent re-evaluation of management factors must be made and new practices developed. It was with these thoughts in mind that the series of experiments herein reported were designed and conducted.

# OBJECTIVES

Experiments were conducted to evaluate the effects of a number of management and nutritional factors on the performance of broilers. Factors studied were:

1. Age of the chicks when first placed under brooders.
2. Floor space per chick to five weeks of age.
3. Floor space per chick to nine weeks of age.
4. The feeding of a tranquilizer.
5. The feeding of an estrogenic substance.
6. Debeaking at one day of age.
7. Intermittent vs. continuous feeding.
8. Size of feed trough.

# LITERATURE REVIEW

The most commonly recommended floor space allotment for broiler chicks is one sq. ft. per bird. There is a wide variation among poultrymen in the amount of space they allow each broiler chick, however. The determination of the optimal space per chick is made difficult because of the many factors involved. On no two broiler farms is it likely that all of these factors would be the same. Among these factors are: season of year, disease conditions, litter condition, live and dressed quality of the birds, housing costs, feed efficiency, feed and water space, and size of the birds at market age.

The first report of an experiment conducted with commercial broilers to determine the influence of the floor space allowed was that by Tomhave and Seeger (1945). Floor space allotments were .5, .6, .75, and 1.0 sq. ft. per bird. In addition, range space was also provided. They report that as floor space was increased rate of growth also increased. Feed efficiency was not related to floor space. There was a higher incidence of coccidiosis in the pens where floor space per bird was less.

Mehrhof and O'Steen (1948) compared the performance of broilers when .5, .75 and 1.0 sq. ft. per bird was allowed. Range was also provided. The birds receiving

1.0 sq. ft. were the heaviest at 12 weeks of age while those allowed 0.5 sq. ft. the lightest. Feed efficiency was best at 1.0 sq. ft. Litter conditions were poorest in the pen allowed only 0.5 sq. ft. per bird.

In a study on floor space reported by Heishman et al. (1952), 0.5, .75, and 1.0 sq. ft. per chick were compared. Cannibalism, increased mortality, increased number of culls, factors generally attributed to crowding, were not encountered in this series of trials. Differences in the quality of the dressed birds between the crowded and uncrowded pens were not significant. Crowding did not reduce average body weight.

In tests conducted during the Summer and Fall Thayer et al. (1953) reported no differences in the growth rate of broilers provided with .75 and 1.0 sq. ft. per bird.

Hartung (1955) compared floor space allotments of .5, .75, 1.0, and 1.25 sq. ft. per bird. As the floor space increased there was a corresponding increase in body weight, an improvement of feed conversion, and an increase in the per cent of grade A carcasses. Litter moisture decreased rapidly as space increased.

Brooks et al. (1958) conducted experiments during Spring, Summer, and Winter to determine the effect of floor space on broilers. The treatments were: .5, 1.0, 1.5, and 2.0 sq. ft. per broiler. There was a progressive decrease

in body weight as floor space per broiler decreased but these differences were relatively small up to the ninth week. Feed was utilized most efficiently in the pens where the broilers were provided 1.0 and 0.5 sq. ft. of floor space each.

It was found in a study by Siegel and Coles (1958) that space allotments of .5, .75, 1.0, and 1.25 sq. ft. per chick had little, if any, effect on body weight or feed efficiency at 4, 6, and 9 weeks of age. Litter conditions were satisfactory under all conditions.

Growth rate of broilers decreased as population density was increased in a study reported by Hansen and Becker (1960). These workers provided .5, .75, 1.0, and 1.25 sq. ft. floor space per bird.

The use of tranquilizing agents in poultry production is of recent interest. These drugs have been shown to be capable of alleviating the effects of various stress factors in chickens as well as in other animals. As there are many stresses affecting poultry, it is reasonable to postulate that certain of the tranquilizing drugs may have a practical place in poultry production.

The laboratory studies of Burger et al. (1959), Van Matre et al. (1957), Huston (1959), and Weiss (1959) have demonstrated that reserpine protected against acute lethal heat stress both from the standpoint of extension of

survival time and reduced production losses in the broiler and laying bird.

Reports of the effects of tranquilizers upon growth rate of chickens are few. Garren and Charles (1957) found that Sparine[1] and Miltown[2] fed to White Leghorns at levels of 125 and 250 mg./lb. of feed caused a reduction in body weight. Serpasil[3] treated White Plymouth Rock males kept at high environmental temperatures showed a slight but higher body weight over non-Serpasil fed males as reported by Huston (1959).

Burger et al. (1959) reported that chlorpromazine fed to S. C. White Leghorn chicks at levels from 10-100 mg./kg. of diet caused a slight but significant increase in growth by the 24th day of age. This drug depressed growth at higher levels. Chlorpromazine fed to New Hampshire chicks at 5-10 mg./kg. of diet did not affect growth. Reserpine fed to S. C. White Leghorn chicks at 0.5 mg./kg. of diet produced a slight increase in growth rate by the

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[1]Sparine is the trade name of Wyett Laboratories for 10(γ-dimethylamino-n-propyl)-phenothiazine hydrochloride.

[2]Miltown is the trade name of Wallace Laboratories for 2-methyl-2-n-propyl-1, 3-propanediol dicarbarmate.

[3]Serpasil is the trade name of CIBA Pharmaceutical Products, Inc., Summitt, New Jersey, for reserpine.

25th day of age but levels of 5.0-500.0 mg./kg. of diet depressed growth.

Two estrogenic compounds, dienestrol diacetate and diethylstilbestrol, have been used in poultry production. Purported results from administering estrogens to chickens are faster growth, better feed efficiency, and improved carcass quality. At the present time it is not permissible to use diethylstilbestrol in the form of implanted pellets in poultry.

Estrogenic substances mixed in the feed in moderate dosages have had no effect, on the average, on rate of gain in growing birds. Individual instances showing slight depression have just about counterbalanced those where slightly greater gains were reported. The gross efficiency of feed conversion is usually somewhat reduced in estrogen-treated birds. Of the various estrogens, dienestrol has been most effective when given orally.

Broiler chicks fed dienestrol diacetate at the rate of 10.4 mg./lb. of feed gained weight more rapidly to four weeks of age than did chicks not receiving the estrogen in experiments reported by Stephens et al. (1961). Feed efficiency and dressing percentage were also improved by use of this compound.

The feeding of dienestrol diacetate to broilers by Matterson et al. (1959) from five to eleven weeks of age

gave a slight but positive increase in growth rate over the control birds.

Lorenz and Bachman (1947) reported slight stimulation of total growth in 8 to 12 week old cockerels fed dienestrol diacetate at the rate of 0.01 per cent of the ration. Quisenberry and Kruger (1948) also obtained an increased rate of gain, as well as greater feed consumption and increased net efficiency of feed conversion, by feeding dienestrol diacetate.

The debeaking of broiler chicks has become a common practice by many producers. There are two principle reasons for debeaking broilers: to control feather picking and to control cannibalism. These vices result in greater mortality and lowered carcass quality. Growth rate and feed efficiency may also be affected.

To be considered in the debeaking of chickens are the factors of age of the birds, the method of removing the beak, and the amount of the beak to be removed. Chickens can be debeaked at any age. The correct age depends upon such factors as the occurrence of cannibalism and feather picking in the flock, and the amount of labor involved. Cutting of the beak accompanied by cauterization is the generally employed method. There are many variations pertaining to the amount of upper and lower portions of the beak to be removed. Debeaking may range from the

removal of the tip of the beak to removal of a majority of either the maxilla or mandible or of both. These factors are all important when evaluating the practice of debeaking broilers.

In field tests involving 30,000 broilers Darrow and Stotts (1954) removed approximately one-third to one-half of the upper beak at 3 weeks of age. The results indicated that debeaking reduced feather picking and that there was an improvement in the percentage of A grade carcasses by 11.4 per cent. Feed conversion was improved by 0.1 lb. per pound of gain. Average weight or mortality was not affected. These workers also reported that debeaking at one day of age resulted in no adverse effect on growth or mortality.

Camp et al. (1955) reported that a block-type debeaking, whereby one-third to one-half of the upper and lower beak of broilers was removed at either one day or five weeks of age, resulted in better growth of the males. The use of a slanting type of debeaking in which approximately two-thirds of the upper beak and one-third of the lower beak was removed retarded growth rate.

Approximately 3,000 broiler type chicks were debeaked by various methods in a study reported by Huston et al. (1956). Debeaking resulted in a highly significant improvement in feather score of broilers fed pellets but did not

improve body weight or feed efficiency. These workers stated that it was found unnecessary to remove more than one-third of the beak to prevent it growing out to normal length by the time the chicks were 10 weeks of age. Tipping of the beak reduced feather picking almost as much as did other methods.

In a study on New Hampshire pullet chicks, Morgan (1957) found that the removal of one-third or one-half of the upper beak at one day of age had no detrimental effect upon growth rate to 8 weeks or 5 months. Mortality was slightly less in the debeaked groups as compared to non-debeaked birds.

Londale et al. (1957) presented data indicating that the removal of one-third maxilla and mandible of day old broiler chicks had no significant effect upon body weight or feed conversion. Removal of two-thirds maxilla and mandible retarded growth.

The removal of one-third of the upper and lower beak at one day of age resulted in no adverse effects from one to ten days of age in a study on broiler chicks by Keene et al. (1959).

In a study reported by Berry and Smyth (1959) using 2400 day old broiler type chicks to ten weeks of age with 1 sq. ft. of floor space debeaking at ten days of age was recommended over debeaking at one day of age. These workers

removed one-third of the maxilla at one day of age, one-third of the maxilla and tip of the mandible seared at one day of age, one-third each of the maxilla and mandible removed at one day of age, one-third of the maxilla removed and tip of the mandible seared at ten days of age and one-third of the maxilla removed at ten days of age. The non-debeaked birds had the greatest mortality and the birds debeaked at ten days of age had the least. Debeaked birds had a lower body weight at marketing but gave a better feed efficiency. Feed efficiency was better for the birds debeaked at ten days of age than those debeaked at one day of age.

Reports in the literature of experiments relative to the effects of periodic or intermittent feeding of chickens upon growth rate and feed efficiency are few in number. Burmester and Card (1939) found that when laying hens were restricted to less than six hours of eating time per day body weight and egg production declined. Lepkovsky and Furuta (1960) reported slower gains in S. C. White Leghorn cockerels when they were allowed to eat for only a two hour period each day as compared with ad libitum feeding.

Lepkovsky et al. (1960) found that chickens could be "trained" to increase their feed intake when feeding time was restricted. Chickens trained for several weeks to eat their daily ration in a period of two hours daily consumed

considerably more feed than did chickens trained for one or two days. The "trained" chickens were found to have developed larger crops.

Examples of "conditioned reflexes" are well known in animals. The classical example were the experiments performed with dogs as reported by the Russian physiologist Pavlov (1927). Instances where chickens have been trained to react to a certain set of stimuli are known. Examples of how chickens react to certain sounds are common knowledge to most poultrymen, such as the response of chicks to the clucking of a mother hen or to the clattering of automatic-feed troughs.

The question of whether or not chickens might be induced to consume additional feed by conditioning them to a stimulus such as sound has not been reported.

While feeder space for broiler chicks has received considerable attention in experimentation information pertaining to the effects of feed trough size on broiler performance is meager.

The practice of using large size feed troughs from one day of age has apparently become a common practice among broiler growers. This practice eliminates the expense of purchasing the smaller troughs and the labor of exchanging them for larger ones as the birds grow larger. No experimental information was found, however, on the effects of trough size on broiler performance.

# METHODS AND MATERIALS

## Trial I

The purpose of this study was to obtain more information on the effect of age of chicks when first placed under the brooders, more efficient use of floor space and the feeding of a tranquilizer on growth rate, mortality and feed conversion up to 5 weeks and 9 weeks of age as well as 9 weeks in the brooder house.

Three thousand and eighty-three broiler-type chicks were sexed, debeaked, wingbanded, vaccinated intra-ocularly with Newcastle and bronchitis vaccine. They were assigned at random to treatments as shown in Table I.

Each of these treatments were conducted in duplicate. Brooding pens were approximated 10 ft. by 12 ft. in size. Shavings were used as litter.

The chicks were kept in standard size chick boxes and received no feed or water prior to being placed under the brooders. All chicks were two days of age when transferred from the boxes to the brooders with the exception of groups 2 and 3. These groups were four and six days of age, respectively.

Serpasil was fed in the feed to chicks of groups 8, 9, and 10 at the rate of 1 lb./ton of feed. This level provided 1 p.p.m. of reserpine in the feed.

The chicks in group 6 received 1/2 sq. ft. floor space each until they reached five weeks of age. They were then divided so as to provide 1 sq. ft. floor space

TABLE I

THE TREATMENTS, CHICKS PER GROUP AND GROUP NUMBER.
EXPERIMENT I

| Group No. | Chicks per group | Treatments[1] |
|---|---|---|
| 1 | 120 | Housed at 2 days of age |
| 2 | 120 | Housed at 4 days of age |
| 3 | 114 | Housed at 6 days of age |
| 4 | 240 | 1/2 sq. ft. floor space per chick to 9 wks |
| 5 | 160 | 3/4 sq. ft. floor space per chick to 9 wks |
| 6 | 240 | 1/2 sq. ft. floor space per chick to 5 wks<br>1 sq. ft. floor space per chick 5 to 9 wks |
| 7 | 160 | 3/4 sq. ft. floor space per chick to 5 wks<br>1 sq. ft. floor space per chick 5 to 9 wks |
| 8 | 240 | 1/2 sq. ft. floor space per chick to 9 wks plus tranquilizer[2] |
| 9 | 160 | 3/4 sq. ft. floor space per chick to 9 wks plus tranquilizer[2] |
| 10 | 120 | 1 sq. ft. floor space per chick to 9 wks plus tranquilizer[2] |

[1]All treatments were conducted in duplicate.

[2]Serpasil (Reserpine - CIBA) 1 lb./ton of feed.

per bird from five weeks to nine weeks of age. The chicks in group 7 received 3/4 sq. ft. floor space per chick until five weeks and at five weeks were divided so as to provide 1 sq. ft. floor space from five weeks to nine weeks of age.

The trough feeding space per bird was maintained approximately the same for all groups throughout the experiment.

Body weights were obtained at weekly intervals by bulk weighing of a sample of 50 males and 50 females from each pen until the sixth week. Groups of 25 males and 25 females were weighed weekly thereafter. At nine weeks after housing, individual body weights were obtained. Individual body weights were also taken of birds in group 2, which were four days of age when housed, at the end of their nine-week period in the brooder house and at which time they were nine weeks and four days of age. Body weights were taken of birds in group 3 after nine weeks in the brooder house and when they were nine weeks and six days of age.

Trial II

This study was for the purpose of obtaining additional information regarding the effects of holding chicks in chick boxes prior to housing. A total of 550 broiler-type chicks, hatched March 18, 1961, were involved.

Groups of 50-100 chicks were removed from the boxes at 2, 3, 4, 5, and 6 days of age and placed in chick starting batteries as given in Table II. Feed and water were available to the chicks ad libitum. The temperature under the brooding units was maintained at 95° F. for the first week and was reduced 5° F. per week until room temperature was reached.

At five weeks of age, the chicks were transferred to growing batteries. Weights of individual birds were recorded at five weeks of age and again when the birds were nine weeks old. Feed consumption and mortality records were kept for each group of birds.

Trial III

In addition to continuing the study made in Winter on the effect of floor space and feeding of a tranquilizer, this study aimed at finding out the effects of debeaking at one day of age, feeding of an estrogen (Lipamone) at the rate of 1/3 lb./ton of feed and intermittent feeding with and without bell at feeding time.

A total of 2,000 broiler-type chicks, hatched June 30, 1961, were involved in a series of nine treatments.

At one day of age, the chicks were sexed, vaccinated for Newcastle disease and bronchitis by the intra-ocular method and with pigeon pox in the wing-web. They were then assigned at random to the treatments shown in Table II with a ratio of 48 females to each 52 males.

TABLE II

THE TREATMENTS, NUMBER OF CHICKS USED IN EACH TREATMENT AND GROUP NUMBER. EXPERIMENT III

| Group No. | No. Chicks | Treatments[1] |
|---|---|---|
| 1 | 100 | Debeaked at 1 day of age |
| 2 | 100 | Debeaked at 1 day of age plus tranquilizer[2] in feed |
| 3 | 200 | .75 sq. ft. floor space per chick |
| 4 | 100 | Tranquilizer[2] in feed |
| 5 | 100 | Lipamone[3] in feed |
| 6 | 100 | Large size feed troughs[4] from 1 day to 9 weeks |
| 7 | 100 | Intermittent feeding |
| 8 | 100 | Intermittent feeding accompanied by electric buzzer |
| 9 | 100 | Control |

[1]Each treatment was conducted in duplicate.

[2]Serpasil (reserpine - CIBA) fed at the rate of 1 lb./ton of feed.

[3]Lipamone (dienestrol diacetate) fed at the rate of 1/3 lb. per ton of feed.

[4]Two 5-foot broiler finisher size feed troughs were used.

Each treatment was conducted in duplicate.

The chicks were housed in pens 10 by 15 feet with wood shavings used for litter. A 1000 watt infra-red unit served as a heat source in each pen.

Except where stated, the following conditions applied: All chicks had 1.5 sq. ft. floor space each; each pen had two 3 ft. chick size feeders for the first two weeks at which time they were exchanged for 4 ft. feeders and these for 5 ft. feeders when the chicks were four weeks of age; water and feed were available ad libitum. The tip of the beak was removed from each chick at one day of age by cutting and cauterizing with heat.

In group 1 approximately 2/3 of the upper beak and 1/2 of the lower beak was removed at one day of age.

The tranquilizer Serpasil was fed in the feed to groups 2 and 4 at the rate of 1 lb./ton of feed.

Group 5 received Lipamone* in the feed at the rate of 1/3 lb./ton of feed.

The feed troughs used by groups 7 and 8 were the 5 ft. size. They were equipped with lids which automatically opened and closed at intervals regulated by time clocks. The troughs were timed to open every two hours and to remain open for a period of 15 minutes. The troughs in

the two pens comprising group 7 opened on the odd-numbered hours while those of group 8 opened on the even hours. Two electric bells, one adjacent to each pen, were wired to ring continuously while the lids of the feed troughs of group 8 were open. The bells were also adjacent to pens of group 7 but the timing was such that the bells rang only when the feed troughs of group 7 were closed.

Feed records were kept for each pen. Individual body weights were obtained when the broilers were four weeks of age.

An all mash broiler diet considered nutritionally adequate for optimal broiler growth was used in the three experiments.

In those instances where data were analyzed, the analysis of variance method according to Snedecor (1956) and Duncan's Multiple Range Test (1955) were employed.

# RESULTS AND DISCUSSION

## Age of chicks when housed

The effects of holding chicks in the chick boxes up to six days post-incubation are shown in Tables III and IV.

It was found that chicks retained in chick boxes without feed and water for as long as four days after hatching suffered mortality of 4 per cent. Mortality rate increased rapidly, however, on the fifth and sixth day being 28 and 91 per cent, respectively. In the two experiments, upwards of 50 per cent of the chicks had died prior to the end of the sixth day in the boxes. It was observed that dehydration and emaciation of the chicks were noticable after about three days and was quite marked by the fifth and the sixth day. It was also found that the percentage of mortality occurring in the chick boxes was closely correlated to the percentage of mortality occurring after the chicks were placed in the brooder pens. Over 90 per cent of the chicks which survived their stay of six days in the chick boxes succumbed after being transferred to the brooder houses.

Growth rate was also found to be correlated with the number of days the chicks were held in the boxes. In Experiment I (Table III) it can be seen that the chicks held four and six days in the boxes grew at a less rapid

TABLE III

EFFECT OF AGE OF CHICKS WHEN HOUSED UPON GROWTH RATE AND FEED CONVERSION
EXPERIMENT I

| Age of chicks (weeks) | | Age of Chicks When Housed | | |
|---|---|---|---|---|
| | | 2 days | 4 days | 6 days |
| | | Av. wt.[1] (oz.) | Av. wt.[1] (oz.) | Av. wt.[1] (oz.) |
| 1 | | 2.7 | 2.0 | 1.4 |
| 2 | | 5.1 | 3.8 | 2.5 |
| 3 | | 8.4 | 6.5 | 4.7 |
| 4 | | 13.4 | 10.5 | 7.7 |
| 5 | | 19.6 | 16.3 | 11.8 |
| 6 | | 26.2 | 25.0 | 18.2 |
| 7 | | 35.2 | 31.4 | 27.4 |
| 8 | | 41.4 | 39.6 | 33.9 |
| 9 | M[2] | 52.9 (58) | 52.7 (45) | 45.9 (24) |
| | F[3] | 43.1 (57) | 43.0 (52) | 37.2 (29) |
| | M + F[4] | 48.0 (115)* | 47.5 (97)* | 41.1 (53)* |
| 9 wks. in brooder house | | 48.0 (115) | 49.4 (97) | 44.6 (53) |
| 9 | F.E.[5] | 2.40 | 2.36 | 1.75 |

[1]Weights through 8 weeks of age are for equal numbers of males and females.
[2]Males - number in parentheses.
[3]Females - number in parentheses.
[4]Averages not underscored by same line are significantly different. P = .05.
[5]Feed efficiency - lbs. feed/lb. gain.
*Total number individuals.

TABLE IV

EFFECT OF AGE OF CHICKS WHEN HOUSED UPON GROWTH RATE, MORTALITY, AND FEED CONVERSION. EXPERIMENT II.

| | Days of Age at Housing | | | | |
|---|---|---|---|---|---|
| | 2 | 3 | 4 | 5 | 6 |
| In chick boxes | | | | | |
| No. chicks | 550 | 450 | 400 | 350 | 240 |
| % Mortality | 0.0 | 0.0 | 0.0 | 2.8 | 41.6 |
| In batteries | | | | | |
| No. chicks | 100 | 50 | 50 | 50 | 100 |
| % Mortality - 3 wks. | 4.0 | 2.0 | 2.0 | 24.0 | 91.0 |
| 6 wks. | 5.0 | 6.0 | 4.0 | 28.0 | 91.0 |
| 9 wks. | 5.0 | 6.0 | 4.0 | 28.0 | 91.0 |
| Av. wt.[1] (oz.) at 9 wks. | 39.5 | 38.0 | 36.5 | 35.5 | 33.0 |
| At 9 wks. in the battery | 39.5 | 39.5 | 38.3 | 39.0 | |
| Lbs. feed/lbs. gain | 1.95 | 2.40 | 2.55 | 3.10 | 3.95 |

[1]Averages not underscored by same line are significantly different. P = .05.

rate for the first few weeks after housing than did the two day group. By the time the chicks were nine weeks of age, the group which was fasted for 4 days gave a mean body weight which was not significantly different from the two day fasted group. The mean weights of the two and four day groups were significantly heavier than the six day group at nine weeks of age. After nine weeks in the brooder house, the four day group had an average body weight greater than the two day group. Thus the chicks held four days in the boxes actually grew at a faster rate than did those held for two days prior to housing. After nine weeks in the brooder house, the six day group still weighed considerably less than the other two groups. In Experiment II (Table IV) at nine weeks of age, the two day group had the highest body weight, the four day group was second best, and thesix day group was poorest.

The feed efficiency for the groups in the two experiments are contradictory. In Experiment I (Table III) the feed conversions for the two, four, and six day groups were 2.40, 2.36, and 1.75, respectively. In Experiment II (Table IV) the order of efficiency for the groups was reversed. No explanation for this reversal is offered.

Floor Space

The effect of floor space per chick is shown in Tables V, VI, VII, VIII and IX. In the case of the groups

with and without reserpine the best growth was obtained at .75 sq. ft. floor space per chick. There was no significant difference in the weights of the broilers receiving .5 and 1.0 sq. ft. each in the two comparisons (Tables V and VI).

Increasing the floor space at five weeks of age from .5 to 1.0 sq. ft. per bird resulted in a significant increase in weight at nine weeks when compared to the lot retained on .5 sq. ft. per chick (Table VII).

Increasing the space allotment per chick from .75 to 1.0 sq. ft. at five weeks did result in an increase in weight as compared to the control groups but this difference was not statistically significant (Table VIII).

Under the conditions of this experiment, it was found that the average weight per bird (Table V) at 0.5 sq. ft. and 1.0 sq. ft. floor space levels were not statistically different. The average weights between birds given 0.75 and 1.0 sq. ft. floor space levels were also not statistically different. But the difference in the average weights between birds at 0.5 and 0.75 sq. ft. floor space levels was statistically significant at the five per cent level of probability. These results, however, show that though the average weight of birds at 9 weeks of age at the 0.5 sq. ft. floor space level is low, the total quantity of meat produced in a given space is significantly greater at the 0.5 sq. ft. floor space level.

TABLE V

EFFECT OF DIFFERENT FLOOR SPACE LEVELS ON GROWTH RATE AND FEED EFFICIENCY OF BROILERS. EXPERIMENT I.

| Weeks in brooder house | Sq. ft. floor space per chick | | | | | |
|---|---|---|---|---|---|---|
| | 0.5 | | 1.0 | | 0.75 | |
| | Av. wt.[1] (oz.) | | Av. wt.[1] (oz.) | | Av. wt.[1] (oz) | |
| 1 | 2.7 | | 2.7 | | 2.7 | |
| 2 | 5.0 | | 5.1 | | 5.0 | |
| 3 | 8.2 | | 8.4 | | 8.3 | |
| 4 | 13.0 | | 13.3 | | 12.8 | |
| 5 | 18.6 | | 19.6 | | 18.9 | |
| 6 | 27.8 | | 26.2 | | 26.7 | |
| 7 | 33.2 | | 35.2 | | 34.0 | |
| 8 | 42.3 | | 41.4 | | 42.4 | |
| 9 M[2] | 51.7 | (228) | 52.5 | (115) | 53.8 | (152) |
| F[3] | 43.4 | (229) | 44.3 | (118) | 44.6 | (158) |
| M&F[4] | 47.5 | (457)* | 48.3 | (233)* | 49.1 | (310)* |
| Lbs. feed / Lbs. gain | 2.21 | | 2.40 | | 2.29 | |

[1]Weights through 8 weeks are for equal no. of males and females.

[2]Males - number in parentheses.

[3]Females - number in parentheses.

[4]Averages not underscored by same line are significantly different. P = .05.

*Total number individuals.

TABLE VI

EFFECT OF FLOOR SPACE WITH TRANQUILIZER[1] UPON GROWTH RATE AND FEED CONVERSION. EXPERIMENT I.

| Weeks in brooder house | | Treatments: .5 sq. ft. floor space | 1.0 sq. ft. floor space | 0.75 sq. ft. floor space |
|---|---|---|---|---|
| | | Av. wt.[2] (oz) | Av. wt.[2] (oz) | Av. wt.[2] (oz) |
| 1 | | 2.8 | 2.9 | 2.9 |
| 2 | | 5.5 | 5.7 | 5.5 |
| 3 | | 9.2 | 9.4 | 9.2 |
| 4 | | 13.6 | 14.9 | 14.5 |
| 5 | | 20.8 | 21.2 | 19.7 |
| 6 | | 25.7 | 26.9 | 27.2 |
| 7 | | 35.5 | 37.0 | 36.7 |
| 8 | | 44.2 | 46.1 | 44.5 |
| 9 | M[3] | 54.3 (233) | 55.5 (117) | 56.1 (150) |
| | F[4] | 44.3 (237) | 45.9 (117) | 47.7 (149) |
| | | 50.4 (460)* | 50.7 (234)* | 51.9 (299)* |
| F.E.[6] | | 2.09 | 2.35 | 2.35 |

[1]All treatments included Serpasil (reserpine - CIBA) fed at rate of 1 lb./ton of feed.

[2]Wts. through 8th weeks are for equal no. of males and females.

[3]Males - number in parenthesis.

[4]Females - number in parenthesis.

[5]Averages not underscored by same line are significantly different. P = .05.

[6]Feed efficiency - lbs. feed/lbs. gain.

*Total number individuals.

TABLE VII

EFFECT OF FLOOR SPACE UPON THE GROWTH RATE AND FEED CONVERSION OF BROILERS. EXPERIMENT I.

| Weeks in Brooder House | | Floor Space per Chick | |
|---|---|---|---|
| | | 0.5 sq. ft. 1 day to 9 wks. | 0.5 sq. ft. to 5 wks. 1.0 sq. ft. to 9 wks. |
| | | Av. wt.[1] (oz.) | Av. wt.[1] (oz.) |
| 1 | | 2.7 | 2.7 |
| 2 | | 5.0 | 5.0 |
| 3 | | 8.2 | 7.8 |
| 4 | | 13.0 | 13.0 |
| 5 | | 18.6 | 17.1 |
| 6 | | 27.8 | 25.0 |
| 7 | | 33.2 | 34.8 |
| 8 | | 42.3 | 43.1 |
| 9 | M[2] | 51.7 (228) | 54.5 (113) |
| | F[3] | 43.4 (229) | 44.6 (106) |
| | M + F[4] | 47.5 (457)* | 49.7 (219)* |
| | F.E.[5] | 2.21 | 2.24 |

[1]Weights through 8 weeks of age are for sexes combined.

[2]Males - numbers are in parentheses.

[3]Females - numbers are in parentheses.

[4]Averages not underscored by same line are significantly different. P = .05.

[5]Feed efficiency - lbs. feed/lbs. gain.

*Total number individuals.

TABLE VIII

EFFECT OF FLOOR SPACE UPON THE GROWTH RATE AND FEED CONVERSION OF BROILERS. EXPERIMENT I.

| Weeks in brooder house | Floor Space per Chick | |
|---|---|---|
| | .75 sq. ft. 1 day to 9 weeks | .75 sq. ft. to 5 weeks 1.0 sq. ft. to 9 weeks |
| | Av. wt.[1] (oz.) | Av. wt.[1] (oz.) |
| 1 | 2.7 | 2.7 |
| 2 | 5.0 | 5.2 |
| 3 | 8.3 | 8.4 |
| 4 | 12.8 | 13.6 |
| 5 | 18.9 | 19.0 |
| 6 | 26.7 | 26.5 |
| 7 | 34.4 | 36.9 |
| 8 | 42.4 | 42.9 |
| 9 M[2] | 53.8 (152) | 54.3 (115) |
| F[3] | 44.6 (158) | 45.5 (105) |
| M + F[4] | 49.1 (310)* | 50.1 (220)* |
| F.E.[5] | 2.29 | 2.44 |

[1]Weights through 8 weeks are for males and females combined.

[2]Females - number in parentheses.

[3]Males - numbers in parentheses.

[4]Averages underscored by same line are not significantly different. P = .05.

[5]Feed efficiency - lbs. feed/lbs. gain.

*Total number individuals.

These data when converted to ounces of meat produced per square foot of floor space showed that 90.4 ounces, 63.4 ounces and 46.9 ounces of meat were produced per square foot of floor space when chicks were given 0.5, 0.75 and 1.0 sq. ft. of floor space each, respectively.

In Experiment III the chicks receiving 1.5 sq. ft. floor space each were significantly heavier at four weeks than those receiving .75 sq. ft. (Table IX).

Litter conditions were not considered good in pens receiving less than 1.0 sq. ft. per bird. Frequent stirring of the litter in these pens was required. The plumage of these birds was noticeably soiled.

Tranquilizer

The feeding of a tranquilizer, reserpine, in Experiment I resulted in significantly heavier broilers at nine weeks regardless of floor space allotments (Table X). In Experiment III reserpine resulted in no significant difference at four weeks of age (Table XI). When fed to debeaked birds in this experiment slight but not significant reduction in weight was noted (Table XII).

Experiment III differed from Experiment I, from the standpoint of the effects of tranquilizer in two respects. Experiment I was conducted during the Winter and floor space

TABLE IX

EFFECT OF FLOOR SPACE UPON GROWTH RATE AND FEED CONVERSION OF BROILERS TO FOUR WEEKS OF AGE. EXPERIMENT III.

| | Treatments | |
|---|---|---|
| | 1.5 sq. ft. floor space per chick | .75 sq. ft. floor space per chick |
| Males | | |
| No. | 108 | 102 |
| Av. wt. (oz.) | 17.9 | 17.1 |
| Females | | |
| No. | 89 | 99 |
| Av. wt. (oz.) | 15.9 | 15.2 |
| Males & Females | | |
| No. | 197 | 201 |
| Av. wt.[1] (oz.) | 17.0 | 16.1 |
| Lbs. feed/lb. gain | 1.76 | 1.64 |

[1]Averages not underscored by same line are significantly different. P = .01.

TABLE X

EFFECT OF FEEDING A TRANQUILIZER* ON THE WEIGHT OF CHICKS AT 9 WEEKS OF AGE AND AT THREE DIFFERENT FLOOR SPACE LEVELS. EXPERIMENT I.

| | Sq. ft. floor space per chick | | |
|---|---|---|---|
| | 0.5 | 0.75 | 1.0 |
| | Av. wt.(oz.)[1] | Av.wt. (oz.)[1] | Av.wt.(oz)[1] |
| With tranq. | 50.4 | 51.9 | 50.7 |
| Without tranq. | 47.5 | 49.1 | 48.3 |

*Serpasil (reserpine-CIBA) - 1 lb./ton of feed.

[1]Weights through 9 weeks are for males and females combined.

TABLE XI

EFFECT OF FEEDING RESERPINE UPON BODY WEIGHTS AND FEED CONVERSION OF BROILERS FROM ONE DAY TO FOUR WEEKS OF AGE. EXPERIMENT III.

| | Treatments | |
|---|---|---|
| | no reserpine | reserpine[1] |
| Males | | |
| No. | 108 | 100 |
| Av. wt. (oz.) | 17.9 | 17.3 |
| Females | | |
| No. | 89 | 93 |
| Av. wt. (oz.) | 15.9 | 15.5 |
| Males & Females | | |
| No. | 197 | 193 |
| Av. wt.[2] (oz.) | 17.0 | 16.4 |
| Lbs. feed / Lbs. gain | 1.76 | 1.97 |

[1]Serpasil (reserpine-CIBA) fed at the rate of one lb./ton of feed.

[2]Averages not underscored by same line are significantly different. P = .05.

TABLE XII

EFFECT OF METHOD OF DEBEAKING AND THE FEEDING OF RESERPINE UPON THE GROWTH AND FEED CONVERSION OF BROILER CHICKS FROM ONE DAY TO FOUR WEEKS OF AGE. EXPERIMENT III.

| | Treatments | | |
|---|---|---|---|
| | 2/3 upper and 1/2 lower beak removed plus reserpine[1] | 2/3 upper and 1/2 lower beak removed | tip of beak removed |
| Males | | | |
| No. | 103 | 99 | 108 |
| Av. wt. (oz.) | 17.5 | 17.8 | 17.9 |
| Females | | | |
| No. | 96 | 93 | 89 |
| Av. wt. (oz.) | 14.8 | 15.3 | 15.9 |
| Males & Females | | | |
| No. | 199 | 192 | 197 |
| Av. wt.[2] (oz.) | 16.2 | 16.6 | 17.0 |
| Lbs. feed/lbs. gain | 1.75 | 1.84 | 1.76 |

[1]Serpasil (reserpine-CIBA) fed at rate of 1 lb./ton of feed.

[2]Averages not underscored by same line are significantly different. P = .05.

allotments were up to 1.0 sq. ft. per chick. Experiment III was conducted in the Summer with 1.5 sq. ft. floor space per chick.

The feeding of Lipamone

Groups of broiler chicks fed Lipamone averaged 16.7 oz. at four weeks of age. Chicks receiving no Lipamone averaged 17.0 oz. Differences between these groupe were not statistically significant at the five per cent level of probability (Table XIII).

One of the objectives for using estrogenic substance in broiler production is to obtain a better carcass finish. The broilers in this study were not evaluated for finish.

Debeaking

The broiler chicks that had 2/3 of the upper beak and 1/2 of the lower beak removed at one day of age averaged 16.6 oz. at four weeks of age. The control groups, with only the tip of the beak removed, averaged 17.0. This difference was not statistically significant (Table XII).

The seriousness of cannibalism in chickens and the effectiveness of debeaking to control this vice is generally unquestioned. No cannabalism was observed in either the debeaked or control groups of this experiment; however, if cannabalism had developed, it is the opinion of the author that the debeaked birds would have suffered less from this

TABLE XIII

EFFECT OF FEEDING LIPAMONE TO BROILERS TO FOUR WEEKS OF AGE UPON GROWTH AND FEED CONVERSION. EXPERIMENT III.

| | Treatments | |
|---|---|---|
| | No Lipamone | Lipamone[1] |
| Males | | |
| No. | 108 | 103 |
| Av. wt. (oz.) | 17.9 | 17.5 |
| Females | | |
| No. | 89 | 92 |
| Av. wt. (oz.) | 15.9 | 15.8 |
| Males & Females | | |
| No. | 197 | 195 |
| Av. wt.[2] (oz.) | 17.0 | 16.7 |
| Lbs. feed/lbs. gain | 1.76 | 1.87 |

[1] 1/3 lb. per ton of feed.

[2] Averages not underscored by same line are significantly different. P = .05.

vice. The method of debeaking used in this experiment resulted in a permanently debeaked chick. As the operation of debeaking can be more easily performed when the chicks are one day of age it would appear the degree of debeaking employed at this age should be recommended either for broilers or layers.

Intermittent feeding

Pens of chicks fed at intervals of two hours for 15 minutes per period were significantly lighter in weight at four weeks of age than were the continuously fed controls. There was no difference in average weight between the groups with and without the electric bells (Table XIV).

It was observed that there was some degree of response by the chicks to the ringing of the bells. When the troughs would open and the bells sounded many of the chicks would rush to eat. This was not true in the pens where the bells did not ring when the troughs were open.

Intermittent feeding of chickens poses a number of problems, each of which might alter the performance of the birds. These are: the mechanics of operating the troughs, the frequency of feeding and the length of time allowed each feeding period. These problems need elucidation.

TABLE XIV

EFFECT OF INTERMITTENT FEEDING OF BROILERS UPON GROWTH RATE AND FEED CONVERSION AT FOUR WEEKS OF AGE. EXPERIMENT III.

| | Treatments | | | |
|---|---|---|---|---|
| | Continuous feeding. Small trough to 3 wks. | Continuous feeding. Large troughs | Intermittent feeding. Large troughs | Intermittent feeding. Large troughs plus bell |
| Males | | | | |
| No. | 108 | 100 | 105 | 96 |
| Av. wt. (oz.) | 17.9 | 17.3 | 16.5 | 16.3 |
| Females | | | | |
| No. | 89 | 94 | 91 | 83 |
| Av. wt. (oz.) | 15.9 | 15.3 | 15.0 | 14.7 |
| Males & Females | | | | |
| No. | 197 | 194 | 196 | 179 |
| Av. wt.[1] (oz.) | 17.0 | 16.3 | 15.8 | 15.5 |
| Lbs. feed / Lbs. gain | 1.76 | 1.79 | 1.90 | 1.97 |

[1]Weights not underscored by same line are significantly different. P = .05.

Feed trough size

At four weeks of age, the average body weight of the chicks having the large size feed trough from one day of age was 16.3 oz. as compared to 17.0 oz. for the broilers having chick size troughs to three weeks of age. The differences (Table XV) are statistically significant at the five per cent level of probability. The feed efficiency for the two groups was quite similar, being 1.79 for the large troughs and 1.76 for the small trough.

These results would indicate that the practice used by some broiler growers of starting chicks with large size feed troughs may not be conducive to best broiler performances. Contamination of the feed by chicks is a potential health hazard. It would seem that additional experiments are needed to obtain more conclusive evidence on these points.

TABLE XV

EFFECT OF FEED TROUGH SIZE UPON GROWTH RATE AND FEED CONVERSION OF BROILERS TO FOUR WEEKS OF AGE. EXPERIMENT III.

| | Treatments | |
|---|---|---|
| | Chick size troughs[1] (3 ft. size) | broiler size troughs (5 ft. size) |
| Males | | |
| No. | 108 | 100 |
| Av. wt. (oz.) | 17.9 | 17.3 |
| Females | | |
| No. | 89 | 94 |
| Av. wt. (oz.) | 15.9 | 15.3 |
| Males & females | | |
| No. | 197 | 194 |
| Av. wt.[2] (oz.) | 17.0 | 16.3 |
| Lbs. feed/lbs. gain | 1.76 | 1.79 |

[1]Changed to intermediate size troughs at 3 wks.

[2]Averages not underscored by same line are significantly different. P = .05.

# SUMMARY

A total of 5,633 broiler-type chicks was used in a series of three experiments designed to study the effects of several management factors and non-nutritive feed additives upon performance. The results of these studies are summarized as follows:

The mortality of chicks retained in chick boxes, without feed or water, for four days was slight but increased rapidly on the fifth and sixth day. The per cent mortality in the boxes was positively correlated with growth rate and mortality of the chicks after being placed in the brooder house.

In a Winter experiment, the most rapid growth of broilers was obtained at a floor space allotment of .75 sq. ft. while .5 and 1.0 sq. ft. per bird resulted in broilers of weights statistically not different. 1.5 sq. ft. floor space per bird gave larger average weights per chick than did .75 sq. ft. at four weeks of age in an experiment conducted during the Summer season. Increasing the floor space from .5 to 1.0 sq. ft. per bird at 5 weeks of age resulted in heavier broilers at 9 weeks. Increasing .75 sq. ft. to 1.0 sq. ft. per bird at 5 weeks did not improve growth rate to 9 weeks.

The data obtained in Experiment I on growth of chicks to 9 weeks at 0.5, 0.75 and 1.0 sq. ft. floor space levels when converted to ounces of meat per square foot of floor space showed that 90.4 oz., 63.4 oz., and 46.9 oz. of meat were produced per square foot of floor space, respectively.

The feeding of Serpasil at the rate of 1 lb./ton feed improved the growth rate of broilers to nine weeks of age during the Winter months regardless of the floor space allowed per chick. In a Summer trial where 1.5 sq. ft. was alloted each chick, the tranquilizer slightly reduced the mean growth rate to four weeks of age.

The feeding of Lipamone at the rate of 1/3 lb./ton of feed did not effect the growth rate of broilers to four weeks of age.

Removing 2/3 of the upper and 1/2 of the lower beak of day-old chicks did not significantly affect the growth rate to four weeks of age. The debeaking was considered to have resulted in a permanent amputation of the beak.

The feeding of chicks at two hour intervals for 15 minute periods reduced the growth rate to four weeks of age. An electric bell sounding while the feed troughs were open attracted chicks to the feed but did not alter the chicks' growth rate.

The use of broiler finisher size feed troughs for chicks from one day to three weeks of age resulted in a significant reduction in growth rate as compared to pens having chick size troughs.

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